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# FOREWORD

I am pleased to put into the hands of readers Volume-8; Issue-7: 2021 (July, 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

August, 2021

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## Geostatistics Applied to the Study of Deforestation and Malaria in Rural Areas of Western Amazon

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**Keywords**— *Geostatistics, semivariogram  
and kriging, deforestation, malaria, Western  
Amazon.*

**Abstract**— *Objective: To analyze the behavior of the spatial dispersion of deforestation and the number of malaria cases, in addition to providing integration of deforestation risk with epidemiological risk of malaria in Gleba União Bandeirantes, current União Bandeirantes District, in Porto Velho, Rondônia, Western Amazon, for a period of 3 years. Method: Two fundamental tools of statistical indicators were used: the semivariogram and the kriging. The semivariogram method is the mathematical modeling that allows studying the natural dispersion of the variable, and the Kriging method, used to analyze the spatial variability of the existing indicators in the area. Results: The indicative method of kriging showed that the occurrence of malaria cases is related to the growth of deforestation. With the advance of deforestation towards the north of the studied area, cases of malaria increased in the same direction. There was an increase in malaria cases east of the population concentration, converging with the area of advance of deforestation. Conclusion: The methods used are efficient to correlate and monitor deforestation and the social production of malaria. Public managers must develop means to implement a deforestation control strategy integrated with the malaria endemic in the União Bandeirantes District area.*

## I. INTRODUCTION

Currently, there is much talk about human activities that cause pollution and environmental degradation in urban and rural areas, especially when these activities become a threat to health. In the Amazon, felling and burning is common, causing an increase in the incidence of diseases, especially malaria, putting the development of the region at risk. In view of the occurrence of deforestation and the proliferation of malaria, we sought to study the risk factors and perspectives for controlling malaria and deforestation in the current District of União Bandeirantes, belonging to the Municipality of Porto Velho, Rondônia, Brazil.

To obtain an understanding of the risk factors or protection against malaria, the implementation of alternative public health and environmental policies constitutes a powerful tool. Therefore, studies in different populations and geographic regions contribute to knowledge about malaria that do not necessarily apply to populations located in other areas of the world, subjected to plasmodium species with different genetic characteristics and different transmission conditions.

Studies show that infectious diseases are prominent in human history as they constitute major public health problems. Malaria, cholera, typhoid fever, leprosy, plague, among others, had a large incidence throughout the world throughout the last century. The improvement in the quality of life in the countries of the northern hemisphere, as well as the effects of the Industrial Revolution and, in particular, the phenomena of urbanization and technological acceleration, restricted these diseases to the "poor areas" of the world, including the tropical zones.

In Brazil, an epidemiological picture is currently characterized by the coexistence of endemic diseases and the return of old infectious diseases [1]. Malaria, leishmaniasis, leprosy, tuberculosis, among others, also represented major health problems, particularly in the Amazon Region.

For Tauil [2], factors that favor the transmission of malaria and hinder the application of traditional control measures were associated in the Amazon Basin Region. Among the first are: a) biological factors, such as the presence of high densities of vector mosquitoes, a migrant population without naturally acquired immunity against the disease and the prevalence of Plasmodium strains resistant to antimalarial drugs for safe use in the field; b) geographical ones, such as the prevailing low altitude, high temperatures, high relative humidity, high rainfall and forest-type vegetation cover, favorable to the proliferation of vectors; c) ecological, such as deforestation, keeping animals that mosquitoes feed on as an alternative to feeding human beings; such as the construction of

hydroelectric plants and irrigation systems, increasing the number of mosquito breeding sites and d) social ones, such as the presence of numerous population groups living in houses with complete or partial absence of side walls and working near or inside forests, providing a very intense contact with the vector mosquito. And this association happens environmental changes as well as malaria transmission mainly in settlement populations, due to changes and alterations in the environment termed as the term border malaria. Alguns estudos corroboram com esse quadro, entre eles os estudos de Barata [3]; Bitencourt et al [4]; Marques e Cárdenas [5]; Alves [6]; Barbieri [7]; Carvalho [8].

And in the current District of União Bandeirantes, since its beginning in 1999, malaria has been a health problem for the local population, due to the large area of forest degraded by deforestation, causing environmental damage and the social production of endemic diseases.

In the late 1990s, Gleba Jorge Teixeira (later called União Bandeirantes) was predominantly a forest area, while it was configured with vacant land corresponding to the São Francisco, Janaiáco and Bom Futuro rubber plantations and adjacent areas, the rubber plantations represented by the intended land by Sebastião Conti Neto and others. Thus, one area resulted in the collection of Gleba Jorge Teixeira and part was regularized in favor of one of the applicants, in a fraction equivalent to about a third of his then claim, which was 99,000.00 ha. While most of those lands represented a pretense of private interest, it remained virtually free of invasion for many years. A Gleba is an unregulated area. When there is no type of land legalization, whether for subdivision, unification or construction.

However, after the incorporation of the União Bandeirantes area into public property, especially in the last 04 (four) years, the location was being modified with extreme speed and, unfortunately, being marked by predatory forms of human intervention, usually resulting from invasion by groups opportunistic social groups that use institutional passivity in order to promote disorderly occupation, combined with illegal logging.

Thus, real estate speculation is practiced in the region and, through this activity, unscrupulous people take the opportunity to "sell landmarks" (fractions of public land), in open use in bad faith, deceiving people who, out of ignorance, end up investing in the scarce economy in "invaded plots of land", running the risk of losing the amounts invested. Furthermore, these people will be subject to penalties, both from agrarian legislation and from the environmental crimes Law.

With the absence of planning, on preventive and conservationist bases, the illegal occupations that proliferate within the Jorge Teixeira de Oliveira Gleba (current União Bandeirantes District) are depredating the forest, causing a vertiginous decline of forest species and, consequently, reducing, drastically, the volumetric potential of economically marketable woods and the local flora and fauna biodiversity. In addition, there is the inadequate use of soil resources, causing a rapid reduction of natural resources in the area, causing major social and political conflicts, in addition to enormous damage to the environment.

The main endemic diseases in the Amazon are closely linked to the destruction of Amazon ecosystems. These diseases are called focal diseases, which are rooted in the elements of fauna and flora. The dynamics of deforestation transforms the circulation of microbial agents such as viruses, bacteria and parasites. The intensity of deforestation will have an impact on the ecosystem. Due to several biological, behavioral and geographic factors, this population of União Bandeirantes is exposed to a greater or lesser incidence of malaria, with greater or lesser transmission instability.

According to Moraes [9], the environment is not homogenized in a single target of actions, but rather merges as an inherent facet to every act of producing space. In this approach, nature and space do not exchange only in a plea of complicity. In this approach, nature and space do not exchange only in a plea of complicity. The natural space does not exist only to be explored, it is much more than that. Man and nature coexist as synonyms [10]; [11]; [12]; [13] and [14]. However, phenomena such as hunger, thirst and epidemics are injunctions focused on what inhabits its core, which are the relationships maintained between man and the natural environment. Santos [13] called it hostile nature, through its catastrophic effects, with harm to the physical and mental health of populations, when nature ceases to be friendly to man. It is noticed that this unplanned human-environment interaction generates a conflict situation mainly on deforestation and endemic diseases.

Using the geostatistical method as a tool, the objective was to analyze the behavior of the spatial dispersion of deforestation and the number of cases of malaria, in addition to providing integration of deforestation risk with epidemiological risk of malaria in the current District of União Bandeirantes, in the municipality from Porto Velho, Rondônia, Western Amazon, for a period of 3 years.

## II. METHOD

### 2.1 Geostatistics

The theoretical basis of geostatistics is centered on the theory of regionalized variables. One of the forerunners of this method was Georges Matheron, who began with the work of Daniel Krige, who aimed at solving mineral reserve estimation problems. As it is a probabilistic method, it uses a position of observations to understand the behavior of the variability of observed values [15].

Thus, the concern of geostatistical analysis is with natural phenomena. From the regionalized variable estimates, using some spatial characteristics of the sampling points of the discrete data set, evaluating the estimation errors, which establishes the degree of security in the forecasts and the optimal sampling patterns, so that the maximum errors estimates are not exceeded.

According to Landim [16], applied geostatistics deals with problems related to regionalized variables. The variables present an apparent spatial continuity, with the characteristic of presenting values very close to two neighbors, this makes the different measures increasingly distant, in addition to presenting their own location, anisotropy and transition.

In the behavior of regionalized variables there are two fundamental tools of statistical methods: the semivariogram and kriging [16].

#### 2.1.1 Semivariogram

The semivariogram is the mathematical modeling that allows studying the natural dispersion of the regionalized variable [17], which, according to Landim [18], this modeling demonstrates the degree of dependence between the samples. The regionalized variable has spatial continuity evidenced in the moment of inertia designated by the variogram.

Huilibregts [19] states that the variogram is a basic tool to support kriging techniques, which allows to quantitatively represent the variation of a regionalized phenomenon in space. This phenomenon is due to the distance and direction between pairs of observations  $[z(x_i), z(x_i + h)]$ .

The variogram is translated as follows:

$$\gamma = \frac{1}{2n(h)} \sum_{i=1}^{n(h)} [Z(x_i + h) - Z(x_i)]^2$$

Where:

$\gamma(h)$  is the semi-variance;

$n(h)$  is the number of pairs of values of the variable considered in a given direction;

$z(x_i)$ ,  $z(x_i+h)$  are values of the variable at two distinct points, separated by a predetermined and constant distance in one direction;

$h$  is the preset distance interval;

$\frac{1}{2}$  is half the mean of the squared differences and represents the perpendicular distance of the two points from line 45 of the spatial dispersion diagram.

The semivariogram is usually called a variogram, and the format of this graph describes the degree of autocorrelation present (Fig. 1).

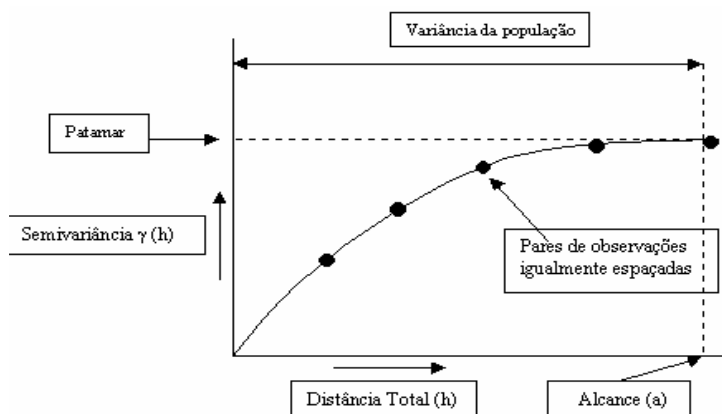


Fig.1: Semi-variogram model.

Where:

$h$ : distance;

$\gamma(h)$ : semi-variance;

Range ( $a$ ): indicates the distance where the samples no longer have spatial correlation, becoming random variation;

Level ( $C + C_0$ ): it is the value of the semivariogram corresponding to its range ( $a$ ). Meaning that there is no longer any spatial dependence between the samples, hence null covariance.

$C$ : is the contribution of the level.

$C_0$ : called the "nugget effect" reveals the discontinuities of the semivariogram for distances smaller than the shortest distance between samples. According to Isaaks and Srivastava [20], this discontinuity may be due to measurement errors. Making it impossible to assess whether the greatest contribution comes from measurement errors or from small-scale variability not captured by sampling.

In practice, variographic models are not known and must be adjusted by a theoretical model that represents the different regionalizations that occur in nature, which can be classified into two categories: non-platform model and b) platform model.

According to Isaaks and Srivastava [20], these models are called isotropic. Models of the first type are referred to in

geostatistics as transitive models. Since some of the transitives reach the level ( $C$ ) asymptotically. For these models, range ( $a$ ) is arbitrarily defined as the distance corresponding to 95% threshold. The second type, on the other hand, does not reach the platform and continues to increase as the distance increases [21]. These models are used for modeling phenomena that have infinite dispersion capability.

According to Landim [18], in models with a platform, there are basically four theoretical functions that fit the empirical semivariogram models: linear, spherical, exponential and Gaussian.

For Camargo et. al [21],

The semivariogram may or may not present structures of spatial variability in the study area, this can be seen by comparing the estimated semivariograms for the  $0^\circ$ ,  $45^\circ$ ,  $90^\circ$  and  $135^\circ$  directions. Therefore, this spatially dependent structure can occur in the same and in all directions, that is, in this case,  $h$  is considered as scalar, the phenomenon is called isotropic, otherwise,  $h$

is considered as a vector and the phenomenon is called anisotropic.

Some natural phenomena are more likely to occur in anisotropic modeling, which can be geometric and zonal. The geometric anisotropy is adjusted in the same model, but there is variation in the range according to directions, with the maximum and minimum ranges being in orthogonal directions. In zonal anisotropy, there is more than one semivariogram model for the area [21].

The parameters found in the classic variogram models are related to scale, extension and continuity, where there is stability characterizing its form of spatial dependence, providing information necessary for the execution of kriging, allowing to find the optimal weights, related to the samples, still allowed estimate the unknown points [22].

### 2.1.2 Kriging

To obtain a more effective diagnosis of deforestation and malaria, the Kriging method was used to analyze the spatial variability of existing indicators in the area.

According to Fuks [23] and Fuks et al [24], kriging is a stochastic spatial inference procedure, whose variographic analysis model provides a spatial covariance structure. It is an elaborate statistical technique that estimates a spatial covariance matrix that determines weights assigned to different samples. A spatial dependence model is obtained, with the intention of predicting values at non-sampled points as well. This interpolator weights the neighbors of the point to be estimated, obeying the criteria of non-bias and minimum variance. There are several types of kriging: simple, ordinary, universal, indicative, among others.

Indicative Kriging basically consists of determining an average value in a non-sampled location. Other values can also be used as a basis for estimating values below or above a certain cut-off level [22]. This technique has the main advantage of being non-parametric, not requiring prior knowledge of the distribution for the random variable (VA).

Kriging by indication allows the estimation of the VA distribution function, allowing the determination of uncertainties and the inference of attribute values, in non-sampled spatial locations. Unlike linear kriging, the indication kriging procedure models attributes with high spatial variability, without the need to ignore sampled data whose values are very far from a trend [25]; [26]. To

achieve these goals, the first step in Indicative Kriging is to transform the original data into indicators, that is, transform the values that are above a certain cut-off level into zero (0) and those below into one (1):

$$I(v_c) = \begin{cases} 1, \dots \text{se} \dots v_j \leq v_c \\ 0, \dots \text{se} \dots v_j > v_c \end{cases}$$

And, therefore, the expected value of the VA per referral,  $E\{I(v_c)/(n)\}$ , provides an F\* estimate of the fdc of  $v_j$  at cutoff value  $v_c$  and conditioned to the n sample data of the attribute  $v_{ji}$

$$E\{I(v_c)/(n)\} = 1 \cdot \text{Prob}\{I(v_c) = 1/(n)\} + 0 \cdot \text{Prob}\{I(v_c) = 0/(n)\} = 1 \cdot \text{Prob}\{I(v_c) = 1/(n)\} = F^*(v_c/(n))$$

According to Deutsch (1998), this technique allows the elaboration of the estimate by a kriging on the set of values per indication for the fdca of  $v_j$  at cutoff value  $v_c$ .

For Landim [16], the experimental semivariograms are calculated for certain cut-off levels and then the Indicative Kriging is applied, which provides maps of probability of occurrence. This aims to provide maps of occurrence of values, below and above the cut-off levels, providing the anomalies of the geoenvironmental research areas.

### 2.2. Study area

The area chosen to carry out the study and assess deforestation, as well as the number of cases of malaria, is located in the region of the municipality of Porto Velho, on the Gleba Jorge Teixeira known as União Bandeirante.

This is a colonization area monitored by the National Institute of Agrarian Reform (INCRA) in the vicinity of Highway BR-364, Km 9.5. It is an area of terra firme forest, which has a history of anthropogenic occupation. (Fig. 02). It is located 160 km from the city of Porto Velho.



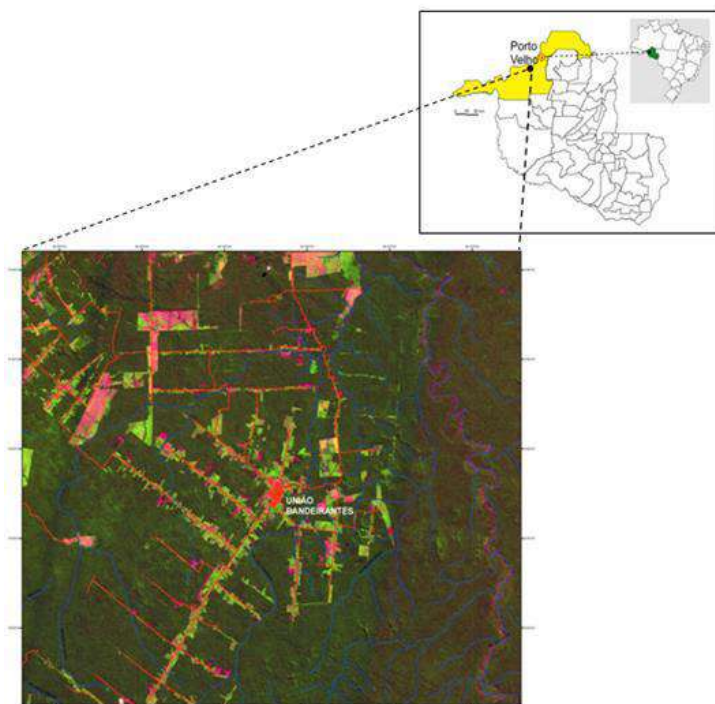


Fig.2: Location of the Gleba União Bandeirante study area.

### 2.3 Database

For the construction of the malaria incidence database in Gleba União Bandeirante over a period of 3 (three) years, data collected by the Surveillance and Epidemiological Information System - SIVEP were used, which were compiled into tables for analysis and identification of the standards of today.

The deforestation images were compiled from the satellite image database of the Rondônia Environmental Development Secretariat.

### 2.4. Statistical treatment

In the statistical treatment of the data, the geostatistical method of kriging was used as a tool for data analysis and geostatistical modeling to describe the spatial behavior of deforestation in Gleba União Bandeirante, current União Bandeirantes District – Municipality of Porto Velho, State of Rondônia, Western Amazon.

Descriptive statistics are often used with the purpose of describing the data and synthesizing the data series of the same nature, thus allowing an overall view of the variation of this set, that is, descriptive measures help to analyze the behavior of Dice.

The statistical measure used as a behavior parameter in this work was the median. This represented the best behavior as a measure that assessed the incidence of deforestation and its possible correspondence with the number of cases of malaria. This statistical parameter describes the measure of the data set as an evaluation that leaves 50% of the elements of the set [27].

This measure of tendency or central position describes the center of a distribution [28]. If the data set has outliers elements, these should not be discarded, since these elements do not affect the set, when using the median as an analysis measure [29].

## III. RESULTS AND DISCUSSION

For the construction of the malaria incidence database in the current District of União Bandeirantes for a period of 3 years, data collected by the Surveillance and Epidemiological Information System - SIVEP were used, which were compiled in the tables below for analysis and identification of the standards of this study.

Table 1. Registration data on the incidence of malaria in the current District of União Bandeirantes (year I).

places	Pop.	Total Positives	IPA	IFA	F	V	F+V	M	O
610	LINHA 1	60	168	2.800,0	31,0	48	116	4	0
616	LINHA 15 DE NOVENBRO	30	50	1.666,7	32,0	16	34	0	0
615	LINHA 1º DE MAIO	36	189	5.250,0	30,7	52	131	6	0
611	LINHA 2	50	125	2.500,0	28,8	34	89	2	0
708	LINHA 4 – SIT	102	228	2.235,3	28,1	62	164	2	0
241	LINHA DO BARRACO AZUL - SIT	10	68	6.800,0	38,2	25	42	1	0
312	LINHA F	145	232	1.600,0	24,1	53	176	3	0
614	LINHA P.O	35	118	3.371,4	24,6	27	89	2	0
613	LINHA TRIANGULO	900	161	178,9	39,8	63	97	1	0
612	LINHÃO – ACAM	100	240	2.400,0	27,9	65	173	2	0
600	RIO CONTRA – POVO	96	328	3.416,7	26,8	85	240	3	0
512	TRAVESSAO 10 – ACAM	23	382	16.608, 7	32,7	123	257	2	0
307	TRAVESSAO 101 – SIT	9	103	11.444, 4	10,7	11	92	0	0
518	TRAVESSAO 11 – ACAM	21	13	619,0	38,5	5	8	0	0
702	TRAVESSAO 4 – ACAM	8	9	1.125,0	22,2	1	7	1	0
405	TRAVESSAO 5 – ACAM	6	62	10.333, 3	30,6	18	43	1	0
513	TRAVESSAO 6 – ACAM	8	12	1.500,0	25,0	3	9	0	0
514	TRAVESSAO 7 – ACAM	5	17	3.400,0	17,6	3	14	0	0
515	TRAVESSAO 8 – ACAM	7	30	4.285,7	40,0	12	18	0	0
516	TRAVESSAO 9 – ACAM	11	52	4.727,3	32,7	17	35	0	0
247	UNIÃO BANDEIRANTE - VILA	1250	100 3	802,4	31,0	290	692	2 1	0
<b>Total</b>		2912	3590	1.232, 8	29,6	1013	2526	51	0 0

Subtitle: IPA – annual parasitic index. IFA – annual falciparum index. F – falciparum. V – vivax. M – malariae.

Table 2. Registration data on the incidence of malaria in the current District of União Bandeirantes (year II).

places	Po p.	Total Positives	IPA	IFA	F	V	F+ V	M	O
610	LINHA 1	60	190	3.166,7	28,4	46	136	8	0 0
616	LINHA 15 DE NOVENBRO	30	50	1.666,7	16,0	7	42	1	0 0
615	LINHA 1º DE MAIO	36	75	2.083,3	30,7	22	52	1	0 0
611	LINHA 2	50	99	1.980,0	23,2	23	76	0	0 0

708	LINHA 4 - SIT	102	190	1.862,7	22,6	40	147	3	0	0
241	LINHA DO BARRACO AZUL - SIT	10	97	9.700,0	25,8	24	72	1	0	0
771	LINHA DO PAVÃO	142	21	147,9	19,0	4	17	0	0	0
772	LINHA DO TUCANO	53	50	943,4	28,0	14	36	0	0	0
312	LINHA F	145	249	1.717,2	19,3	47	201	1	0	0
614	LINHA P.O	35	126	3.600,0	24,6	31	95	0	0	0
613	LINHA TRIANGULO	900	101	112,2	16,8	17	84	0	0	0
612	LINHÃO - ACAM	100	279	2.790,0	18,3	48	228	3	0	0
600	RIO CONTRA - POVO	96	74	770,8	10,8	8	66	0	0	0
512	TRAVESSAO 10 - ACAM	23	284	12.347,8	25,4	68	212	4	0	0
307	TRAVESSAO 101 - SIT	9	594	66.000,0	18,2	10	486	5	0	0
518	TRAVESSAO 11- ACAM	21	45	2.142,9	26,7	12	33	0	0	0
702	TRAVESSAO 4 - ACAM	8	23	2.875,0	26,1	6	17	0	0	0
405	TRAVESSAO 5 - ACAM	6	79	13.166,7	19,0	15	64	0	0	0
513	TRAVESSAO 6 - ACAM	8	28	3.500,0	21,4	6	22	0	0	0
514	TRAVESSAO 7 - ACAM	5	117	23.400,0	12,0	14	103	0	0	0
515	TRAVESSAO 8 - ACAM	7	162	23.142,9	15,4	23	137	2	0	0
516	TRAVESSAO 9 - ACAM	11	137	12.454,5	13,9	19	118	0	0	0
786	TRAVESÃO DO TRIÂNGULO	35	10	285,7	20,0	2	8	0	0	0
247	UNIÃO BANDEIRANTE - VILA	125 0	1728	1.382,4	19,4	31 7	139 3	18	0	0
<b>Total</b>		314 2	4808	1.530,2	20,0	91 6	384 5	47	0	0

Subtitle: IPA – annual parasitic index. IFA – annual falciparum index. F – falciparum. V – vivax. M – malariae.

Table 3. Registration data on the incidence of malaria in the current District of União Bandeirantes (year III).

places	Po p.	Total Positives	IPA	IFA	F	V	F+ V	M	O	
610	LINHA 1	60	198	3.300,0	29,8	57	139	2	0	0
616	LINHA 15 DE NOVEMBRO	30	85	2.833,3	25,9	18	63	4	0	0
615	LINHA 1º DE MAIO	36	52	1.444,4	15,4	8	44	0	0	0
611	LINHA 2	50	97	1.940,0	27,8	27	70	0	0	0

708	LINHA 4 – SIT	102	130	1.274,5	17,7	21	107	2	0	0
789	LINHA ABACAXI	79	91	1.151,9	40,7	34	54	3	0	0
241	LINHA DO BARRACO AZUL - SIT	10	43	4.300,0	41,9	17	25	1	0	0
790	LINHA DO FERRUGEM	68	215	3.161,8	38,6	81	132	2	0	0
771	LINHA DO PAVÃO	142	21	147,9	9,5	2	19	0	0	0
772	LINHA DO TUCANO	53	31	584,9	25,8	7	23	1	0	0
312	LINHA F	145	159	1.096,6	28,9	41	113	5	0	0
614	LINHA P.O	35	84	2.400,0	27,4	21	61	2	0	0
613	LINHA TRIANGULO	900	89	98,9	24,7	22	67	0	0	0
612	LINHÃO - ACAM	100	213	2.130,0	25,8	52	158	3	0	0
600	RIO CONTRA - POVO	96	24	250,0	41,7	10	14	0	0	0
512	TRAVESSAO 10 - ACAM	23	79	3.434,8	16,5	13	66	0	0	0
307	TRAVESSAO 101 - SIT	9	456	50.666,7	27,2	11	332	6	0	0
						8				
518	TRAVESSAO 11 - ACAM	21	21	1.000,0	38,1	8	13	0	0	0
702	TRAVESSAO 4 - ACAM	8	8	1.000,0	25,0	2	6	0	0	0
405	TRAVESSAO 5 - ACAM	6	27	4.500,0	18,5	5	22	0	0	0
513	TRAVESSAO 6 - ACAM	8	21	2.625,0	52,4	11	10	0	0	0
514	TRAVESSAO 7 - ACAM	5	63	12.600,0	44,4	28	35	0	0	0
515	TRAVESSAO 8 - ACAM	7	81	11.571,4	32,1	26	55	0	0	0
516	TRAVESSAO 9 - ACAM	11	101	9.181,8	32,7	31	68	2	0	0
786	TRAVESÃO DO TRIÂNGULO	35	21	600,0	19,0	4	17	0	0	0
247	UNIÃO BANDEIRANTE – VILA	125 0	637	509,6	21,2	12 9	502	6	0	0
	<b>Total</b>	328 9	3047	926,4	27,3	79 3	221 5	39	0	0

Subtitle: IPA – annual parasitic index. IFA – annual falciparum index. F – falciparum. V – vivax. M – malariae.

### Semivariogram Analysis

The first adjusted variographic model is Gaussian (Figure 3), whose direction is NE - SW. The parameters are: nugget effect (C0) = 20000, level is 1620,000 and range is

10500. This model describes the behavior of the deforestation variable. In this way, the map of figure 04 resulted.

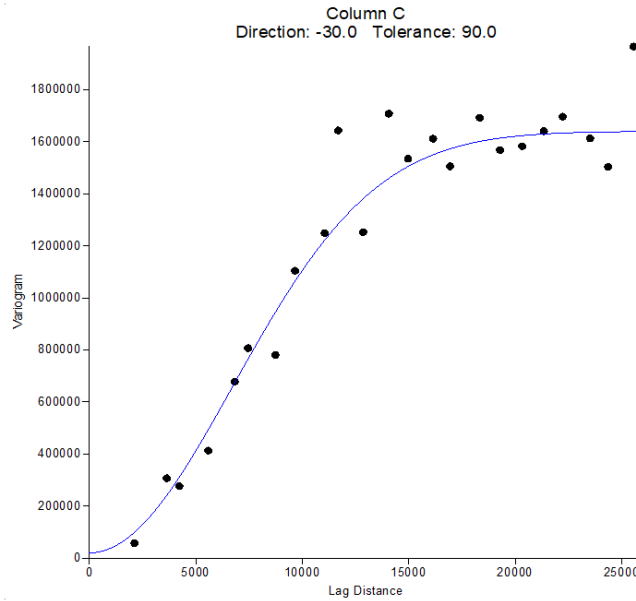


Figure 3. Experimental variogram of deforestation, adjusted for median (1410 ha). (year 1).

For the deforestation map (Figure 4), it is observed that it has a behavior of a large portion in the central region of Gleba União Bandeirante. This means that the occurrence of deforestation was highly prevalent in this area. In the southern and western parts of the tract, there is no deforestation, that is, it is not yet possible to make statements in relation to the portion, but it is clear that it may be an area that is or is not explored.

In the western portion of the Gleba are located the Karipunas indigenous reserve and the Bom Futuro reserve and the Jacy Paraná district, forming a deforestation control belt, thus reducing the rate of deforestation. As expressed in the clear part of the map, as the cut level approaches 0 (zero), deforestation is intense.

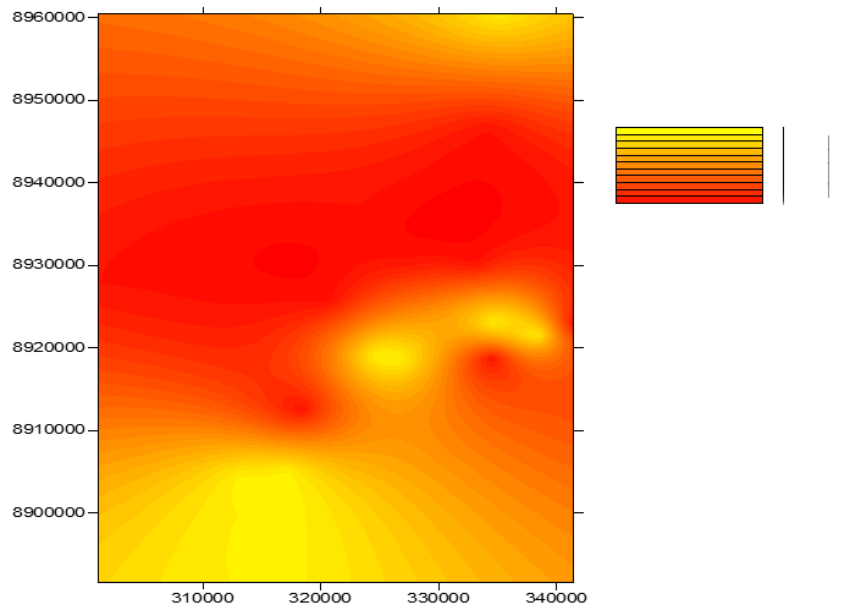


Fig.4: Probabilistic map of deforestation occurrence, median cut level (1410 ha).

The adjusted variographic model (Figure 5) is a Gaussian whose direction is NE – SW. Its parameters are: nugget effect ( $C_0$ ) = 436, threshold is 21000 and range is 13000.

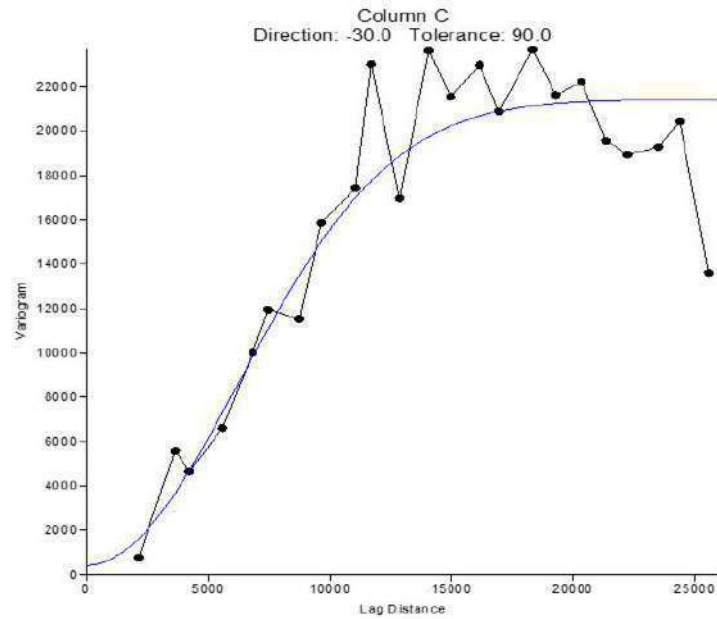


Fig.5: Experimental variogram for risk of malaria cases, adjusted for median (118 cases). (year one (1))

For the malaria risk map, it is observed that there was a great trend of occurrence of cases, in the entire northern portion of the glebe, demonstrating that this area has more than 118 cases. (Figure 6).

As for the combined occurrence map, in which the occurrence of deforestation and malaria is seen, the growth in cases of malaria occurs as deforestation advances to the north. This means that the growth of cases is due to human activity in an uninhabited field, leaving the population

vulnerable to tropical endemics, especially malaria. (Figure 7).

The study by Paraguassu-Chaves [1] carried out in a subspace of Western Amazonia is another argument in favor of this interpretation. According to this author, the migrant population that lives in precarious housing conditions favors the expansion and development of a relevant environment for the social production of malaria.

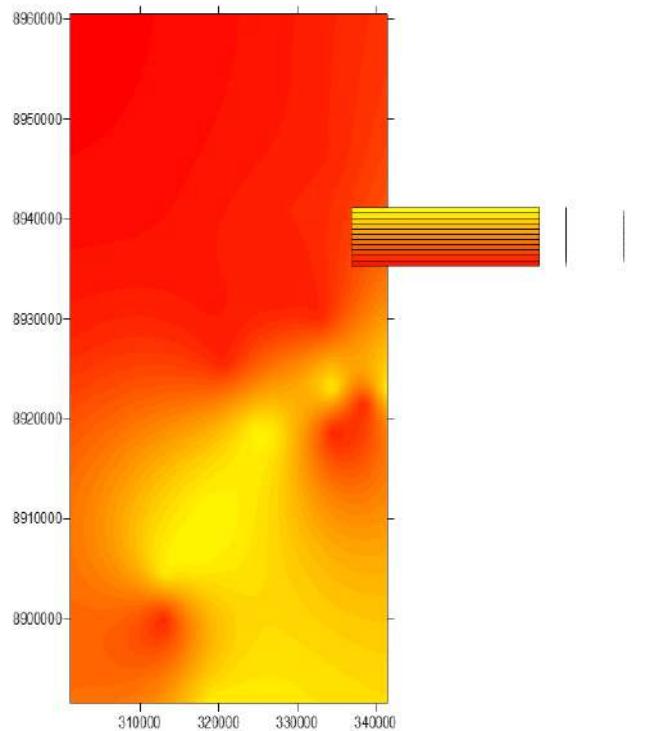


Fig.6: Map of probability of occurrence of malaria, median cut-off level (110 cases). (year 1).

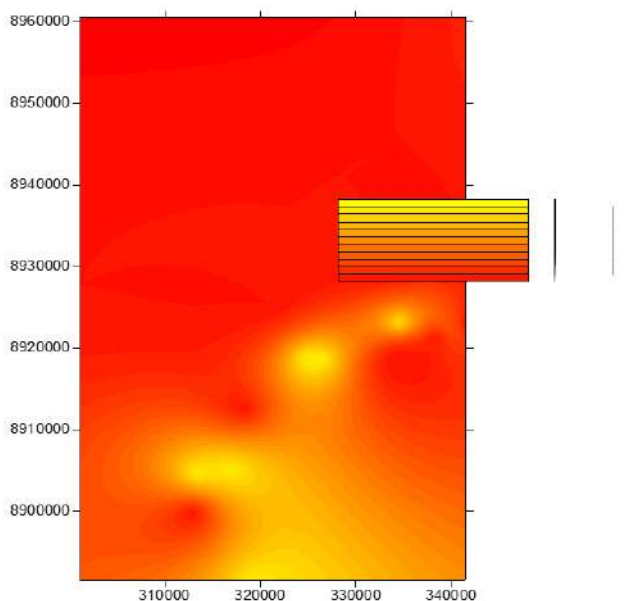


Fig.7: Combined occurrence probability map for the median cut-off level of deforestation (1410 ha) and malaria cases (110 cases).

The adjusted model (Figure 8) is Spherical whose direction NE – SW and follows the following behavioral characteristics of the variable. Its parameters are: nugget effect ( $C_0$ ) = 0, threshold is 550000 and range is 15000.

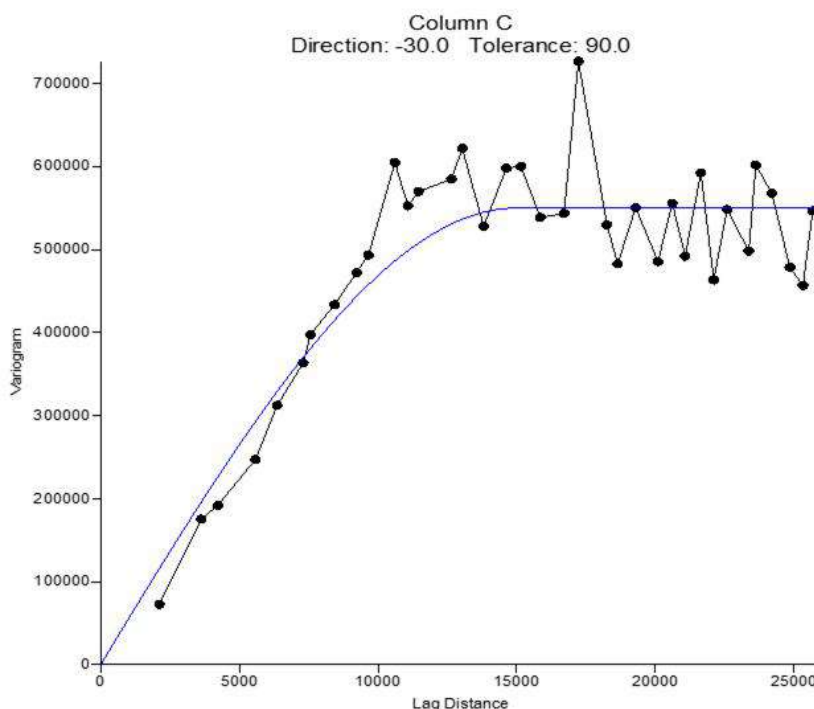


Fig.8: Experimental variogram of deforestation, adjusted for median (1317.5 ha). (year II).

The deforestation risk map (Figure 9) indicates that the incidence of deforestation occurred in the northwest of the region (year II). The other regions have a low incidence of deforestation, leading to believe that there was a strong influence of the public sector in managing deforestation that year.

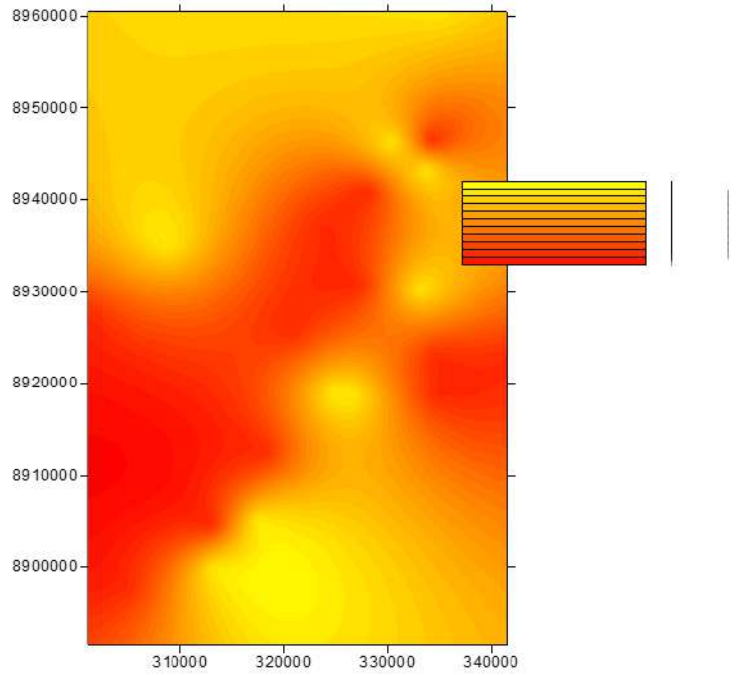


Fig.9: Probabilistic map of deforestation occurrence, median cut level (1317.5 ha). (year II).

The fitted model (Figure 10) is Gaussian whose direction and N - S parameters are: nugget effect ( $C_0$ ) = 300, level is 7400 and range is 6800.

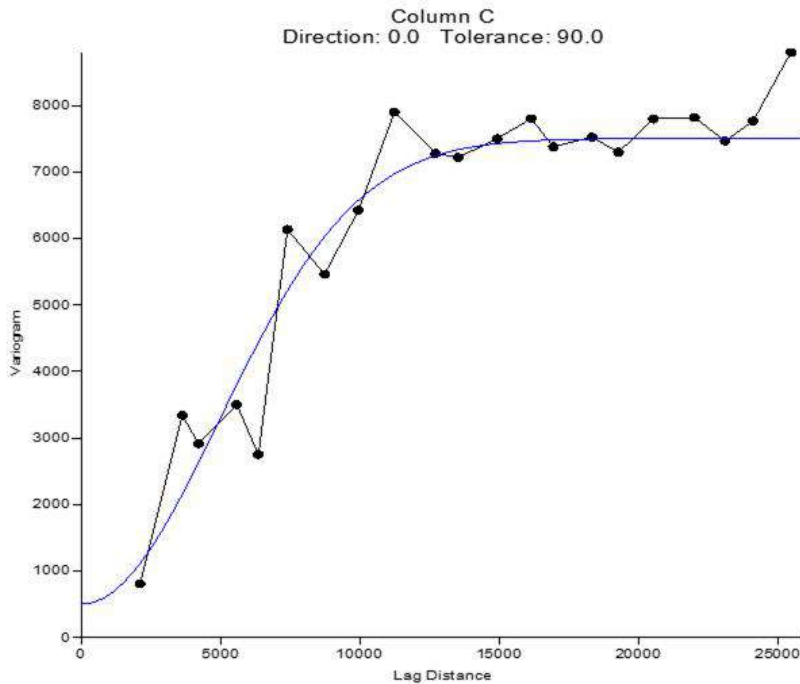


Fig.10: Experimental variogram for risk of malaria cases, adjusted for median (82.5 cases). (year II).

For the malaria risk occurrence map (Figure 11), there is a large concentration of cases above the median in the central portion of the Gleba, growing to the east, demonstrating convergence with the area of advance of deforestation. This convergence may probably be due to an area that is still difficult to access for inspection. Therefore, the number of cases in this sector is likely to increase.



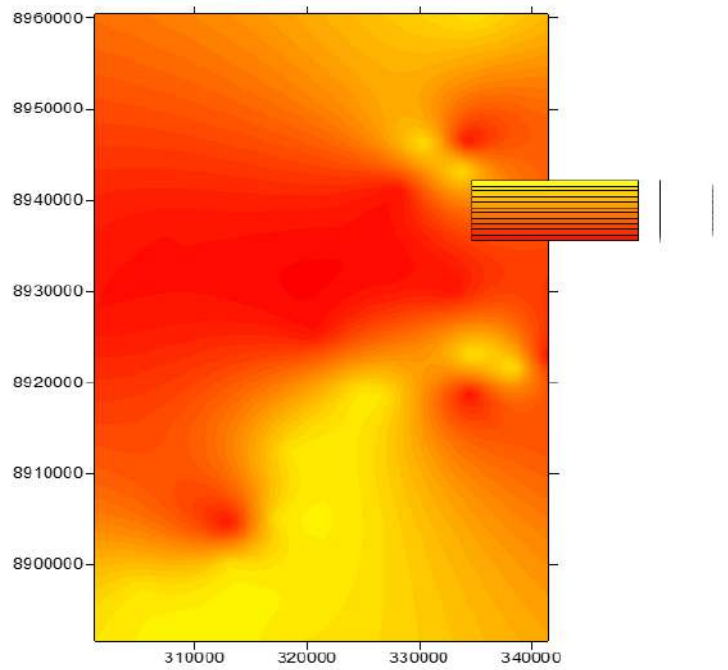


Fig.11: Probabilistic map of malaria occurrence, median cut-off level (82.5 cases). (year II).

As for the map (Figure 12), it shows a strong growth trend for the eastern sector both in terms of deforestation and malaria. Therefore, there is a low trend in deforestation growth. Furthermore, the occurrence of malaria will continue to exist in this area, as it is a very dense forest sector and the man who enters the region will run the risk of contracting some tropical disease.

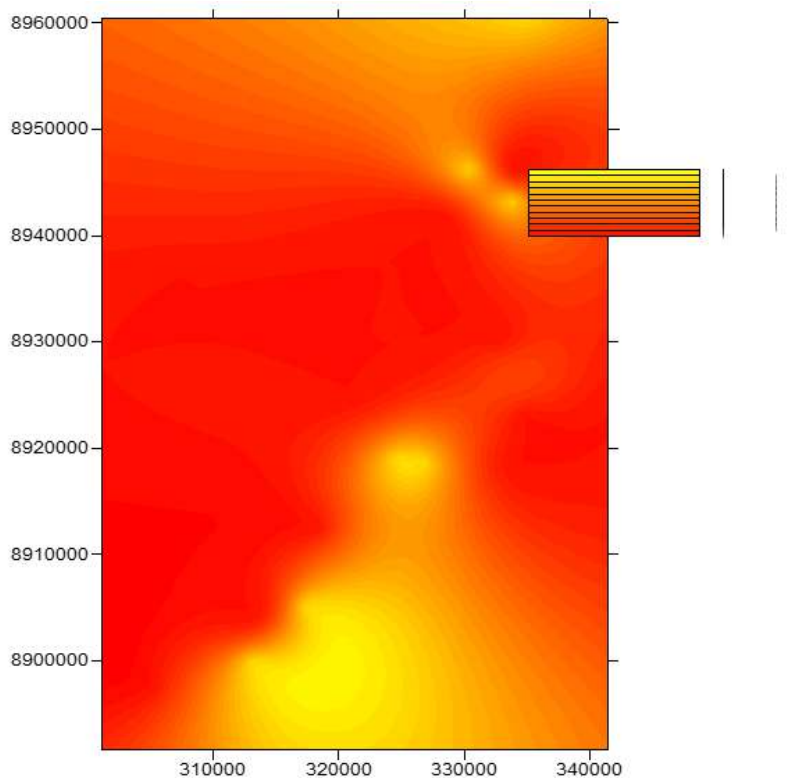


Fig.12: Combined occurrence probability map for the median cut-off level of deforestation (1410 ha) and malaria cases (82.5 cases). (year II).

The adjusted model (Figure 13) is Spherical whose direction NE - SW, whose parameters are: nugget effect ( $C_0$ ) = 0, level is 211700 and range is 10000. (year III).

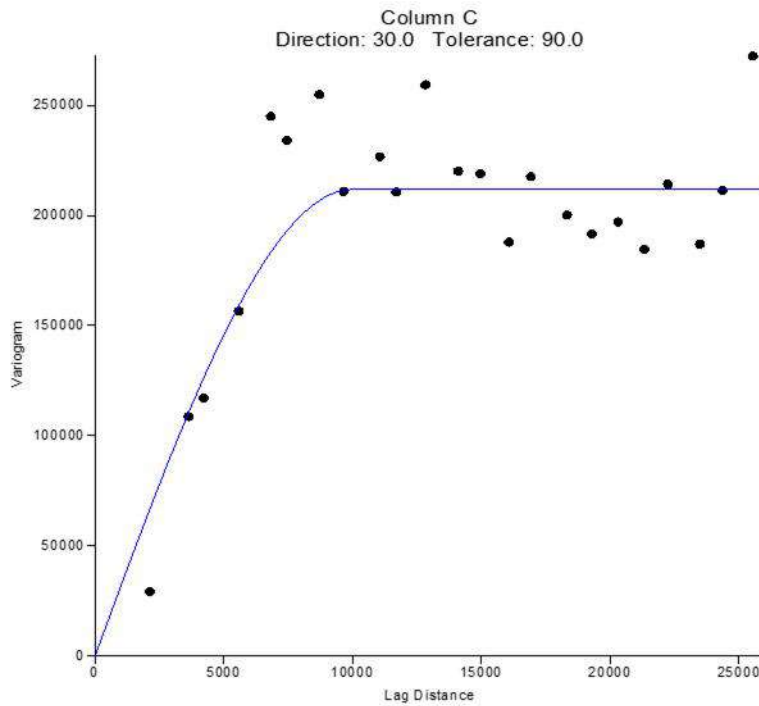


Fig.13: Experimental variogram of deforestation, adjusted for median (1019 ha). (year III).

The map (Figure 14) of deforestation occurrence demonstrates accommodation in all regions, that is, a decline in deforested areas, with deforestation outbreaks appearing in the central areas of Gleba União Bandeirante. Therefore, it is clear that this year was a year of great accommodation compared to previous years.

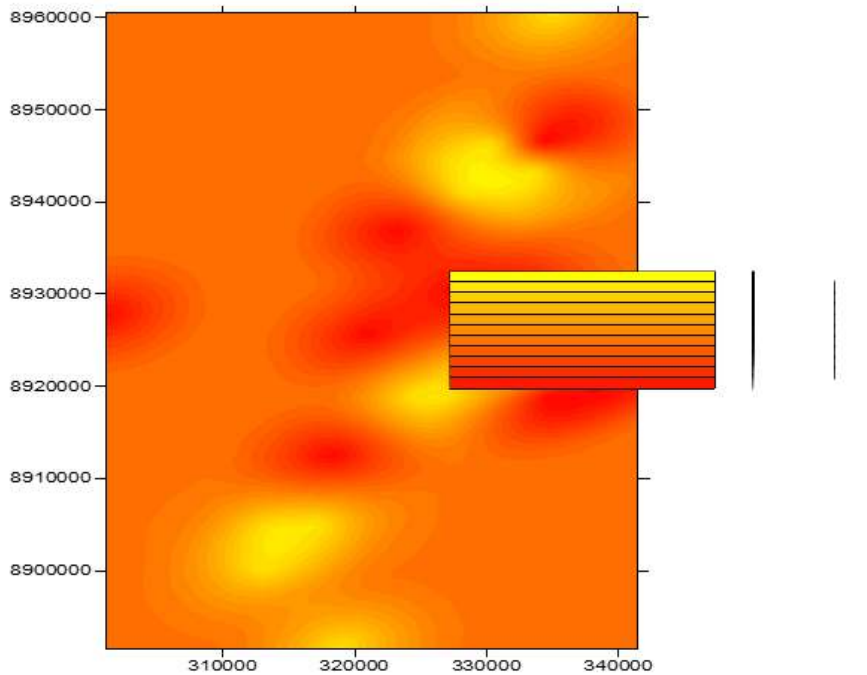


Fig.14: Deforestation occurrence map, median cut level (1019 ha). (year III).

The adjusted variogram model (Figure 15) is Spherical whose direction is NE – SW and its parameters are: nugget effect ( $C_0$ ) = 679, threshold is 44690 and range is 11800.

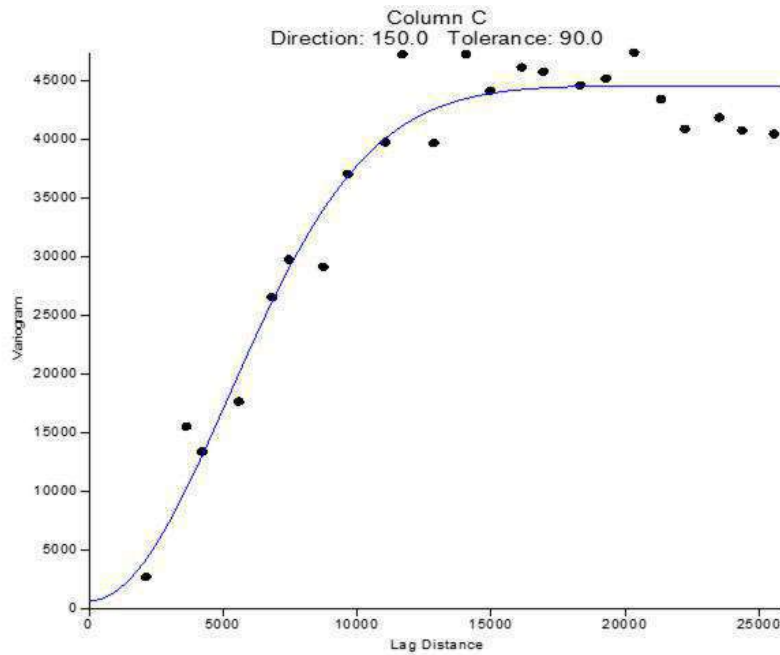


Fig.15: Experimental variogram for risk of malaria cases, adjusted for median (100 cases). (year III).

The map (Figure 16) shows practically the same trend of deforestation, that is, the areas with the highest concentration of malaria are in the northeast and southwest of the União Bandeirante gleba. (year III).

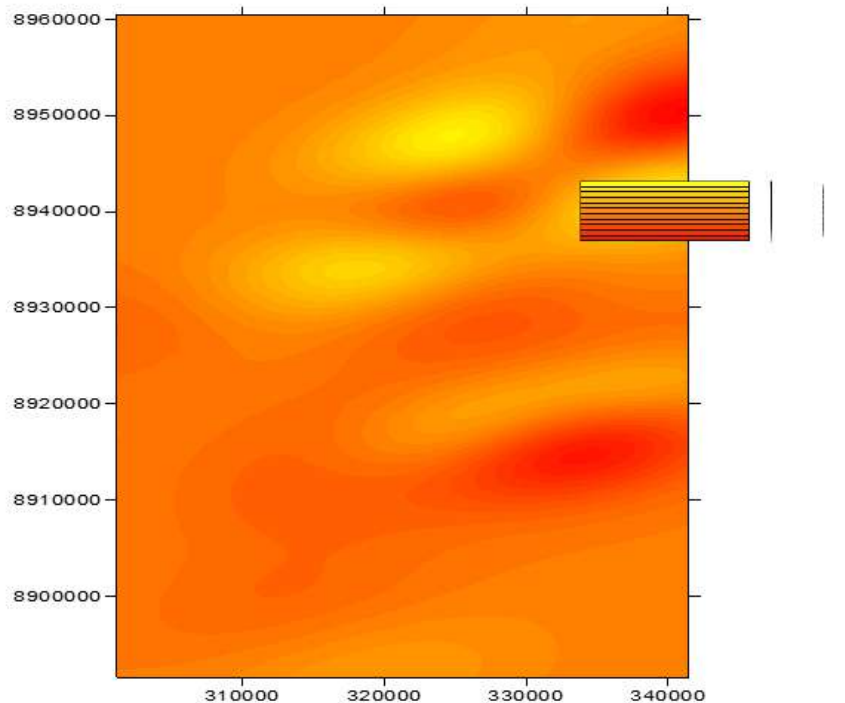


Fig.16: Probabilistic map of malaria occurrence, median cut-off level (100 cases). (year III).

For the occurrence of deforestation combined with the occurrence of malaria, it is observed that the map (Figure 17) shows a declining trend both in the trend of deforestation and cases of malaria, that is, the deforested areas were abandoned and the cases of malaria occurred only in the local population.

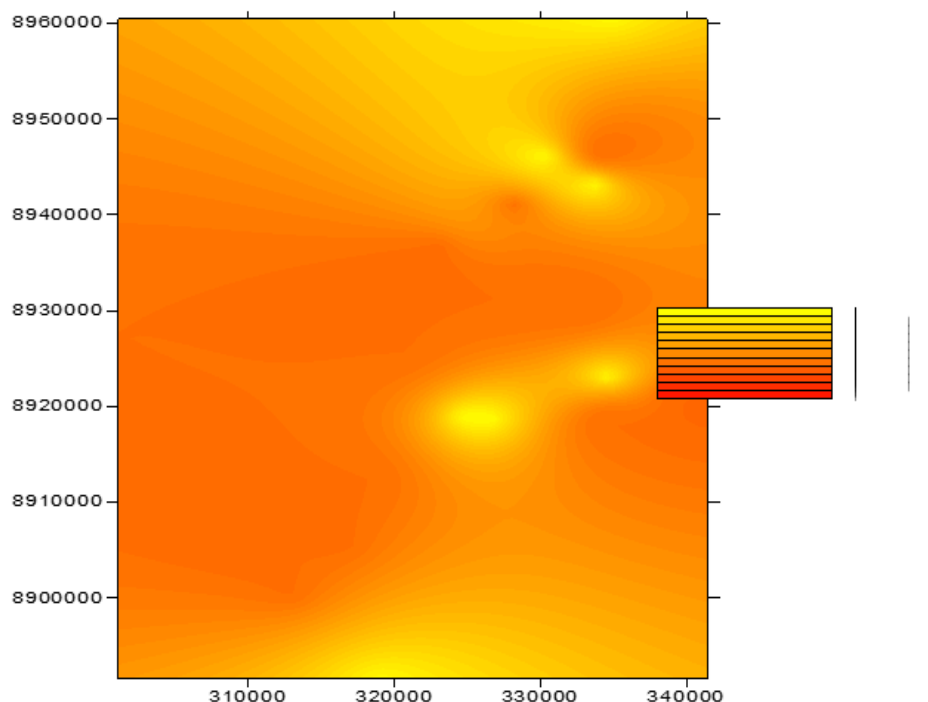


Fig.17: Combined occurrence probability map for median cut-off level of deforestation (1019 ha.) and malaria cases (100 cases).

#### IV. CONCLUSION

The present study was carried out in the current District of União Bandeirantes, in the municipality of Porto Velho, Rondônia, in which the rates of deforestation and incidence of malaria in the area were investigated.

The geostatistical method of kriging was used for statistical analysis and modeling, in which the behavior of the variables and their growth direction were observed both for cases of malaria and for local deforestation. The indicative kriging method proved to be satisfactory for presenting the occurrence of malaria cases in step with the growth of deforestation. In fact, it was noticed that, as deforestation advances towards the north of the studied area (Figure 7), the cases of malaria increased in the same direction.

The population in contact in the deforested region north of União Bandeirantes is vulnerable to contracting malaria. Likewise, there was an increase in malaria cases east of the population concentration studied, converging with the area of advance of deforestation. In fact, to the east of União Bandeirantes (Figure 12) there is a very dense forest sector, ideal habitat for malaria vectors.

From this perspective, the illegal occupations that proliferate in the União Bandeirantes area cause an expressive rate of local deforestation, which damages not only the environment, but also the fragile population structure of the sector. With the absence of planning and logistical guidance for the occupation of the area, the União Bandeirantes District is on a vertiginous path of decline in forest species and their biodiversity.

On the other hand, while the migrant population lives in precarious conditions of housing and basic sanitation, it will favor the emergence of an environment conducive to the emergence of endemic diseases.

Finally, at the study site, malaria transmission accompanies the process of occupation of the territory. It is pointed out that the incidence of malaria has a higher vector density on the outskirts of the Gleba, with a progressive reduction towards the more central areas of the urban core.

Therefore, by identifying the areas in which the highest levels of autochthonous transmission are concentrated, the possibility of the particularized area being the object of necessary intervention measures increases, enabling the

right choice and targeting of control measures handled by program managers of endemic control.

Thus, managers must develop the means to implement a deforestation control strategy integrated with the malaria endemic in the area of the União Bandeirantes District. This necessarily implies creating conditions for coordinated multisectoral action, capable of facing up to local factors that make the transmission of malaria and the increase in deforestation in the District of União Bandeirantes heterogeneous and complex.

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# Water consumption in 10 residential civil works in the city of Boa Vista, Brazil: A case study applying the calculation of Water Footprint as an estimation method

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**Keywords—** Water management, Civil  
Construction, Water Footprint,  
Sustainability.

**Abstract—** The use of water resources is highly employed in the civil construction industry, and good management of this resource enables a more favorable environmental impact to the environment. This article is a case study on water consumption in 10 works in the municipality of Boa Vista-RR, Brazil. Thus, the Water Footprint (WF) calculations were applied in order to estimate the total demands of water consumed and the portions of these that will be lost in your works. The methodology had a descriptive, bibliographical and case approach. Of the calculations performed, work 2.1 had the lowest water volume value consumed per m<sup>2</sup> built and construction 4.3, the highest value, represented in m<sup>3</sup>/m<sup>2</sup>. At the end, it was concluded that the results obtained were satisfactory, encouraging companies and construction companies with the possible implementation of these calculations in their works, with the purpose to gain greater control over water management.

## I. INTRODUCTION

With the growth of civil construction and population, combined with carefree environmental, lead to an increase in water consumption in housing works, in most of the times, without worrying about how this water is being used, or even in the increase of the generation of liquid and/or gaseous effluents and solid waste that results in higher quantities of materials extracted for the manufacture of raw materials, which often, causes great damage to river environments. Which represents an increase in the loss of water quality and negative environmental impacts.

Thus, making it difficult to obtain and treat it for the purposes of public supply and consequently increasing

costs. Since water represents one of the most important components in the production of mortar and concrete, in addition to being fundamental in the compaction of landfills and in the humidification of the soil, as well as it is used in secondary services such as cleaning works and equipment and, in the process of curing the concrete. Because according to Pessarello [1] for the production of a cubic meter of concrete, spends an average of 160 to 200 liters of water, and also in the compaction of one meter cubic landfill can be consumed up to 300 liters of water.

According to Comploier [2], it is estimated that there is a waste of approximately 20 liters of water per m<sup>2</sup> built, possibly due to damaged hoses or connected unused, leaks in hydraulic installations and negligence on the part of

workers. As a result, the same author cites that civil construction has rates that range from 25% to 30% of waste of natural resources such as water.

This can occur in Roraima as there was a population increase of 40.11% in last 10 years [3], which leads to a significant increase in civil construction and with that to the excessive consumption of water in works. According to Souza [4] there is usually no meters to measure the water demand in the works, or rather, there is no prior control of the amount consumed in the state's construction sites.

Faced with these problems mentioned above, the choice of the object of study of this work arose from the need to understand how water management works that consumed in civil constructions in the city of Boa Vista-RR, Brazil. In this way, looking for present a dynamic calculation method that estimates the amount of water consumed in the residential construction sites, in order to help companies and builders with the possible reduction of water waste, as well as an improvement in the management of water resources.

In view of this, the general objective of this work aims to apply the calculation of the Water Footprint (WF) as an estimation method, in order to determine the water demands that possibly will be consumed and lost on their construction sites, carrying out a study of case in ten residential works in the city. With that, the specific objectives will be: carry out a bibliographic survey about the material; survey the works aimed at the collection of water consuming processes at the construction sites (direct) and from the materials used in constructions (indirect); perform the calculation of the Total Water Footprint of the works; perform an analysis of water consumed between works through indicators specific.

## II. THEORETICAL REFERENCE

### 2.1 Water consumption in construction

Regarding water consumption, civil construction has great potential consumer, dealing directly in the use of processes such as concrete production, mortars, dust suppression and cutting, and indirectly in the manufacture of its materials and products used in the works [5]. According to Silva and Violin [6] water is also used in the consumption of workers, cleaning and curing concrete activities, and because of this, it presents a high rate of water use for the execution of works.

In this sense, Pereira [7] emphasizes that the share of water consumption per year for uses in small-scale civil construction in Brazil is around 17% of the total volume existing in the country, and 11% worldwide, with concrete

being the main consumer. Tied to previous quote, Ghrair et al [8] states that only the concrete industry consumes 1 billion m<sup>3</sup> of water per year globally, in addition, large volumes of drinking water are used to wash trucks, concrete mixers, equipment, concrete pumps, aggregates, and for healing.

With regard to water management, it is a highly complex matter, and the performance of civil society (public and private) must be articulated at multiple levels, generating policies and methods of raising awareness in the population. In the case of civil construction, to obtain a improvement in the form of this management, was developed in 2019 by the Civil Construction Union From the State of São Paulo (SindusCon-SP) a method that makes it possible to estimate the consumption of water that a work will use, as well as the amount of lost water it will have, through the WF calculations, which will be explained below.

### 2.2 Water Footprint Concepts (WF)

The water footprint (WF) serves as "an indicator of water use that does not only its direct use by a consumer or product, but also its indirect use" [9]. WF also refers to water lost in a given process, usually by incorporation into the product or by evaporation, that is, one that does not it becomes effluent (sewage), in the case of direct consumption [4].

According to SindusCon-SP [10], water footprint assessment in construction civil is composed of three main stages and which are examined through direct and indirect water in a given work, which are: definition of goals and scope: clarify the objectives of the water footprint assessment; quantification (calculation) of the water footprint: estimate the amount of water that will be used in the work; and analysis of final result with the sustainability of the work: relationship between the water footprint and the setting.

Thus, the use of WF as an assessment mechanism is linked to the agricultural products, however, studies on the water footprint of certain materials used in civil construction, such as: mortar, steel, concrete and cement. Therefore, the WF calculation results in volume values (m<sup>3</sup>) of water used, being which depends on the area of the project, depending on the total built area (A<sub>t</sub>), having as unit o m<sup>3</sup>/m<sup>2</sup>, as per the author above.

For Pereira [7], the largest portion of WF is related to indirect uses (from the materials), and not to the direct on site, that is, the indirect WF is given above 85% of the total, while the direct WF is below 15%. Already according to SindusCon-SP [10], the calculation of the Total Work Water Footprint (WF<sub>T</sub>) is defined by the sum of Direct Work Water Footprint (WF<sub>DIRECT</sub>) and Indirect

Work Water Footprint ( $WF_{INDIRECT}$ ), according to equation (1), having as unit the  $m^3$ . And in equation (2), there is the Specific Work Water Footprint ( $WF_{SPE}$ ), which lists  $WF_T$  as a function of area total built ( $At$ ), having as unit the  $m^3/m^2$ .

$$WF_T = WF_{DIRECT} + WF_{INDIRECT} \quad (1)$$

$$WF_{SPE} = WF_T / At \quad (2)$$

**2.3 Direct Water Footprint Calculation ( $WF_{DIRECT}$ )**

According to SindusCon-SP [10],  $WF_{DIRECT}$  is related to the consumption of estimated water at the construction site, in processes such as: concrete curing, preparation of mortars, washing and sanitary uses by employees.

Since generally, as there are no meters to measure the demand for water in the works, and as a first step, Souza [4], through his studies on the water consumption in the works visited, reached the conclusion of two coefficients, the demand for area (DPA) and per capita demand (DPC), whose values are:  $DPA = 0.25 m^3/m^2 \cdot At$  and  $DPC = 2.0 m^3/empc \cdot month$ . The second step is to estimate the total demand (DT) with base on each coefficient, equations (3) and (4), then take the mean between the two.

$$DT_{DPA} = At \cdot DPA \quad (3)$$

$$DT_{DPC} = Nf \cdot Da \cdot DPC \quad (4)$$

Where:  $DT_{DPA}$  – Total Demand per Area, measured in  $m^3$ ;  $DT_{DPC}$  – Total demand per capita, measured in  $m^3$ ;  $At$  – Total constructed area, measured in  $m^2$ ;  $Nf$  – Average number of employees per month;  $Da$  – Duration of the work, measured in months (estimate).

So the third step is to estimate the demands for sanitary uses ( $Q_{SAN}$ ) in the temporary toilets in the works, where they are used for flushing toilets, washbasins, showers, etc.; and for processes ( $Q_{PROC}$ ), where they are used, for example, for concrete curing, mortar preparation and floor cleaning, using equations (5) and (6).

$$Q_{SAN} = D_{SAN} \cdot Nf \cdot Jt \cdot Da \quad (5)$$

$$Q_{PROC} = DT - Q_{SAN} \quad (6)$$

Where:  $D_{SAN}$  – Average daily demand for sanitary uses, whose value varies between 10 to 80 l/empc.day, according to the quantities of toilets, sinks and showers in the flowerbed;  $Nf$  – Average number of employees per month;  $Jt$  – Average working hours per days/month;  $Da$  – Duration of the work, measured in months (estimate).

Finally,  $WF_{DIRECT}$  is calculated, according to equation (7), using the coefficients of return  $C_{san} = 0.80$  and  $C_{proc} = 0.20$ , in which, for sanitary uses 80% of the water demanded converts to sewage and for process uses only 20%.

$$WF_{DIRECT} = Q_{SAN} \cdot (1 - C_{SAN}) + Q_{PROC} \cdot (1 - C_{PROC}) \quad (7)$$

It was defined by the Brazilian standard NBR 15491/2010: Dump box for cleaning of sanitary basins - Requirements and test methods [11], that from 2010 all basins toilets manufactured in the country meet the reduced volume with the discharge of 6 liters per flow, as the standard mentions that before the water consumption was 12 liters per flow to the basin with attached box and 10 liters per flow for basin with well-regulated wall valve.

**2.4 Indirect Water Footprint Calculation ( $WF_{INDIRECT}$ )**

As for  $WF_{INDIRECT}$ , according to SindusCon-SP [10], it is related to materials used in the works such as concrete, steel, cement, mortar and ceramic block, or that is, it is considered the appropriations of water that occur outside the construction site, such as water incorporated during all manufacturing processes of these materials.

It is important to highlight that design decisions directly influence this part of the calculation, where the categorization and quantity of materials to be used will be defined, with the project's budget being the main guide for this calculation.

Souza [4] highlights that WF of secondary materials, for example, for materials electrical and hydraulic, can be considered irrelevant compared to materials such as concrete and steel, as the construction budget usually does not contain quantities of piping, parts, hydraulic connections, wiring, etc.

According to SindusCon-SP [10] the formula of each WF of the material is formed by the product between the quantity of materials and their water footprint coefficient (CWF), consistent in equation (8), then sum up all these WF of the materials to obtain the  $WF_{INDIRECT}$  represented in equation (9).

$$WF_{MATERIAL} = quantity \cdot CWF \quad (8)$$

$$WF_{INDIRECT} = \sum WF_{MATERIAL} \quad (9)$$

Therefore, in table 1 the main materials are represented contributors to the WF in the works. And in table 2 the water footprint coefficients (CWF), which corresponds to the volume of water required for manufacture of these materials.

*Table 1 Contribution of main construction materials to WF*

Material	% average	accumulated average
Concrete	42.6	42.6
Steel	40.5	83.0
Concrete block	4.0	87.1
Prefabricated slab	3.4	90.5
Electric	2.3	92.8



Mortar	1.9	94.7
Hydraulics	1.3	95.9
Screen	1.2	97.2
Ceramic block	0.8	98.0
Cement	0.8	98.8
Coating	0.3	99.1
Wood shapes	0.3	99.4
Floor	0.2	99.7
Plaster	0.1	99.8
Ink	0.1	99.9
Stone	0.1	99.9
Wood	0.0	100.0
Monocoat	0.0	100.0
Sand	0.0	100.0

Table 2 CWF for the main materials that consume water

Material	CWF (L/UF)	Unity
Steel	67.3	L/kg
Sand	7.5	L/kg
Mortar	0.8	L/kg
Ceramic block	4.7	L/unity
Concrete block	13.4	L/unity
Cement	2.7	L/kg
Concrete	3840	L/m <sup>3</sup>
Plaster	2.8	L/m <sup>2</sup>
Prefabricated slab	8541	L/m <sup>3</sup>
Wood	11.4	L/m <sup>2</sup>
Monocoat	4.0	L/m <sup>2</sup>
Floors	18.2	L/m <sup>2</sup>
Tiles	12.0	L/m <sup>2</sup>
Stones	93.8	L/m <sup>3</sup>
Ink	1.1	L/m <sup>2</sup>
Glass	79.5	L/m <sup>2</sup>

### III. METHODOLOGY

This research was bibliographical, quantitative and descriptive, being categorized as a case study, whose methods were based on the Methodological Guide of Water Footprint Calculation for Buildings, a guide developed by SindusCon-SP [10]. And for better understanding of water consumption in civil construction, it was sought pertinent information in articles, books, theses, dissertations and monographs, with the in order to obtain technical knowledge on the topic addressed.

The work began with the analysis of water consumption in 10 residential works in 5 companies in Boa Vista/RR, Brazil, whose companies have been in the civil construction market for more of 6 years, where visits were carried out in these works in order to estimate how many volumes of water will be needed to run them and how much of this water will be lost during your constructive process, through the applications of WF calculations.

And in obtaining the data, information was collected through the companies performers to be included in the WF calculations, in order to analyze in their works the direct and indirect water consumption.

To perform the direct WF calculation, data were sought in the projects and in the report of construction control, in order to collect information on: Total constructed area; average number of workers per month; duration of the work (estimate); number of days weekdays/month that employees work.

Subsequently, it was analyzed in loco in the works in order to determine the demands of water for sanitary and process uses, by employees. To calculate the consumption demands of employees, only the sanitary use of the temporary toilets of the works, belonging precisely to their temporary use, and also as it is the only variable that enters the WF calculation formula. It should be noted that the companies were chosen for the respective study precisely because they contain an installation of temporary use bathroom in his works, which serves as a requirement in the calculation part.

And to measure water flows in liters per minute of bathrooms that included showers and sinks, the following methodology was used: a 5 liter pot was used for perform the measurement, at an average water speed, performing in 3 repetitions and taking the medium, where the measures of the pot were 31.8 cm long, 13.5 cm thick and water height depending on the value to be filled with water every minute, according to figure 1, in which, by multiplying the three variables, the volume of water was obtained and then multiplied by the clocked time, obtaining the flow in L/min.



Fig.1: Pot measurements to measure water flows in L/min

After this, the estimates of the daily sanitary water demand per employee of the works were carried out, through a structured interview, using a questionnaire with the employees, which consisted of: how often did each one use the toilet per day, so that he could estimate the water consumed in liters with the flush; average time of use of the sink in seconds, for hand hygiene, in order to estimate the water consumed in liters with the sink; and if they used the temporary shower, how many times a day and the average time of use in minutes, in order to estimate the water consumed in liters with the shower.

Then, to perform the calculation of indirect WF, data were sought from the budget worksheets of the works, in order to collect information on the quantities of the main materials that lead to water consumption in their works, which have higher WF rates. In view of this, in this work were addressed the quantities of concrete, steel, mortar, cement, ceramic blocks and concrete blocks.

Thus, he performed the two calculations of the WF of direct and indirect work ( $WF_{DIRECT}$  and  $WF_{INDIRECT}$ ), and then was made the calculation of the Total Water Footprint of the work ( $WF_T$ ).

And when obtaining the  $WF_T$  of the works studied, a comparison was made using specific indicators, which consists of comparing the amount of water consumed that each of them will possibly have, depending on the total constructed area, through the estimates made in the calculation.

#### IV. RESULTS AND DISCUSSIONS

Starting with the analysis of direct water consumption, table 3 shows the data that were collected from the companies.

Table 3 construction works data

Construction Company	Work	Neighborhood	Total built area (m <sup>2</sup> )	Monthly average of employees	Duration of the work (months)	Workday (days/month)
1	1.1	Paraviana	179,79	10	08	22
2	2.1	Caçari	125,12	07	06	26
3	3.1	Caçari	1915,92	19	23	22
4	4.1	Paraviana	215,30	09	09	22
	4.2	Caçari	307,18	11	10	22
	4.3	Paraviana	213,94	09	10	22
5	5.1	Paraviana	265,81	08	09	26
	5.2	Caranã	99,24	06	08	22
	5.3	Caçari	254,69	09	11	22
	5.4	Caçari	305,12	08	08	26

According to table 3, it is highlighted that the work 3.1 is a residential type of condominium work with 12 houses, and the 9 remaining works are of the residential types of houses. And according to the installations of the temporary restrooms of these works, it was observed that the installations present in works 2.1, 4.1 and 5.3 contained only toilets. Works 1.1, 3.1 and 5.2 contained toilets and

sinks. Works 4.2 and 4.3 contained toilets and showers. Finally, works 5.1 and 5.4 contained toilets, sinks and showers.

Then, table 4 presents the values of the flow measurements carried out in the sinks and showers of some temporary bathrooms in the works.

Table 4 Measurements of water flows from faucets and showers

Construction Company	Work	Faucet flow (L/min)	Shower flow (L/min)
1	1.1	4,74	-
3	3.1	4,50	-
4	4.2	-	4,21
	4.3	-	4,30

	5.1	5,32	3,40
5	5.2	3,54	-
	5.4	3,26	3,93
Total	-	21,36	15,84

It can be seen in table 4 that work 5.1 had the highest flow in its faucet, having approximately 25% of the total flow, and work 5.4 the lowest flow, about 15.3% of the total. Regarding the shower flow, work 4.3 had the highest flow, having around 27.2% of the total, and work 5.1 the lowest flow, around 21.5% of the total.

Subsequently, the daily sanitary water demand per employee and the total water demand that the work will possibly consume was estimated, the latter divided for sanitary use and for the use of processes such as concrete curing, mortar and concrete dosing, activities of cleaning, etc., as shown in table 5.

Table 5 Water demand for the works

Construction Company	Work	Daily Sanitary Demand of Water per Employee (L/empc.day)	Total water demand (m³)	Demand for sanitary use (m³)	Demand for use of processes (m³)
1	1.1	15,38	102,47	27,07	75,40
2	2.1	15,60	57,64	17,03	40,61
3	3.1	15,87	676,49	152,57	523,92
4	4.1	13,50	107,91	24,05	83,86
	4.2	23,78	148,39	57,54	90,85
	4.3	20,09	116,74	39,78	76,96
5	5.1	19,26	105,22	36,05	69,17
	5.2	13,57	60,40	14,33	46,07
	5.3	13,50	130,83	29,40	101,43
	5.4	26,31	102,14	43,78	58,36

Regarding the sanitary demand for water per employee of the works, it can be seen in table 5 that, not always the more facilities there are in the temporary bathroom, the more water consumption it will have, an example is work 2.1 with 5.2, in which the first it only contains the toilet and the second contains a toilet and sink, and it is clear that the water consumption of the first is higher than the second, this is possibly due to the fact that the employees of the first use the toilet more often, which, using the flush, is where the most water is used.

Also in table 5, it can be seen that in relation to the total water demand, work 3.1 is the one that will be able to obtain the highest water consumption in m³ during its

construction process, which is explained by the fact that it is a larger work, as it is a condominium, and work 2.1 had the lowest water consumption overall.

In calculating the demand for water for sanitary use, it was analyzed that all the toilets in the temporary bathrooms of the works met the recommendation of NBR 15491:2010, where the consumption of water for each discharge made is 6 liters per flow.

Table 6 presented below shows the values of  $WF_{DIRECT}$ , which is an estimate of the amount of total direct water in m³ that may be lost in the works. Then, the percentage of this water was removed, making a relationship between the  $WF$  and the total water demand.

Table 6 Value of  $WF_{DIRECT}$  in the works under study

Construction Company	Work	Total water demand (m³)	$WF_{DIRECT}$ (m³)	Percentage of water lost (%)
1	1.1	102,47	65,73	64,14
2	2.1	57,64	35,90	62,28
3	3.1	676,49	449,65	66,47

4	4.1	107,91	71,90	66,63
	4.2	148,39	84,19	56,73
	4.3	116,74	69,52	59,55
5	5.1	105,22	62,54	59,44
	5.2	60,40	39,72	65,76
	5.3	130,83	87,02	66,51
	5.4	102,14	55,44	54,28

Analyzing table 6, it is observed that the three highest values of  $WF_{DIRECT}$  are in works 3.1; 5.3 and 4.2, which is explained by the fact that there are longer durations of works and staff. However, work 4.2 has one of the lowest lost water ratios in percentage. And the three lowest values of  $WF_{DIRECT}$  are in works 2.1; 5.2 and 5.4. However, despite the fact that work 5.4 has in its temporary bathroom the three sanitary facilities (flush, faucet and shower) and being the largest work with daily sanitary water demand per employee, the amount of water lost is

the third smallest among the 10 works studied, this is possibly due to the fact that the work has one of the smallest staff and the flow in liters per minute is one of the lowest, which means that its percentage of lost water ratio is the smallest of all.

Continuing, for the calculation of indirect water consumption, table 7 presents the quantities of the main materials used in the works, according to the budget spreadsheets made available by the companies.

Table 7 Quantitative of the main materials used in the works

Construction Company	Work	Material					
		Concrete (m <sup>3</sup> )	Steel (kg)	Mortar (kg)	Cement (kg)	Ceramic block (unity)	Concrete block (unity)
1	1.1	39,45	2412,01	2834,53	11127,94	16360,18	229,57
2	2.1	31,13	1566,74	2074,96	9604,74	10899,12	-
3	3.1	489,24	31909,71	49652,84	113305,68	163399,96	-
4	4.1	87,60	4415,87	4003,65	15662,10	17603,59	-
	4.2	129,31	6533,93	4635,20	21380,47	37632,48	-
	4.3	91,11	5072,97	3848,30	16424,73	22164,12	-
5	5.1	104,10	5858,79	4702,65	16806,35	19244,19	-
	5.2	26,88	1275,28	1798,89	5728,98	9579,03	-
	5.3	98,14	4801,34	5322,91	17043,07	17823,43	562,50
	5.4	120,51	6156,58	5862,84	16479,32	22416,33	537,52

In table 7, it is observed that works 3.1; 4.2 and 5.4 are the three works that contain the largest quantities of materials used. And the works with the smallest of these numbers employed were in works 5.2; 2.1 and 1.1.

Then, the indirect water consumption of the works was calculated, multiplying each material by the water footprint coefficient. Table 8 presents the values.

Table 8 Value of  $WF_{INDIRECT}$  in the works under study

Construction Company	Work	$WF_{INDIRECT}$ (m <sup>3</sup> )
1	1.1	426,10
2	2.1	303,80
3	3.1	5139,83

4	4.1	761,80
	4.2	1174,59
	4.3	842,87
5	5.1	933,62
	5.2	250,97
	5.3	841,57
	5.4	1038,84

According to table 8, it can be seen that works 3.1; 4.2 and 5.4 have higher values of water consumed in m<sup>3</sup> through the consumption of materials used in their works, this is because they have larger volumes of concrete and kilos of steel, according to table 7, in which they are the two materials that most consume water in their

manufacturing process. And works 5.2; 2.1 and 1.1 are the three works with the lowest values.

Then, table 9 shows the sum of the direct and indirect WF values, obtaining the total WF. Subsequently, the specific WF was obtained, comparing the water consumed per m<sup>2</sup> built.

Table 9 Estimated WF values of the works under study

Construction Company	Work	Total built area (m <sup>2</sup> )	WF <sub>DIRECT</sub> (m <sup>3</sup> )	WF <sub>INDIRECT</sub> (m <sup>3</sup> )	WF <sub>T</sub> (m <sup>3</sup> )	WF <sub>SPE</sub> (m <sup>3</sup> /m <sup>2</sup> )
1	1.1	179,79	65,73	426,10	491,83	2,73
2	2.1	125,12	35,90	303,80	339,70	2,71
3	3.1	1915,92	449,65	5139,83	5589,48	2,91
4	4.1	215,30	71,90	761,80	833,70	3,87
	4.2	307,18	84,19	1174,59	1258,78	4,09
	4.3	213,94	69,52	842,87	912,39	4,26
5	5.1	265,81	62,54	933,62	996,16	3,74
	5.2	99,24	39,72	250,97	290,69	2,93
	5.3	254,69	87,02	841,57	928,59	3,64
	5.4	305,12	55,44	1038,84	1094,28	3,58

According to table 9, it can be seen that works with higher WF values, in m<sup>3</sup>, are not necessarily those with the highest specific values, in m<sup>3</sup>/m<sup>2</sup>. For example, work 3.1 is the one with the highest total WF value, but one of the lowest specific values. On the other hand, work 4.3 is the one with the median value of the total WF and the one with the highest specific value.

V. CONCLUSION

The theoretical reference provided the understanding of water consumption in civil construction and its peculiarities, as well as a method that makes it possible to estimate the total amount of water that a work will use and its relation of the quantity of this water that will be lost, measuring through the calculation of the Water Footprint

according to the two premises, direct and indirect consumption.

In order to verify the consumption of water in the 10 residential works, it was found through research and data collection that water is used in practically all activities of the work, constituting an indispensable element, being applied in the manufacture of materials that are used in construction, making mortar and concrete, cleaning works and equipment, in addition to employee consumption.

In view of the results obtained from the analysis of the 10 works, it was noted that to estimate the direct water consumption of the works, corresponding to the sanitary and process uses, it was necessary to verify the hydro-sanitary installations of the temporary toilets of the same for the use of employees, as well as flow rates were measured in L/min for taps and showers in some

bathrooms in the works. In this context, it was observed that construction 5.4 had the lowest percentage of water lost (evaporated) in consumption, despite its temporary bathroom having a toilet, sink and shower.

It was also possible to estimate the amount of indirect water consumed that the works will have in relation to the materials that were/will be used in their works, through incorporations to the materials, where the highest value was in the work 3.1.

On the other hand, when comparing the volume of water consumed in the works through specific comparative volume/area values, in  $m^3/m^2$ , it was noted that work 2.1 had the lowest value and work 4.3 had the highest value.

Therefore, given what was presented, it was observed that the proposed objectives were achieved. In this way, the relevance of the work is remarkable for contributing to the management of water resources for companies and construction companies, which can implement measures and possibly use these estimates in their works, either in the design phase or in the design phase, in order to obtain greater control in water management when they are implemented.

The research had limitations in the part of collecting data for direct water consumption, and it was not possible to estimate human consumption, which would analyze the number of glasses of water on average that employees consumed, and it was then possible to estimate only the one for sanitary use.

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# A review of the fractal geometry in structural elements

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**Keywords—** *Fractal geometry, Hausdorff  
fractal dimension, structure elements.*

**Abstract—** *Fractal geometry is a secret language nature follows to grow, to face unknown challenges, and to bloom and blossom with optimal energy. The fractal property of self-similarity, fractional dimensionality, optimality, and innovative fractal patterns, attracted the author(s) to pose the question, what could be the direct relation between fractal geometry and the structures?*

*To inquire about the relation between the two, the work of Benoit Mandelbrot is referred to develop the understanding of fractal geometry and its relationship with nature. Simultaneously, research review is framed by referencing published articles, which explicitly discusses the fractal geometry and their application in structural forms. In addition to the above, a brief study about contemporary works and computational tools are discussed, which has enhanced the productivity, efficiency, and optimality of structures, architects, and engineers.*

*This interdisciplinary research presents a brief overview of fractal geometry and some of its applications in structural forms. Concluding as The mathematics is a key language between nature and engineering. Fractal geometry gives us an optimal solution to the problem with aesthetics and architectural valued structures. Computational tools like machine learning, digital robotic fabrication, high-end modelling software's and coding, help to imitate, imagine and fabricate nature-inspired structures in an ontological, optimal, and sustainable way.*

## I. INTRODUCTION

Nature grows progressively in metric space, by repeating, copying, and evolving infinite geometric patterns. This growth is non-linear in metric space which results in the form of fractional dimension. This observation of French mathematician Benoit Mandelbrot gave a new view of the real geometry of nature. Mandelbrot explains in his book, "The fractal geometry of nature" that all-natural forms have fractal dimensions and the form is generated by following the fractal properties [4]. This research raises questions about: The fractal property of self-similarity and self-structuring creates structural forms. In this regard, can we contemplate the direct relation between fractal

geometry and structures? How fractal geometry is applied by architects and engineers in their practice? How efficient and sustainable are the structures inspired by fractal geometry? The fundamental objectives of this research are (1) to research fractal geometry exhibits in nature and its properties. (2) To research existing structures designed by architects and engineers inspired by the fractals. In addition to the above, a brief study of contemporary works and computational tools are discussed. Which has enhanced productivity, efficiency, and optimality.

## II. FRACTAL GEOMETRY IN NATURE AND ITS CLASSIFICATION.

*“Clouds are not spheres, mountains are not cones, coastlines are not circles, and bark is not smooth, nor does lightning travel in a straight line.”* \_ Benoit Mandelbrot

Benoit Mandelbrot in 1982 in his book, “The fractal geometry of nature” [4] described the word, “Fractal” comes from the Latin word *frangere* means, “to break, fragment”. The geometrical shapes composed of fragments that may be similar, identical, repetitive, or random are called fractals [1]. In nature, everything is formed from fragments and disperse into fragments. For example, the smallest flower of cauliflower is self-similar to the whole flower, the branching pattern of a tree, the more we zoom, a self-similar pattern is observed. The fractals are self-similar and create structural form by self geometrical repetition Mandelbrot, in his paper in 1989, Fractal geometry: what is it, and what does it do? Defines fractal geometry as a link between Euclidean geometry and nature’s mathematical chaos [5]. Figure -1 shows the photographs of some natural elements having fractal geometry

### 2.1 Classification of fractals

Benoit Mandelbrot in his books and research papers in 1982, 1989, Also Vrdoljak et. al in his paper, “Principle of fractal geometry in architecture and civil engineering” in 2019[4][5][27] described that fractals can be classified based on the degree of self-similarity and type of formation [30].

#### 2.1.1 Degree of self-similarity

1. Exactly self-similar fractals - Contains exact scale similar copies of the whole fractal. (Strongest self-similar fractals) also called geometric fractals.
2. Quasi self-similar fractals - Contains few scaled copies of whole fractals and few copies not related to whole fractals. Also called algebraic fractals
3. Statically self-similar fractals- Do not contain copies of themselves but some fractal properties remain the same. (lowest degree of self-similarity)

#### 2.1.2 Type of formation

1. Iterative fractals - Such fractals are formed after translation, rotation, copy, replacing elements with copies. Such fractals are self-similar.
2. Recursive fractals - Such fractals are defined from recursive mathematical formulas. Which identifies the given point in space (Complex

space) falls under a domain or not such fractals are quasi self-similar fractals.

3. Random fractals - Such fractals contain partial properties of iterative fractals and recursive fractals hence it is very natural fractals. Nature's creations like clouds, snowflakes, etc. are the best example of random fractals. As Benoit Mandelbrot in his book “fractal geometry of nature” said, “the best fractals are those that exhibit the maximum of invariance.”

## III. FRACTAL DIMENSION

To justify the fractal geometry and patterns mathematicians developed the concept of fractal dimension (roughness). Benoit Mandelbrot in 1982 in his book, “Fractal geometry of nature” defines fractal as “A fractal is by definition a set for which the Hausdorff Besicovitch dimension strictly exceeds the topological dimension” [4] [5]

In 1918 the great mathematician Felix Hausdorff., introduced the Hausdorff dimension. It is a measure of roughness. Hausdorff dimension for Euclidian’s geometry, say point, line, square, cube is zero, one, two, three respectively, such shapes with Hausdorff dimension as an integer also known as the topological dimension. But the Hausdorff dimension of rough shapes is a fraction that is calculated by the ratio of the logarithm of the number of self-similar copies (M) obtained after (N) number of iterations.

i.e.

$$D = \log(M)/\log(N)$$

Observation from the above pattern denotes that a single line has divided into three parts but the middle part is removed and iterated progressively in a similar pattern. Two similar patterns after each iteration are obtained (Figure -2). As per definition, the Hausdorff dimension after three iterations will be 1.584 (calculated by using equation 1). In this way, the Hausdorff dimension of fractal geometry is calculated. As we can see above geometry is not one dimensional or two but it is in fractional dimension.

## IV. APPLICATION OF FRACTAL GEOMETRY IN STRUCTURAL ELEMENTS

Consciously or unconsciously architects and engineers are using the concept of fractal geometry. Either in contemporary modern design innovation or architectural ornamentation of ancient Hindu temples, Buddhist temples, or roman churches [18][28]. The work of Benoit



Mandelbrot on fractal geometry and its mathematics changed the perception of the scientific and technological world. The use of fractal geometry in image processing, virtual reality, artificial intelligence, antenna, etc. are revolutionary ideas. Which has changed the computational, medical, technological world. The impact of that has also been seen in the architecture and civil engineering world.

The fractal property of self-similarity and self-organization can easily be observed in the branching pattern of trees. Trees are organisms that stand by themselves, so their shape has an inherent structural rationality' [20]. They are non-static structural forms, a seed takes the form of a tree after a long time. The challenge to the upcoming form is unknown. It uses its natural intelligence to obtain the best form at minimum use of energy. Trees are fractal-like structures following the rule of self-similarity and random fractals.

The paper, "The mechanical self-optimization of trees" by C. Mattheck & I. Tesari[6], explains the optimized growth of trees and relation between forces, stresses with the form and their fiber organization in correlation with the five theorems, minimization of the lever arm, Axioms of uniform stresses, minimization of critical shear stresses, Adaptation of the strength of wood to mechanical stresses, Growth stresses counteract critical loads[7]. The tree is a natural vertical member, designed by the intuition of nature to withstand the dynamic self-weight and lateral loads. Tree as a structural form, always been a keen inspiration for architects and engineers. The term dendriform is used for the forms and shape which are imitations of tree or plants. 'Dendron' is a Greek word for 'tree'. The branching-like structure is also known as the 'dendritic structure' (Schulz and Hilgenfeldt, 1994). the term 'dendritic structure' uses this natural entity for describing a mesh-free ramified system or branching structure(KullandHerbig,1994)[8]

#### 4.1 Capital

Md Rian et. al. in his paper in 2014 "Tree-inspired dendriform and fractal-like branching structures in architecture:"[17] explained - The true wooden dendriform can be seen in Chinese Dougong Brackets, 'Dou' means wooden block or piece and 'gong' means wooden bracket. The Typical Construction Of dugong is an interlocking assemblage of some 'gongs'. The 'gongs' are interlocked, to form the structural cantilever capital which takes the load of the roof and transmits it into columns.[17] Refer figure 3.a. Xianjie Menga et. al. in 2019 their paper "Experimental study on the seismic mechanism of a full-scale traditional Chinese timber structure"[29], they studied the behavior of dugong in dynamic loading condition, in which they modeled the full-scale timber

structure which has this dendriform in it. They generated experimental data on 15 sets of shake table models, compared the horizontal and vertical displacement with the acceleration, and concluded that such structure can resist large earthquakes[29] refer to figure 3.b & 3.c. This system of interlocking was also practiced in India, roman, Egypt, and Greece by using stone as a material.

#### 4.2 Column

Tang et. al. in 2011 in his paper "Developing evolutionary structural optimization techniques for civil engineering applications." And Fernández-Ruiz et. al. in 2014 in his paper "Patterns of force: length ratios for the design of compression structures with inner ribs." [24][10] concluded that in the 19th century, poetic architect Antoni Gaudi used some tree-inspired structures in his designs like in Sagrada Familia, in Barcelona refer figure 4.a. He developed a unique technique of hanging chain models to develop stable structural forms. Gaudi studied the member's loads by suspending the cables under gravity. He produced a group of the arch that was only subjected to compressive axial forces, hence free from bending [10][24] Inspired by the mechanical and structural characteristics of nature. Ahmeti et. al, in 2007 in his paper "Efficiency of lightweight structural forms: The case of treelike structures-A comparative structural analysis." And in 2016 in his paper L. Aldinger, "Frei Otto: Heritage and Prospect," [1][16]concludes that, During the 20th century, Frei Otto, a very experimental German architect, has introduced the term lightweight structure in his practice and research [16]. His design philosophy is focused on the relationship between architecture and nature, and their performance. Otto scrutinized the new concepts of form-finding by experimenting with lightweight tents, soap films, suspended constructions, dome and grid shells, and branching structures [1]. He is also fascinated by the tree's fractal-like geometry and started using them in his practice, at Stuttgart airport, Stuttgart Germany refers to figure 4.b. Another architect, structural engineer, educator at Harvard University, Allen and Zalewski in his book "Form and force" [2] exemplified the used graphic static for finding the optimized form for steel-made dendriform structures by achieving maximum force equilibrium in designing a long-span market roof. [2]

#### 4.3 Beam and trusses

Benoit Mandelbrot in his book nature's geometry [4] mentioned that even before Koch, Peano and Sierpinski. The tower that was built by French engineer Gustave Eiffel in Paris deliberately incorporated the idea of a fractal curve, full of branch points. The A's and tower are not solid beams but every member is a colossal truss, with

every sub-member as a truss. Which makes the structure stiff and lightweight [4].

Roderick lake in 1993 in his paper “Materials with structural hierarchy”, which was published in Nature. Gives us insight into bone structure hierarchy and its implication in materials. Also Meenakshi Sundaram et.al. in 2009 in his paper “Gustave Eiffel and his optimal structures,” justify more clearly structure hierarchy and its role in optimization of structure which as follows.[23][21] Fractal patterns are even observed at the microscopic level by the scientist and practiced by engineers like Gustave Eiffel (Consciously or unconsciously) understanding this by relating the structure of bone and Eiffel tower design. Cortical or compact bone and trabecular or cancellous bone are the outer and inner parts of our bone respectively refer to figure 5. Haversian canals are layered rings carrying blood vessels that are surrounded by lamellae. Lamellae are made of collagen fibers, which are in turn made of fibrils. These five layers inside one another, if we denote structural hierarchy level by n, our compact bones are hierarchy level 5. Such structure imparts special structural property. A similar structural hierarchy is observed in Gustave Eiffel works like Eiffel tower, Garabit Viaduct Bridge, Maria Pia Bridge.[21] [23]

P. Weidman in 2004 in his paper “Model equations for the Eiffel Tower profile: Historical perspective and new results,” And C. Roland in 2004 in his paper “Proposal for an iron tower: 300 meters in height,” discusses the topology and behavior of the tower under wind condition. The core of their research is [22][27][7]- To withstand heavy wind load and self-weight by the tower itself, proper geometry selection is needed. The four legs of the tower are supported at the bottom but only bottom support is not sufficient enough to resist the wind load. So four structural belts are provided at different heights of 91,129, 228, and 309 meters from the ground. Also to resist the wind load the exterior profile of the tower is considered as nonlinear and at a determined scale of the curve of the bending due to wind[22]. Eiffel and co. are very familiar in construction with truss systems(trails/cross beam) and piers, where horizontal forces are taken by viaduct but in the case of the Eiffel, tower piers have to counter the thrust of wind[7]. But in the case of the Eiffel tower, they have to give away the cross beams. Which has been explained by M Meenakshi Sundaram and G K Ananthasuresh in their paper “Gustave Eiffel and his optimal structure” [21]

#### 4.4 Slab

This section mainly reviews the work of Pier Luigi Nervi. The research work of T. Iori et. al. in 1960 “Pier Luigi Nervi’s Works for the 1960 Rome Olympics,”. In 2018 D. Thomas, “The Masters and Their Structures,”

in *Masters of the Structural Aesthetic* were majorly referred and explored, The Victoria Amazonica leaves (figure -6.a) appear to be very delicate but due to the fractal branching of the ribs and the veins, it gets enough structural strength. Its delicacy, fractal pattern, and strength attracted architects and engineers to understand and develop the architectural structural form based on its geometry. Victoria Amazonica has radial and circular veins, the intersection of two makes the ribs like a pattern which gives it great structural strength [3]. Above mentioned rib pattern is made up of airy tissues which make it light and have a high bouncy which enables the leaf to float above the surface of the water[27]. Such pattern also observed in equiangular spiral, growth spiral, logarithmic spiral, can be constructed from equally spaced rays by starting at a point along one ray, and drawing the perpendicular to a neighboring ray. As the number of rays approaches infinity, the sequence of segments approaches the smooth logarithmic spiral [9]. The fractal property of self-similarity and self-organization is observed in the equiangular spiral, sunflower, and many natural elements.[26]

Above mentioned geometric pattern is seen frequently in the work of a great structural engineer, architect, constructor Pier Luigi Nervi (figure 6b). He conflates the geometry and construction technique so intelligently which gives captivating aesthetical structural elements without any embellishment.

Using such a pattern along with the concept of prefabrication and Ferro cement gave a very optimal solution for large span roofs, half dome, vaults, and shell structures.[26] [25] [8]. Which can be seen in Palazzetto dello sports Arena in Hanover, New Hampshire, Thompson Arena in Hanover, New Hampshire, and many more.

#### 4.5 Contemporary work and computational tool

Fractal geometry has been of keen interest for architects and engineers for all time. But imitating them in practice is far easier in the contemporary world due to technological advancement. The computational tools like rhino, grasshopper, python, robotic fabrication, Machine learning, etc. made the process of modeling, designing, analysis, and fabrication very quick, easy, and efficient. The fractal branching of trees inspired the structure of a modern chapel in Nagasaki, Japan refers figure 7.a. Designed by architect Yu Momoeda, the building uses a branching timber column system that begins with four pillars each splitting into eight branches. These branches are connected by white steel rods and in turn support the next level of eight smaller pillars, which branch to support the top section of 16 branching pillars[25]. Another

example is the Sierpinski pyramid 17.25m (56ft 7in) tall[15] refer to figure 7.b. Which has been constructed by using a 3D printing machine. Made for the International Science Festival in Gothenburg, Sweden. Last but not least, Yijiang Huang, Caelan R. Garrett, Caitlin T. Mueller used the automated sequence and motion planning for robotic spatial extrusion of 3D trusses [14]. Figure 7.c

Software like rhino, grasshopper, python in their research for modeling, form-finding, stress distribution, and structural behavior to analyze their design concepts. Also, the fabrication techniques like robotic fabrication used by Professor Catlin Muller in her research lab, ‘Digital structure’ at MIT in various projects like making a crystal truss system, Islamic shells. Explored the various possible computational techniques which bridge the structure and architecture [12].

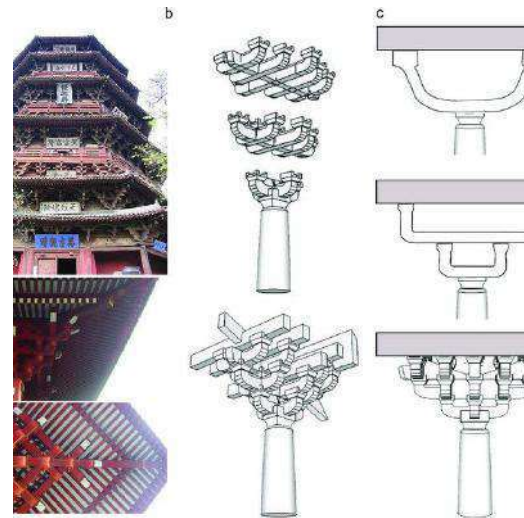


Fig.3.a Chinese Dougong Brackets

V. FIGURES



Fig.1: Source : Zdimalova, Maria & Škrabul'áková, Erika. (2019). Magic with Fractals.[30]

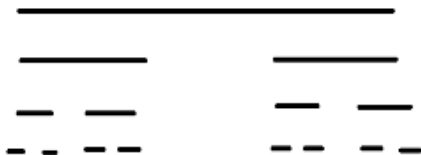


Fig.2: Self similar division on line

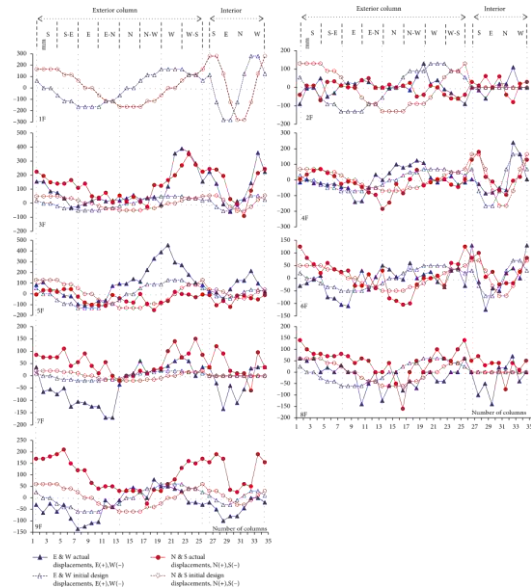


Fig: 3.b graphs showing horizontal deflection under dynamic loads

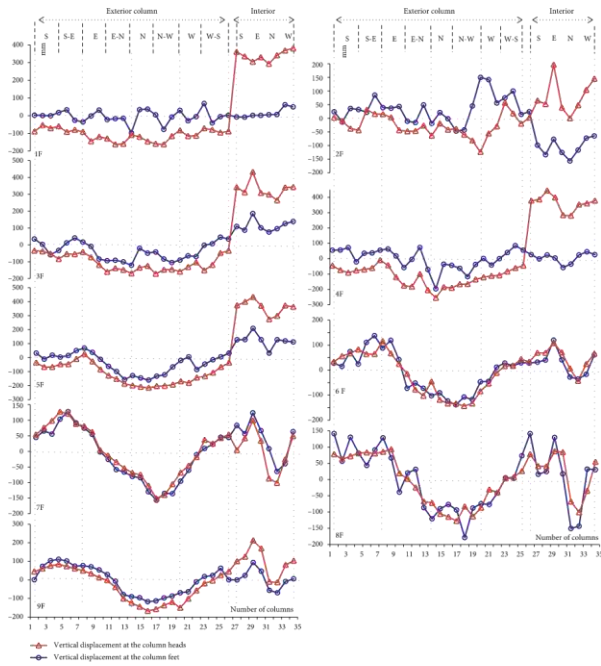


Fig 3.c graphs showing vertical deflection under dynamic loads

Source:

Fig 3.a Md Rian, Iasef. (2014). Tree-inspired dendriforms and fractal-like branching structures in architecture: A brief historical overview. *Frontiers of Architectural Research*. 3. 10.1016/j.foar.2014.03.006.[17]

Fig 3.b,c Xianjie Menga , Tieying Lia,\* , Qingshan Yang,cXianjie Menga , Tieying Lia,\* , Qingshan Yang,c in their paper “Experimental study on the seismic mechanism of a full-scale traditional Chinese timber structure”[29]



Fig 4.a Sagrada familia



Fig 4.b Stuttgart airport

Source:

Fig 4.a

<https://www.flickr.com/photos/7455207@N05/5491325900/in/photostream/>

Fig 4.b

<https://in.pinterest.com/pin/96264510756888828/>

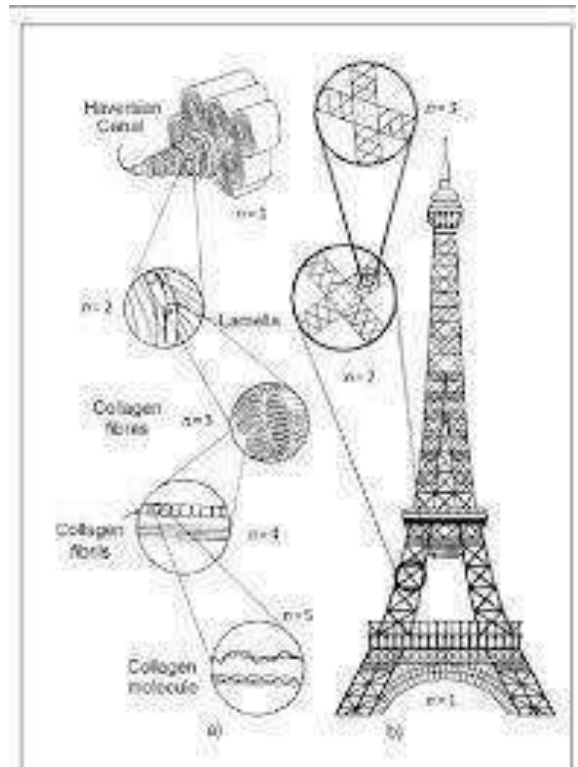


Fig 5 Bone internal structure & Eiffel tower

Source:

Meenakshi Sundaram and G K Ananthasuresh in their paper “Gustave eiffel and his optimal structure”[21]



Fig 6.a Victoria Amazonica leaves



Fig 6.b Pier Luigi Nervi roof

Source:

Fig 6.a

<https://in.pinterest.com/pin/318277898639049456/>

Fig 6.b

<https://www.pinterest.co.uk/pin/544794886167830366/>



Fig 7.a chapel in Nagasaki, Japan

Source:

<https://www.designboom.com/architecture/yu->

momoeda-architecture-office-agri-chapel-japan-01-03-2018/

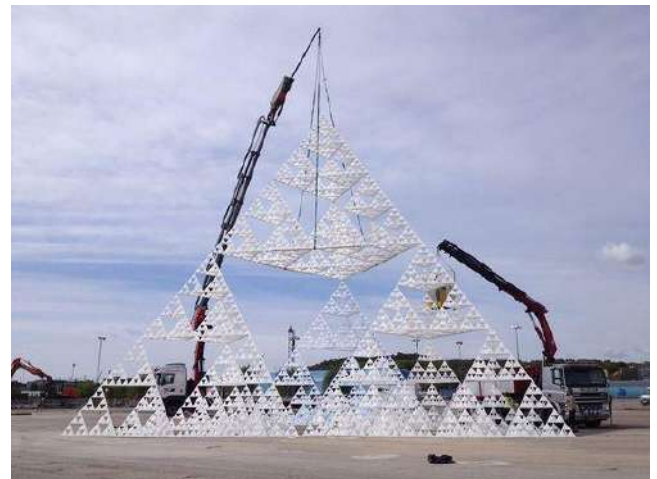


Fig 7.b 3D print fractal pyramid

Source:

<https://www.pinterest.co.kr/pin/286541595019046905/>

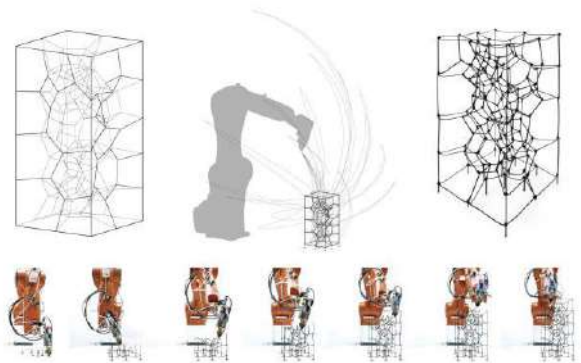


Fig 7.c Robotic fabrication

Source:

<https://web.mit.edu/yijiangh/www/publications/>

## VI. CONCLUSION

This paper briefs about one of the greatest secrets of nature's design: irregularity, self-similarity, repetition, optimality, fractal dimensionality. The degree of their self-similarity and their mode of formation is the basis of their classification. There are infinite types of fractals present in nature. A research review is established to identify the direct relation between fractal geometry and the structural elements. Architects and engineers are using this concept of self similarity and fractal geometry from the ancient to contemporary time consciously or unconsciously. Which give beautiful structural forms with great efficiency and optimality. Fractal geometry supports creativity and builds a connection between human and nature. The idea for new structural forms helps architects and engineers in defining

new senses of structures. Many research has used this concept in form finding and optimization problems. Furthermore, computational tools and advancement in technology will act as catalyst and supportive agent to explore the new structural forms, which are efficient, lightweight weight, optimal, and economical along with aesthetical beauty.

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- [15] [https://www.pinterest.com.mx/pin/286541595019046905/?amp\\_client\\_id=CLIENT\\_ID\(&mweb\\_unauth\\_id=%7B%7Bdefault.session%7D%7D&\\_url=https%3A%2F%2Fwww.pinterest.com.mx%2Famp%2Fpin%2F286541595019046905%2F](https://www.pinterest.com.mx/pin/286541595019046905/?amp_client_id=CLIENT_ID(&mweb_unauth_id=%7B%7Bdefault.session%7D%7D&_url=https%3A%2F%2Fwww.pinterest.com.mx%2Famp%2Fpin%2F286541595019046905%2F)
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## **Cinema and interfaces in approaches related to respect for diversity and sexual orientation: Experience report**

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**Keywords—** *Sexuality. Gender Identity. Gender and Health. Motion Pictures as Topic. Sex Education.*

**Abstract—** *Objective: to report the experience of nursing students related to educational practice through cinema and its interfaces in approaches related to respect for diversity and sexual orientation. Method: experience report that aims to describe aspects experienced in the opportunity of an educational action that was developed by students from the seventh period of the Bachelor's Degree in Nursing, in a private Higher Education Institution in Belém, Pará, Brazil, from September to October 2019. Results: 19 students from the first year of the undergraduate nursing course participated. The experience provided the realization of the importance of actions in Health Education, which must be performed in different scenarios of society. It was evident that a Health Education activity, based on the real needs of the target population, has the potential to cause significant changes in lifestyle habits, promoting health. Conclusion: the intervention proved to be a powerful educational tool to contribute to paradigm shifts in health education. The experience and the thematic approach provided deep reflections on the importance of Health Education and the systematic planning of educational activities that meet the real needs of the population, which was facilitated in this experience by the choice of the methodological strategy.*

## I. INTRODUCTION

For a long time, intimate relationships between people of the same sex were seen, according to prevailing morals, as sin, perversion, deviation or crime. Affective relationships and variants of sexual desire such as homosexuality, bisexuality and transsexuality are often incorporated in society's imagination as evidence of deviation, disease or character flaw, drawing on the involved meanings and disqualifying representations that reinforce prejudices, stigmas and promote discrimination and intolerance<sup>1</sup>.

One of the most controversial issues in recent years has been the struggle for freedom of sexual orientation, which is one of the results of an arduous struggle for official

recognition by the state of same-sex unions, and whose discussion has been expanded to other types of manifestation of human sexuality, what is called sexual diversity “on the different nomenclatures”<sup>2</sup>.

When addressing issues about sexuality, it is understood that it is a fundamental and essential constituent for the existence of an individual, being present and impacting throughout the extension and dimensions of life and in the social networks that are built in it, both in interpersonal relationships, as in intrapersonal relationships that involve the subjectivity of the individual, more specifically, the relationship between them, which ultimately determines the ways of being, seeing, thinking and revealing themselves to society, as sexuality is the



main constitutive element of identity and personality, as it unifies the biological, psychological and social dimensions<sup>3</sup>.

Loving someone of the same sex, and being in love as in any relationship in which we bond, has presented itself in a more challenging way for homosexuals and other representations of human sexuality, since the risks of encounter and mismatch of loving someone symbolize breaking up with the sociocultural world that individuals are inserted in<sup>4</sup>.

In this context, the ways to express sexuality are determined by a complex interaction of factors. They can be affected by the individual's relationships with others, by the circumstances of his life or by the culture in which he is inserted, which denotes, therefore, that the mode of expression of sexuality is something built gradually during growth and psychosocial development, in the face of their relationships with others, reflecting the evolutionary experiences of human beings during their life cycle, delimited by what was commonly chosen to be characterized as performance and gender identity<sup>3</sup>.

Gender as a constitutive element of social relations between men and women is a collective, social, historical, political and economic construction. It is built and fed based on symbologies, norms and institutions that define paradigms of masculinity and femininity. In this way, the sex/gender system operationalizes power relations, initially delimiting and reinforcing patterns of behavior, acceptable or not for men and women, and, more recently, allowing generalizations for the interpretation of new forms of expression of the sexuality of individuals, such as sexual diversity<sup>5</sup>.

Talking about sexual diversity is to rescue elements to understand meanings and make sense of this social construction, which is revealed from a sexual identity. Such sexual identity is defined based on four criteria: biological sex (characterized by the genetic definition); gender identity (the perception of each individual as being male or female); social sexual roles (defined by the socially established characteristics of the female and male, from a gender perspective); and sexual orientation (characterized by the sexual affective desire of a subject in the face of another, be it of the opposite sex or of the same sex)<sup>3</sup>.

Sexuality is variable and multifaceted, taking different forms within each person, from the perspective of genders, in societies and operating through a heterogeneous set of discourses and social practices. As a social result, it differs from gender to gender, from class to class and from society to society. Furthermore, sexuality can also be understood as a human condition that the individual has

since birth and that integrates the natural, inalienable and imprescriptible factor<sup>6</sup>.

Contradicting previous ideas, the construction of sexuality and gender happens throughout life, continuously, and is therefore taught. For the author, the definition of male and female is not made at birth and subsequent biological classification of the body as male or female, being the subject of several discussions and still giving rise to heated debates that do not allow consensus at present<sup>7</sup>.

Throughout history, society has been organized through the voice of the heterosexual man (cisgender). The constructions of social representations are born from this worldview, which holds and regulates cultural spaces such as the media, schools, universities, among other social, economic and political scenarios. Currently, homosexuality is a topic that brings together many theoretical and empirical studies, especially among the human sciences that investigate the different forms of expression of this sexual orientation and the social impact it causes. Such repercussions point to a context that still discriminates against homosexuals and places them on the margins of society. Even so, the struggle of homosexuals to have their rights guaranteed under the Constitution is undervalued by certain social groups. These groups criticize the creation of specific laws with the objective of guaranteeing rights such as legalizing marriage, starting a family, having children, sharing the health plan, among other rights, a privilege only for heterosexual couples<sup>8</sup>.

Therefore, it is essential to debate and develop the democratic right to sexuality and examine, from the perspective of human, constitutional and fundamental rights, the various legal norms, whose scope of protection addresses the various manifestations of human sexuality. These rights are inserted in a context that delimits sociocultural parameters for the sexual orientation of its members and that, for a long time, understood heterosexuality as something obligatory, biologically determined. In this sense, sexuality was reduced to the binary regime of male and female, and was configured as a limit between lawful and unlawful, permitted and prohibited<sup>7</sup>.

Conceived for a long time as a pathology, homosexuality has only recently been removed from the category of disease in classification manuals. Some definitions led to the crystallization of this misunderstanding, as in the case of the World Health Organization (WHO), which considered egodystonic homosexuality as a diagnostic category according to the classification of mental disorders by the American Psychiatric Association, that is, when the individual is

uncomfortable with his sexual orientation, which induces him to seek treatment<sup>9</sup>.

Even though the inspiring model of Western society, the nuclear family, is increasingly becoming a minority experience, given the emergence of distinct family arrangements, the traditional idea of families formed by heterosexual, monogamous and procreative marriage, appears as an installed norm in the collective imagination, with the other family configurations being classified based on this understanding of the “gold standard”. This family configuration tends to be seen as immutable, unequivocal and natural, mischaracterizing the family as a social and historically constructed institution. This is analogous to what happens with heterosexuality, considered natural, according to divine laws, which would justify the prejudice against homosexuality. In this discussion, Brazil has been the stage of recent clashes, debates, and redefinitions about the themes that involve Gays, Lesbians, Bisexuals, Transvestites, among others (GLBTQIA+)<sup>10</sup>.

In this context, the experience, concretely lived or represented, of the moral dilemmas addressed is fundamental in the educational process, as it determines motivation and the active search for knowledge. The images and emotions presented on the screen constitute alternative paths that stimulate rationality. Therefore, cinema can play several roles (pedagogical, interpretive and experimental) in education, which contribute to the reflection and reinterpretation of social dilemmas. It can be a facilitating instrument for communication between educators and students as it is a didactic tool that meets the prevailing cultural pattern today. It ends up optimizing the possibility of seeing, hearing and experiencing something not experienced in reality. Thus, both fictional and non-fiction narratives (documentaries) offer students the opportunity to move from mere abstraction to a portrait cut from the concrete through an artistic representation of the concepts and themes addressed in the theory<sup>11</sup>.

Fictional films make desires, fears, longings and nightmares visible and audible, and express what is, may become or never will be. They can, therefore, indicate infinite ideas and points of view that can make it possible to accept or reject established concepts. On the other hand, documentaries represent aspects of a world that has already been occupied and shared and can therefore provide realities and worldviews to be explored and understood. Indeed, cinema enables the student and educator to reflect, reassess prejudices and re-signify them through the stories and narratives of others. In this sense, cinema allows the student to recreate preexisting humanistic values, which are so important personally and professionally for the benefit of future clients<sup>12</sup>.

Another important aspect is related to the opportunity that cinema creates to establish a varied, complex, multidisciplinary, less formal dialogue, outside the molds and limitations imposed by theory. These dialogues generate discussions capable of expressing the students' personal experiences, stimulating debate and providing a new look from the student to the object of study<sup>11</sup>.

From this perspective, this study seeks to reconcile the insertion of the curricular components of the undergraduate nursing course with the approach to controversial issues, using cinema as an educational tool. Given the above, the following questions emerged: what is the perception of nursing students regarding educational practice as a didactic tool to address issues related to respect for diversity and sexual orientation? And what is the impact that dynamic educational actions, focused on the individual, can provide?

Thus, the objective of the study was to report the experience lived by nursing students related to educational practice through cinema and its interfaces in approaches related to respect for diversity and sexual orientation, in order to promote debate, encourage reflection among participants, and consequently generate, on their part, critical reasoning and intellectual autonomy, thus enabling an expanded assessment of the impact that stimulating educational actions may provide.

## II. METHOD

Experience report that aims to describe aspects experienced by the authors, in the opportunity of an educational action that was developed by students of the seventh period of the Bachelor's Degree in Nursing, in a private Higher Education Institution in Belém, Pará, Brazil in the period from September to October 2019, after prior authorization from the coordination and direction. It is a qualitative approach, which addressed the problem outlined from descriptive, observational and participatory methods in the light of the problematization theory. The experience report is a descriptive research tool that presents a reflection on an action or a set of actions that address a situation experienced in the professional sphere of interest to the scientific community<sup>13</sup>.

The project of this research was not submitted to the Research Ethics Committee because it is an experience report of the authors, with the consent of the place where the action took place and guarantees of confidentiality of the data of those involved. The following data collection techniques were used: field diary, structured observation (participant researcher) and participation in activities (educational action). Personal data were not used, only

those of interest to the study, but without making any mention of data that could identify the participants.

The problematization has as basic axis the action-reflection-action that leads the process and has in Paulo Freire's studies, its origin, when the educator allows the student to perceive himself/herself as being inserted in the world, trying to respond to new challenges. The problems that must be studied start from a real scenario and have their political-pedagogical work marked by a critical posture of education<sup>14</sup>. It is described by an arc, as can be seen in Figure 1, in which there are five steps: observation of the problem, identification of the most important factors about the problem, study of the causes of the problem, development of solution hypotheses and, finally, actions to solve the problem<sup>15</sup>.

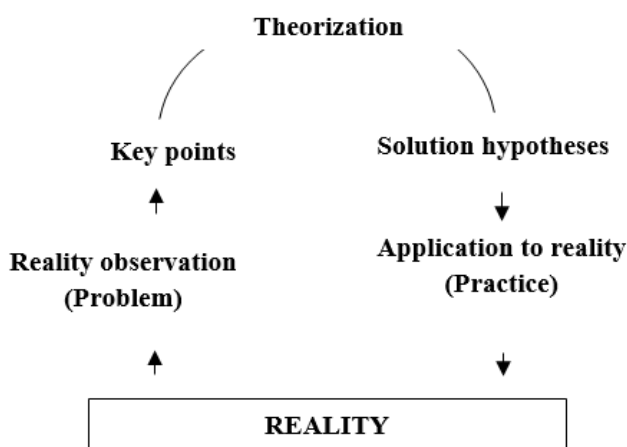


Fig.1: Charles Maguerez's Arch Method. Prepared by the authors, adapted from Miter et al. 2008<sup>16</sup>.

Therefore, problematization was the selected methodology for planning the activities proposed in this experience. During the reality observation phase, the students were instigated by the facilitator, starting from a generator theme "Issues related to respect for diversity and sexual orientation", to identify possible problems of solution abstracted from the dynamic reality, and elaboration of key points. Then, the students proceeded to theorization, with the objective of collecting scientific information in databases in the health area, in order to establish a theoretical-scientific basis and update information, in order to support action planning educational.

The solution hypothesis generated, then, was to elaborate a Health Education action based on the needs of the target population, with the concern to implement and adopt these habits not only in the academic environment, but in everyday life.

The educational action consisted of thematic cinema "SuperCine ESAMAZ", untying the knot of prejudice", using the film "To Wong Foo, Thank you for everything! Julie Newmar". Because it is aimed at the adult audience, which facilitated the approach of the team with the participants, in addition to promoting socialization and facilitating the reception.

After building the action proposal, the desire to convert the film's presentation into something more attractive and meaningful to the participants arose. Therefore, the coordination was consulted about the possibility of offering snacks and gifts during the educational action. Students will raise funds for the creation of gifts. At the end, a conversation circle was held for socialization and feedback.

The development of the activity took place in a single day, in the morning, in the space of the educational institution itself. Students from the 1st period of the nursing course participated in the educational action, totaling 19 participants.

The activity began with the presentation of students, with the objective of socialization. Then, the film was presented, lasting 1 hour and 48 minutes. After the film, a documentary about people (LGBTQIA+ and cisgender) who suffered some type of homophobic and racist violence was presented, lasting 9 minutes.

Thus, there was a round of conversation at the end, in which the participants were asked about the lessons presented in the story and their opinion on the subject discussed. This stage of the activity was of great importance in the Health Education process, as it provided clarification of doubts and feedback. After the conversation round, the gifts were distributed. The activity ended with a snack and socialization among the participants.

### III. RESULTS AND DISCUSSION

The experience provided the realization of the importance of Health Education actions, which must be performed in the most diverse scenarios, including in the academic environment. It is because of the importance of different knowledge that one sees the importance of the nurse's improvement, and one should always think of Article 14 of the nursing professionals' code of ethics, which states that the professional must improve their technical, scientific, ethical knowledge, cultural and humanistic, for the benefit of the person, family and community and the development of the profession<sup>17</sup>.

Health promotion is understood as a combination of educational and environmental support networks that aim

to achieve dimensions of life conducive to health and that involve the construction of attitudes and values that lead individuals to autonomous behavior, reverting to the benefit of self and of those around<sup>18</sup>.

The theme of this educational action was selected from the identification of a problem in the daily life of the target population, which allowed students to understand that Health Education actions are only valid when they meet the population's demands, needs and expectations.

Based on this understanding, we emphasize that health promotion actions should not be limited to just providing knowledge. We need to motivate learning, encourage students to analyze and evaluate information sources and, therefore, enable them to adopt behavioral practices based on knowledge<sup>18</sup>.

The interesting thing about this activity was that the topic addressed, in the first analysis, would not draw the attention of the participants in the context in which it was carried out. The importance of carrying out health actions based on the interests and needs that emerge from people's reality is emphasized. It is noteworthy that to meet this criterion, the authors initially performed a sensitive listening, using the brainstorming technique. It is likely that the impact caused by a previously planned action, without taking into account the interests of the participants, without the researchers having prior contact with the reality of the target population and observing the real needs, was little accepted by those involved.

It is described that, for a long time, health education focused its action on individualities, trying to change behaviors and attitudes, often without considering the countless influences arising from the reality in which people were inserted. It was common for isolated actions aimed at work for health, based on an assistencialist view of education and without discussing the awareness of the health theme and its interrelationships for the dynamic balance of life<sup>19</sup>.

We believe that, if health actions were based only on the expectations of students and teachers, they could result in an action whose theme was related to pathologies and decontextualized from the reality of the participants, causing little impact and timid changes in behavior. However, the experience and previous and dialogic contact with the participants showed that the problem that needed a solution was another, completely different, and not related to diseases.

The feedback provided by the participants of the activity to the organizers was very positive, with acceptance and appreciation of the knowledge built, with deep reflections identified through the speeches. Thus, it was found that a Health Education activity, based on the

real needs of the target population, can cause significant changes in lifestyle habits, promoting health. It is noteworthy that the orientation and planning of the activity from a real problem identified in practical experience were essential to support the action.

Thus, we found that a Health Education activity, based on the real needs of the target population, can cause significant changes in lifestyle habits, promoting health. We also emphasize that the orientation and planning of the activity based on a real problem identified in the practical experience in the field were facilitated by the methodology used, based on the problematization theory.

The action of health professionals in educational practices requires assistance based on the theoretical-practical domain, built from practical experiences and during graduation. We also note the importance of support and guidance meetings, as a bond of trust is needed between the educator and the student together with the family. Thus, the promotion of actions aimed at improving the quality of life tends to be facilitated.

We emphasize that it is not new that the link between health and education is recognized. From the perspective and argument of this intimate connection between the two areas, there is at least a consensus: good levels of education are related to a healthier population, just as a healthy population has greater possibilities to seize knowledge, formal education and informal<sup>20</sup>.

#### IV. CONCLUSION

The Intervention Project proved to be a powerful educational tool to contribute to paradigm shifts in training and in the care model. The development of the Health Educational action in the academic environment, related to the addressed theme, provided the participants with a positive impact, a fact identified through the steps developed during and after the educational action. The way in which information on the topic was addressed enabled everyone to actively participate, facilitating learning.

The experience and the thematic approach provided deep reflections on the importance of Health Education and the systematic planning of educational activities that meet the real needs of the population, which was facilitated in this experience by the choice of the methodological strategy through the problematization theory.

This experience also provided the opportunity to develop skills in students as facilitators of the educational process, in order to promote changes and ensure a healthy life context for the community in their future profession.

Therefore, there is a need for planning, organization and awareness of the team and users to participate in the proposed activities.

Through this action, it was possible to provide a theoretical and practical learning of stages such as the identification of needs, possibility of carrying out the activity, teaching-service integration and evaluation of the activities developed. We understand that health education should contribute to the individual's self-training, in order to teach and promote the quality of life and the human condition, teach how to live and teach how to become a citizen, in addition to being understood as a proposal to develop in the individual and in the group the ability to critically assess their reality, as well as to decide on joint actions to solve problems in their microspace and modify the health-disease conditions, in order to organize and carry out the action and evaluation her critically.

The higher education of health professionals was historically built on the fragmentation of content and organized around power relations, which gave the specialist teacher a central position in the teaching-learning process. This construction was linked to excessive specialization and distancing from the curricular content necessary for the formation of a health professional with a profile capable of meeting the needs of the population.

Teachers must seek strategies to innovate the teaching of practice, with health education being an effective tool in the modern context of health care. The practical moments aim at developing the skills necessary to master competence in the areas of health, management and systematization of care. They are privileged spaces that focus on real health care practices. Students have contact with the dynamic reality, accompanied by a facilitator who will assess the performance of the skills aimed at the profile of the professional to be trained.

All this innovation helps the facilitators to contribute to the excellence of the teaching-learning process, which is increasingly focused on what the job market requires from a professional nurse; thinking, critical, reflective in their doing. At the same time, nursing students begin to think and rethink their training, still seeing in the academy the need to build and develop their technical and scientific skills, and not least, attitudinal.

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# **Sustainable Rural Development: The contradictions and possibilities of Agroecology and Solidarity Economy Contributions**

## **Desenvolvimento rural Sustentável: As Contradições e as possibilidades de Contribuições da Agroecologia e da Economia Solidária**

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**Keywords— Sustainable rural development. Agroecology. Sustainable goals.**

**Abstract—** *This article is a reflection on sustainable development, from a rural and local perspective. The text is presented as a counterpoint to the logic of globalization, according to which it is possible under the hegemony of capitalism to successfully undertake sustainable development on a world scale. However, the complexity of the theme and the enormous difficulties for the implementation of the decisions of the world forums made since the pioneer Eco-92 until the most recent Agenda 2030 were evidenced. On the other hand, the article seeks to highlight aspects in which the emergence of Agroecology can contribute to the establishment of sustainable rural development strategies, emphasizing some elements that can serve as guidelines for this new praxis. Furthermore, a reflection is developed on the importance of local or endogenous development, highlighting the importance of local knowledge, as a basic strategy for*

agroecological transition processes. Finally, it is reaffirmed that the path to be followed to achieve sustainability goals is complex, but it is a path of political struggle that should never be abandoned.

**Resumo**— O presente artigo é uma reflexão sobre o desenvolvimento sustentável, dentro de uma perspectiva rural e local, abordando as correntes que abordam o ambientalismo. O texto é apresentado como contraponto à lógica da globalização, segundo a qual é possível sob a hegemonia do capitalismo empreender com sucesso o desenvolvimento sustentável em escala mundial, conciliando desenvolvimento e conservação ambiental consoante os ensinamentos do ambientalismo moderado. Entretanto, é evidente a complexidade do tema e as enormes dificuldades para a implementação das decisões dos Fóruns Mundiais realizados desde a pioneira Eco-92 até a mais recente Agenda 2030 diante das contradições da pauta. O artigo procura destacar aspectos em que a emergência da Agroecologia pode contribuir para o estabelecimento de estratégias de desenvolvimento rural sustentável, enfatizando alguns elementos que podem servir como orientadores para essa nova prática, como fonte de justiça social. Ademais, se desenvolve uma reflexão sobre a importância do desenvolvimento local ou endógeno na ótica da ecologia política, destacando a importância do conhecimento local e o desenvolvimento territorial, como estratégia básica para processos de transição agroecológica e busca do desenvolvimento rural sustentável.

**Palavras-chave**— Desenvolvimento rural sustentável. Agroecologia. Objetivos sustentáveis.

## I. INTRODUÇÃO

O Ecossistema é a unidade funcional básica, uma vez que inclui tanto organismos (comunidade biótica) como o ambiente abiótico, cada um deles influenciando as propriedades do outro, sendo ambos necessários para a conservação da vida tal como existe na terra (ODUM, 2004). De observar que a condição necessária dessa interação entre organismos vivos e o ambiente é o equilíbrio natural do sistema, sustentável portanto. Dessa capacidade de sustentação de um sistema surge a noção de sustentabilidade.

De acordo com Nascimento (2012), a sustentabilidade possui duas origens: a biológica e a econômica. Numa perspectiva ecológica pode-se citar que diante das agressões antrópicas (uso abusivo dos recursos naturais, desflorestamento, fogo etc.) ou naturais (terremoto, tsunami, fogo) surge a capacidade de recuperação e reprodução dos ecossistemas. Dessa resiliência advém a sustentabilidade. Já no viés econômico, por sua vez, o conceito tem relação direta com produção, consumo e capacidade de equilíbrio com a finitude dos recursos naturais, como adjetivo e suporte de desenvolvimento.

A partir dessas premissas advém as diversas doutrinas e correntes abordando as pautas de sustentabilidade e desenvolvimento sustentável, para relacionar ecologia e economia fomentando as antinomias e possibilidades da temática. Sobressai nesse aspecto três abordagens teórica sobre o movimento ambiental, quais sejam: 1) a ecologia radical, que engloba a ecologia tradicional, o protecionismo, o conservacionismo, a ecologia profunda, a economia ecológica e outras correntes que enfatizam o enfoque ecológico; 2) o ambientalismo

moderado, que enfoca basicamente a conciliação do crescimento econômico, do desenvolvimento social e da conservação ambiental, por meio do desenvolvimento sustentável; e 3) a ecologia política, que propõe a análise dos problemas ambientais em função do seu contexto socioeconômico e político-ideológico (JATOBA; CIDADE; VARGAS, 2009).

Por assim dizer, a proposta deste artigo é examinar as contradições que envolvem o Desenvolvimento Sustentável em suas abordagens teóricas em escala macro ou global, e, por outro lado, lançar luz sobre a alternativa possível de estabelecimento de um processo micro ou local de desenvolvimento rural sustentável com base na agroecologia.

Em primeiro lugar, buscou-se entender o significado do termo – desenvolvimento sustentável – e processar uma análise sucinta deste na agenda global, desde os primeiros debates em torno do ecodesenvolvimento nos anos 70, nos primeiros fóruns internacionais, até a criação do termo Desenvolvimento Sustentável a partir do *Relatório Brundtland* da Organização das Nações Unidas de 1987, que o define como o desenvolvimento que "satisfaz as necessidades do presente sem comprometer a capacidade das gerações futuras satisfazerem as suas próprias necessidades". Outro marco importante a ser considerado na formação do aludido conceito foi a realização da Conferência das Nações Unidas sobre o Meio Ambiente e o Desenvolvimento, também conhecida por Rio 92 ou Eco-92. O documento mais recente tem sido a Agenda 2030 para o Desenvolvimento Sustentável, apresentada aos Chefes de Estado e de Governo e Altos Representantes na



sede das Nações Unidas, em Nova York, de 25 a 27 de setembro de 2015.

Em sequência, são apresentadas as contradições sistêmicas ao desenvolvimento sustentável global, cuja dinâmica de funcionamento da economia capitalista comandada por meio das empresas multinacionais concentram riqueza e aumenta a desigualdade no mundo.

Por sua vez, discutem-se o conceito de agricultura sustentável em meio às contradições impostas pelo sistema capitalista em vigência. Mostram-se também a falácia no cumprimento dos objetivos da Agenda 2030 por parte do Brasil, signatário da agenda em companhia de outros 192 países ao redor do globo terrestre. Tanto Tribunal de Contas da União (TCU) quanto o Grupo de Trabalho da Sociedade Civil (GTSC) avaliaram a falta de empenho por parte do Governo brasileiro na implementação dos objetivos da Agenda 2030, especificamente o 2º objetivo voltado para “Erradicar a fome, alcançar a segurança alimentar, melhorar a nutrição e promover a agricultura sustentável.”

Posteriormente, discutem-se o desenvolvimento rural sustentável possível em cujo contexto se impõe um debate sob o ponto de vista micro ou local, considerando a máxima de pensar global, agir local. Cogita-se que a natureza e a dinâmica desse desenvolvimento devam ser implementadas em base local, porque é nessa instância que se pode contrapor à capacidade de influência do capital ou do poder instituído através de alguma espécie de controle social legitimamente instituído. Outro fator de grande potencial em favor do desenvolvimento rural sustentável é a agroecologia em razão dela proporcionar uma produção agrícola que não expõe o meio natural aos danos provocados pela agricultura convencional, além de resgatar os “modos de vida” e os conhecimentos das comunidades que trabalham e vivem basicamente da agricultura, agregando as propostas agroecológicas ao desenvolvimento da agricultura familiar.

Conclui-se o artigo com o entendimento de que a implementação do Desenvolvimento Rural Sustentável depende de mudanças profundas do modelo de desenvolvimento vigente na sociedade contemporânea, isto é, entre outros aspectos, na elaboração de estratégias de desenvolvimento fundamentadas nas linhas local e regional. Por sua vez, isso depende de decisões política da sociedade civil para impor instrumentos de política agrícola, ambiental e sociocultural que estimulem a adoção por parte dos agricultores familiares de modelos agroecológicos de produção.

## II. DESENVOLVIMENTO SUSTENTÁVEL NA AGENDA GLOBAL

A consciência pública ambiental floresceu e tomou dimensão a partir dos anos cinquenta no século passado, diante das questões nucleares, uso de agrotóxicos em escala mundial, poluição desenfreada, uso intenso de fontes de energia para abastecer a produção, aumento da população mundial e as crescentes degradações ambientais. Ressalta-se nessa esteira os eventos sobre meio ambiente e desenvolvimento pertinentes ao presente artigo, destacando-se o evento do Clube de Roma fundado em 1968 que tratou sobre o futuro da humanidade diante de questões como poluição, energia, saneamento, população, ambiente, tecnologia etc.

De consequente ocorreu a Conferência das Nações Unidas sobre o Meio Ambiente Humano (CNUMA), realizada em Estocolmo em 1972, focando na possibilidade de se alcançar o crescimento econômico e industrial sem agredir o meio ambiente. Anos mais tarde a Organização das Nações Unidas (ONU) instituiu, em 1987, a Comissão Mundial sobre Meio Ambiente e Desenvolvimento (CMMAD) dirigida pela ex-primeira-ministra norueguesa Gro Harlem Brundtland, apresentou o relatório *Our common future*, que tinha como missão propor uma agenda global conciliando a preservação do meio ambiente com o desenvolvimento econômico, onde se atribui a gênese do termo Desenvolvimento Sustentável (NASCIMENTO, 2012).

O relatório *Our common future* acrescenta à perspectiva ambiental a dimensão social, na medida em que trata a pobreza como uma das maiores causas de degradação ambiental. Aqui a sustentabilidade passa a ser percebida sob os aspectos ambientais, econômicos e sociais, de sorte que somente se concebe nessa ótica uma sociedade sustentável erradicando a pobreza e as desigualdades sociais. Dessa forma, o citado relatório traz como predicado fundamental do desenvolvimento sustentável o fato dele ser multidimensional, isto é, deve considerar as dimensões ambiental, econômica, social, político-institucional e histórico-cultural.

Conforme questiona Nascimento (2012), é pertinente nos perguntarmos se as três dimensões (econômica, ambiental e social) da sustentabilidade são suficientes, e qual o seu significado. Consequência lógica desse questionamento é a análise das contradições e possibilidades do desenvolvimento sustentável.

Merece destaque ainda outro marco importante a ser considerado na formação do aludido conceito que foi a realização da Conferência das Nações Unidas sobre o Meio Ambiente e o Desenvolvimento, também conhecida por Rio 92 ou Eco-92, em que 173 chefes de estado e de

governo aprovaram um documento, e onde igualmente foi elaborada a primeira versão da Carta da Terra, que é a busca de um modelo de sociedade em que todos sejam responsáveis por ações de paz, respeito e igualdade. Entretanto, a Carta da Terra somente foi ratificada e assumida pela Unesco em 2000 com a adesão de mais de 4.500 organizações do mundo, incluindo o Brasil.

Além de cuidar pelo bem-estar mundial ao tratar de temas éticos de grande importância para todos os cidadãos do século XXI, a Carta da Terra também se constitui em um extraordinário instrumento de educação. Em 2002, as Nações Unidas lançaram a Década da Educação para o Desenvolvimento Sustentável (2005-2014).

Por derradeiro, o documento mais recente sobre Desenvolvimento Sustentável tem sido a Agenda 2030, apresentada aos Chefes de Estado e de Governo e Altos Representantes na sede das Nações Unidas, em Nova York, de 25 a 27 de setembro de 2015, que é baseada nos princípios e objetivos da Carta das Nações Unidas, incluindo o pleno respeito ao Direito Internacional. Fundamenta-se na Declaração Universal dos Direitos Humanos, nos tratados internacionais de direitos humanos, na Declaração do Milênio e no documento final da Cúpula Mundial de 2005. Contempla 17 objetivos de desenvolvimento sustentável<sup>1</sup> e 169 metas associadas que entraram em vigor em janeiro de 2016 e orientarão as decisões tomadas até 2030. Tal agenda tem como norte a erradicação da pobreza como maior desafio global e premissa básica para o desenvolvimento sustentável.

Diante do articulado, necessário se faz questionar se é possível conciliar crescimento econômico, conservação ambiental e desenvolvimento social, contemplando toda essa agenda global dos organismos internacionais em conexão com as abordagens teóricas sobre o tema. (JATOBA; CIDADE; VARGAS, 2009).

### III. CONTRADIÇÕES SISTÊMICAS AO DESENVOLVIMENTO SUSTENTÁVEL

A questão ambiental começou a ter grande repercussão a partir dos anos 70 do século XX. Em quase todo o mundo, especialmente nos países desenvolvidos,

<sup>1</sup> 1. Erradicação da pobreza, 2. Fome zero e agricultura sustentável, 3. Saúde e Bem-estar, 4. Educação de qualidade, 5. Igualdade de gênero, 6. Água limpa e saneamento, 7. Energia limpa e acessível, 8. Trabalho de decente e crescimento econômico, 9. Inovação infraestrutura, 10. Redução das desigualdades, 11. Cidades e comunidades sustentáveis, 12. Consumo e produção responsáveis, 13. Ação contra a mudança global do clima, 14. Vida na água, 15. Vida terrestre, 16. Paz, justiça e instituições eficazes, 17. Parcerias e meios de implementação.

surgiram preocupações com o impacto inerente à sociedade industrial avançada, ao progresso e aos modelos de desenvolvimento, ao consumo desenfreado da sociedade moderna, à superexploração dos recursos naturais e a possibilidade de comprometimento da sobrevivência da humanidade em escala planetária (VIOLA; LEIS, 1990 apud, DE CARLO, 2006).

Boaventura de Sousa Santos (1996) afirma que a modernização científico-tecnológica apresentou consequências inevitáveis: o agravamento da injustiça social devido à grande concentração de riqueza e a exclusão social; devastação ecológica e com ela a destruição da qualidade de vida e mesmo a sustentabilidade da vida no planeta. O cenário de crise possibilitou reações organizadas de forças contra-hegemônicas comprometidas com o equacionamento dos problemas ambientais. Desenvolveu-se de forma mais consequente e participativa a ideia de que era preciso e urgente tornar efetivo o conceito de desenvolvimento sustentável como uma aposta num futuro diferente do presente.

A constatação da problemática ambiental fez surgir muitos fóruns e conferências destinados a debater alternativas ao estado em que se encontrava o meio ambiente, devido à ação predatória de um modelo de desenvolvimento admitido como insustentável. O mundo assistiu ao surgimento do ambientalismo como movimento social, em reação à ação destrutiva do homem sobre a natureza. O discurso ambiental deu ensejo ao surgimento das Organizações Não-Governamentais - ONGs, que com uma linguagem alternativa e pressionando fortemente os governos nacionais e organizações internacionais, assumiram uma importância muito grande no debate da problemática ambiental sob uma nova perspectiva.

No campo acadêmico, a partir de meados dos anos 1970 começaram a surgir estudos e pesquisas como tentativas integradas de reflexão sobre a questão ambiental. Estimulados pela crescente atividade de grupos ambientalistas, os sociólogos norte-americanos Riley Dunlap e William Catton começaram a elaborar trabalhos sobre o ambientalismo e o movimento ambiental, propondo um Novo Paradigma Ecológico que eliminasse as divisões no âmbito da teoria sociológica e incorporasse uma explicação menos antropocêntrica, colocando em seu lugar uma abordagem ecocêntrica (HANNIGAN, 1995).

De Catton e Dunlap, Hannigan (1995) sintetiza o interessante modelo das três funções competitivas do ambiente. Um modelo que toma o ambiente como habitat, manancial e depósito.

O modelo de Catton e Dunlap especifica três funções gerais que o

ambiente oferece aos seres humanos: “armazém de provisões”, espaço para viver e depósito de resíduos. Utilizado como um *depósito de resíduos*, o meio ambiente é um recurso de fontes naturais renováveis e não renováveis (ar, água combustíveis fósseis) que são essenciais à vida. A utilização em excesso destes recursos resulta na sua diminuição ou escassez. O *espaço para viver* ou *habitat* fornece o alojamento, sistemas de transportes e outros elementos essenciais para a vida. A sobreutilização desta função resulta no excesso populacional, congestão e destruição de *habitat* de outras espécies. Com a função do *depósito de resíduos*, o ambiente serve como “esgoto” para o lixo doméstico e industrial e para outros subprodutos. Exceder a capacidade dos ecossistemas de absorver os lixos resulta em problemas de saúde com origem nos resíduos tóxicos e na ruptura do ecossistema (HANNIGAN, 1995, p. 29) [Grifos do autor].

Por esta reflexão teórica, as funções competitivas do meio ambiente para as sociedades humanas implicam em uma situação dramática, em que a sobrecarga de uma das funções compromete a realização plena das outras duas funções. A sobrecarga da função manancial compromete a realização da função habitat limitando o espaço para viver, bem como sobrecarregando o uso de áreas como depósito de resíduos. A sobrecarga da função habitat, por sua vez, pelo uso excessivo de áreas para fundação de cidades, compromete os mananciais de abastecimento e a disponibilidade de áreas produtivas, além, claro, de que os assentamentos humanos produzem resíduos sólidos, gases e efluentes líquidos que são despejados no ambiente, muitas vezes sem os devidos cuidados, comprometendo a qualidade de vida nas cidades e seus entornos.

A grande repercussão da questão ambiental, incluindo preocupações e críticas relativas aos padrões de produção e consumo inerentes à sociedade industrial avançada indica a necessidade da passagem do modelo de crescimento baseado na exploração crescente e insustentável dos recursos naturais a uma alternativa de relação sociedade e natureza que permita reduzir o impacto ambiental das atividades humanas, o desenvolvimento sustentável.

O conceito de desenvolvimento sustentável tem encontrado inúmeros defensores, muitas vezes sem análise criteriosa de seus limites e possibilidades explicativas. Uma crítica do conceito como ele aparece originalmente no Relatório Nosso Futuro Comum da ONU evidencia que o conceito contém elementos contraditórios:

por um lado seus defensores investem nos avisos a respeito dos limites do meio ambiente e acerca dos perigos de não respeitá-los, e, por outro, enfatizam exortações ao avanço determinado em direção da ‘nova era de crescimento econômico’ [...] Esse seu caráter dúbio favorece sua utilização no sentido de encobrir práticas questionáveis, oferecendo, sob a aparência de uma política de preservação do meio ambiente, o alibi de que necessitam as operações interessadas de agentes econômicos, buscando sempre o controle de novas áreas e de novas oportunidades de negócios, além de proteger de qualquer possibilidade de alteração o modelo de produção e consumo dominante (GUERRA; FERNANDES; RAMALHO, 2002, p. 26).

O uso indiscriminado do conceito de desenvolvimento sustentável tem servido para orientar políticas e projetos governamentais que expressam preocupações com os problemas ambientais no nível retórico, mas sem questionar o modelo de produção e consumo. “As imprecisões e contradições da noção de desenvolvimento sustentável são as razões de sua aceitação universal, fazendo com que sua definição seja decidida no debate teórico e na luta política entre os defensores do meio ambiente e os defensores do desenvolvimento” (DE CARLO, 2006, p. 39).

É importante considerar que há uma relação inversamente proporcional entre atividade econômica e meio ambiente. Nessa ordem lógica, registre-se que o processo produtivo pressupõe a utilização de fontes de energia para satisfazer as necessidades, escolhas e por via de consequência o mercado. Destacando a finitude dos recursos naturais, quanto mais economia, quanto mais crescimento, naturalmente teremos mais impactos, mais degradação e menos meio ambiente.

Seguindo essa pauta, a visão transdisciplinar da Economia Ecológica aponta que a atividade produtiva não pode ultrapassar limites ditados pela natureza, que possui condição de suporte insubstituível e único. Nesse aspecto,

Cavalcanti (2015) aborda essa contradição sistêmica por meio das leis da termodinâmica, citando que a economia não gera riquezas, mas transformação (metabolismo) de matéria e energia de baixa entropia em matéria e energia de alta entropia. Desta sorte, essas crescentes conversões estão aumentando a temperatura e a entropia do planeta. Ou seja, aumentando a desordem do sistema Terra, com vasta degradação.

Nesse roteiro, a realidade da economia global transita em dimensões antagônicas aos postulados da sustentabilidade. Jorge Streit (2014) ilustra bem essa contradição quando analisa a dinâmica de operação da economia capitalista por meio das empresas multinacionais que concentram riqueza e aumenta a desigualdade no mundo.

Desde o fracasso do socialismo real, no fim dos anos 80, a ideologia capitalista ganhou força por todo o mundo. A especulação e a fusão de grandes grupos de empresas multinacionais levaram muita riqueza para um pequeno número de países, aumentando a desigualdade global. Calcula-se que apenas 20% dos países têm mais de 80% das riquezas do planeta. Por sua vez, os 20% mais pobres sobrevivem com menos de 2% dos recursos. (STREIT, 2014, p, 369).

Henrique Leff, principal expoente da Ecologia política latino-americana, afirma que a questão ambiental aparece como uma problemática social e ecológica de alcance planetário, impactando todos os âmbitos da organização social, os aparatos do Estado e todos os grupos e classes sociais. O alcance generalizado da questão ambiental, entretanto, não pode servir para obscurecer a compreensão de que esta acarreta problemas específicos para comunidades, etnias, setores das sociedades contemporâneas e países envolvidos num intercâmbio desigual, em conflitos distributivos e em oposição entre países ricos e países pobres.

A dívida ecológica põe a descoberto a parte mais perversa, e até agora oculta, do intercâmbio desigual entre países ricos e pobres, quer dizer, a destruição da base de recursos naturais dos países 'subdesenvolvidos', cujo estado de pobreza não é consubstancial a uma essência cultural ou à sua limitação de recursos, mas resulta de sua inserção em uma racionalidade econômica global que superexplorou sua natureza,

degradou seu ambiente e empobreceu seus povos. Esta dívida ecológica resulta incomensurável, pois não há taxas de desconto que consigam atualizá-la nem instrumentos que possam medi-la (LEFF, 2006: 303).

O autor recorre à conhecida formulação de Franz Fanon, afirmando que a "pilhagem do Terceiro Mundo" (FANON, 1968 apud LEFF, 2006) se instrumentaliza através de mecanismos de apropriação da natureza. Países desenvolvidos e empresas transnacionais de biotecnologia com sede nos países desenvolvidos apropriam-se da natureza através da propriedade intelectual sobre os direitos de propriedade das nações e povos pobres. "Para estes últimos, a biodiversidade representa o território onde estão arraigados os significados culturais de sua existência e o patrimônio de recursos naturais e culturais com o qual coevoluiram na história" (LEFF, 2006: 303).

Por sua vez, o teólogo Leonardo Boff (2017) pondera que a mudança de sistema econômico é a única maneira de abolir os problemas sociais e ecológicos do planeta, e sugere a adoção de um novo modelo que combine igualdade social e preservação do meio ambiente.

A sustentabilidade significa a garantia de que todos os seres têm as condições de viver, reproduzir-se e permanecer na natureza. Também diz respeito ao cuidado, que é a atitude subjetiva de renúncia a toda agressão e violação da natureza, de zelo em curar as chagas passadas e impedir as futuras. (BOFF, 2017).

O teólogo Boff acredita que não obstante a relevância do debate alusivo à sustentabilidade já esteja reconhecida, mesmo assim ainda falta empenho efetivo com a procura de um novo acordo entre economia e ecologia na perspectiva da conservação da vida na terra. Diante de consecutivas crises do capitalismo, entende ele que a alternativa procurada com a sustentabilidade deveria resolver prioritariamente os problemas da humanidade e não os do capitalismo.

Desta maneira é fundamental considerar a dimensão ética no desenvolvimento sustentável global para permitir salvar o planeta terra e a natureza devastada, como também deliberar sobre a exclusão de expressivos contingentes humanos do sistema capitalista hegemônico, que provoca a injustiça mundial e traz insustentabilidade. "O capitalismo em sua lógica torna a Terra e a natureza insustentáveis, o que Marx já tinha apontado no terceiro Livro de 'O Capital'. Há uma contradição entre o

desenvolvimento de tipo capitalista e a natureza”. (BOFF, 2017).

Por tal fundamento, o discurso do desenvolvimento sustentável é contraditório ao buscar novos termos para justificar práticas antigas, e não encara de frente a raiz do problema que está no modelo predatório que as empresas e os governos adotam em suas economias. “A ideia de que os povos pobres podem algum dia desfrutar das formas de vida dos atuais povos ricos é simplesmente irrealizável” (FURTADO, 1974).

Segundo Leff (2006), o ‘princípio da sustentabilidade emerge do discurso teórico e político da globalização econômico-ecológica’, de sorte que o capitalismo usa uma roupagem de “sustentabilidade ecológica mais como um critério normativo para a reconstrução da ordem econômica”. De outro modo, pode-se dizer que esse sistema econômico que concentra terras destinadas à produção de monoculturas para exportação, enquanto o povo morre de fome.

#### IV. AGRICULTURA SUSTENTÁVEL EM MEIO ÀS CONTRADIÇÕES NA ÓTICA DA AGENDA 2030 DA ONU

Para procurar compreender as contradições nos debates sobre desenvolvimento sustentável sob ponto de vista macro é necessário ter consciência de que para superar a crise socioambiental do planeta e ao mesmo tempo o sistema capitalista continuar na sua condição de hegemonia há de se realizar profundas mudanças no *modus operandi* desse sistema, principalmente na política fundiária. Segundo os cientistas em geral e os geocientistas em particular, a trajetória histórica do planeta terra face à lógica destrutiva prevalecente do capital é de colapso total.

Diversamente dessa lógica capitalista que somente fomenta o crescimento econômico, o modelo familiar agrário com políticas adequadas, é econômica e socialmente eficiente, sensível às questões ambientais e, por isso, se afirma crescentemente como sustentável ou durável. As contestações à generalização desse modelo, principalmente nas décadas de 60 e 70, representavam uma defesa do latifúndio e da oligarquia ou uma postura ideológica de defesa do comunitarismo empresarial (empresas coletivizadas). Estas críticas foram superadas pela sua eficácia econômica e social inquestionáveis, nos países onde o modelo possui expressividade (GEHLEN, 2004).

Por sua vez, trazendo o debate para a Organização da Nações Unidas (ONU), constata-se que o modelo produtivo da agricultura familiar está em perfeita

consonância com a Agenda 2030, sendo o horizonte para consecução dos objetivos da ONU.

Merece relevância registrar que após reunião com 193 países em 2015, ratificou-se os 17 objetivos do desenvolvimento sustentável, dentre ao quais foi destacado no presente artigo, para efeito de avaliação de desempenho por instituições de controle do aparelho de estado e da sociedade civil. O 2º objetivo do desenvolvimento sustentável da Agenda 2030, o qual tem como enunciado “erradicar a fome, alcançar a segurança alimentar, melhorar a nutrição e promover a agricultura sustentável”, detalhamos no Quadro 1 a seguir.

<b>Quadro 1</b>	
<b>2º Objetivo de Desenvolvimento Sustentável no Brasil:(ODS):</b>	
<b>Erradicar a fome, alcançar a segurança alimentar, melhorar a nutrição e promover a agricultura sustentável.</b>	
2.1 Até 2030, acabar com a fome e garantir o acesso de todas as pessoas, em particular os pobres e pessoas em situações vulneráveis, incluindo crianças, a alimentos seguros, nutritivos e suficientes durante todo o ano.	2.2 Até 2030, acabar com todas as formas de desnutrição, incluindo atingir, até 2025, as metas acordadas internacionalmente sobre nanismo e caquexia crianças menores de cinco anos de idade, e atender às necessidades nutricionais dos adolescentes, mulheres grávidas e lactantes e pessoas idosas.
2.3 Até 2030, dobrar a produtividade agrícola e a renda dos pequenos produtores de alimentos, particularmente das mulheres, povos indígenas, agricultores familiares, pastores e pescadores, inclusive por meio de acesso seguro e igual à terra, outros recursos produtivos e insumos, conhecimento, serviços financeiros, mercados e oportunidades de agregação de valor e de emprego não agrícola.	2.4 Até 2030, garantir sistemas sustentáveis de produção de alimentos e implementar práticas agrícolas resilientes, que aumentem a produtividade e a produção, que ajudem a manter os ecossistemas, que fortaleçam a capacidade de adaptação às mudanças climáticas, às condições meteorológicas extremas, secas, inundações e outros desastres, e que melhorem progressivamente a qualidade da terra e do solo.

<p>2.5 Até 2030, manter a diversidade genética de sementes, plantas cultivadas, animais de criação e domesticados e suas respectivas espécies selvagens, inclusive por meio de bancos de sementes e plantas diversificados e bem geridos em nível nacional, regional e internacional, e garantir o acesso e a repartição justa e equitativa dos benefícios decorrentes da utilização dos recursos genéticos e conhecimentos tradicionais associados, como acordado internacionalmente.</p>	<p>2.a Aumentar o investimento, inclusive via o reforço da cooperação internacional, em infraestrutura rural, pesquisa e extensão de serviços agrícolas, desenvolvimento de tecnologia, e os bancos de genes de plantas e animais, para aumentar a capacidade de produção agrícola nos países em desenvolvimento, em particular nos países menos desenvolvidos.</p>
<p>2.b Corrigir e prevenir as restrições ao comércio e distorções nos mercados agrícolas mundiais, incluindo a eliminação paralela de todas as formas de subsídios à exportação e todas as medidas de exportação com efeito equivalente, de acordo com o mandato da Rodada de Desenvolvimento de Doha.</p>	<p>2.c Adotar medidas para garantir o funcionamento adequado dos mercados de commodities de alimentos e seus derivados, e facilitar o acesso oportuno à informação de mercado, inclusive sobre as reservas de alimentos, a fim de ajudar a limitar a volatilidade extrema dos preços dos alimentos.</p>

Fonte: ONU-Brasil, 2020.

No plano local, para efeito de avaliação de desempenho do 2º objetivo da Agenda 2030 no Brasil, foram utilizadas as informações disponíveis do Relatório do Tribunal de Contas da União (TCU) e do Relatório Luz do Grupo de Trabalho da Sociedade Civil (GTSC), o que nos remete a graves incertezas e contradições.

O Relatório de Políticas e Programas de Governo de 2019, elaborado pelo Tribunal de Contas da União, referente ao acompanhamento da implantação dos Objetivos de Desenvolvimento Sustentável, mais especificamente o 2º objetivo, item 2.4, expresso no Quadro 1 acima, revelou que poucos eventos foram realizados pelo governo brasileiro para pôr em marcha sua implementação.

Entre os exercícios de 2017 e 2019, o Tribunal de Contas da União realizou auditoria coordenada acerca da preparação do governo federal para a

implementação dos ODS. A auditoria tinha por objetivo avaliar a presença de estruturas de governança no governo federal para implementar a Agenda 2030 e a meta 2.4 dos ODS no Brasil e consolidar os resultados com os de outras onze Entidades Fiscalizadoras Superiores da América Latina e Caribe sobre o mesmo tema. (BRASIL-TCU, 2019).

Em termos de deliberação, o TCU por meio do Acórdão 709/2018-TCU-Plenário determinou ao executivo federal implementar as seguintes medidas, entre outras:

- ao antigo Ministério do Planejamento, Desenvolvimento e Gestão (MPDG) que informasse ao TCU as providências instituídas para elaborar a estratégia nacional de desenvolvimento econômico e social 2020-2031;

- à Comissão Nacional para os Objetivos de Desenvolvimento Sustentável que: (i) estabelecesse o responsável por definir as metas e os indicadores nacionais; (ii) formalizasse estratégia de longo prazo para seu funcionamento; (iii) estabelecesse mecanismos de coordenação entre as ações de sensibilização à Agenda 2030; (iv) estabelecesse processo de elaboração dos Relatórios Nacionais Voluntários;

- ao antigo Ministério do Planejamento, em conjunto com o Instituto Brasileiro de Geografia e Estatística (IBGE) e o Instituto de Pesquisa Econômica Aplicada (Ipea), que estabelecesse estratégia de monitoramento e avaliação integrada das políticas públicas brasileiras a nível nacional. (BRASIL-TCU, 2019).

O monitoramento dos objetivos do desenvolvimento sustentável no Brasil, realizado no âmbito do Grupo de Trabalho da Sociedade Civil (GTSC), por meio do Relatório Luz, se depara com decepcionantes verificações de resultados. Assim, constata-se que o Brasil desde 2015 se afasta do cumprimento do objetivo de erradicação da fome, agravada com a Covid-19, preconizada pela concretização do objetivo 2.1, Quadro 1. Com relação ao objetivo 2.2 desnutrição infantil (<5 anos), informações do Ministério da Saúde, em 2018, revelam que os índices desnutrição voltaram a crescer no país.

Importante destacar que no início de 2019 o governo federal extinguiu o Conselho Nacional de Segurança Alimentar e Nutricional (CONSEA), encerrando uma experiência extremamente exitosa de participação social e de construção e implementação coordenada da Política Nacional de Segurança Alimentar e Nutricional. Isso ocorreu em um cenário em que a Organização das Nações Unidas para Alimentação e Agricultura (FAO/ONU) já advertia sobre a alta possibilidade de que o Brasil esteja voltando ao Mapa da Fome, de onde tinha saído em 2014. (GTSC, 2019, p.14).

Os demais objetivos do desenvolvimento sustentável na vertente 2, isto é, erradicar a fome, alcançar a segurança alimentar, melhorar a nutrição e promover a agricultura sustentável, estão ameaçados, pois o governo federal vem desmontando importantes estruturas e programas voltados ao abastecimento alimentar, como por exemplo, o desmonte da estrutura da Companhia Nacional de Abastecimento (CONAB) nos Estados e a redução orçamentária do Programa de Aquisição de Alimentos da Agricultura Familiar (PAA). A intervenção estatal, via planejamento, é considerada indispensável para reduzir ou evitar os efeitos nocivos dos processos de crescimento econômico, ou ainda, para poder eliminar ou reparar distúrbios e danos já existentes (FREY, 2001, p. 07).

Ressalte-se ainda que os alimentos adquiridos pelo PAA são destinados à formação de estoques estratégicos ou ao atendimento de pessoas em situação de vulnerabilidade econômica e social, abrigadas em centros de convivência de idosos, comunidades terapêuticas, associações beneficentes, creches públicas, hospitais e restaurantes populares.

Saliente-se também que embora ainda não tenham sido disponibilizados dados suficientes para uma avaliação mais abrangente dos objetivos 2.3 dobrar a produtividade e a renda dos pequenos produtores de alimentos e 2.4 garantir sistemas sustentáveis de produção de alimentos, admite-se que com o desmonte na Política Nacional de Agroecologia e Produção Orgânica (PNAPO), os resultados esperados para os próximos anos deverão ser muito reduzidos. Também se constatou um aumento abusivo das importações de agrotóxicos para comercialização no país, inclusive alguns proibidos em vários países.

Pelo exposto, não há como atingir os objetivos da agenda 2030 com políticas de tipo desenvolvimentistas predominantes na agropecuária brasileira que estimulam a violência, atribuindo-lhe, por vezes, sentido de crueldade para a maioria que pertence às categorias subordinadas (GEHLEN, 2004).

## V. DESENVOLVIMENTO RURAL SUSTENTÁVEL POSSÍVEL

A despeito das forças contrárias ao alcance dos objetivos da Agenda 2030 no Brasil, é importante destacar os esforços e as iniciativas da sociedade civil, das universidades e de forças políticas comprometidas com o planejamento e a implementação de planos, programas e projetos de desenvolvimento sustentável de âmbito, local e rural. A crise ecológica global tem-se tornado nas últimas três décadas um dos maiores desafios da humanidade (FREY, 2001). Portanto, nesse contexto deve-se impor o debate sob o ponto de vista micro ou local, considerando a máxima de “pensar global, agir local.”

Com relação especificamente ao desenvolvimento rural sustentável, cogita-se que o mesmo deva ser implementado em base local, porque é nessa instância que se pode contrapor à capacidade de influência do capital ou do poder instituído através de alguma espécie de controle social legitimamente instituído, (p. ex. participação nas audiências abertas, Conselhos e em reuniões de interesse público). No entanto, é fundamental que prevaleça um ambiente democrático e participativo nas comunidades locais e suas representações para barrar a tendência do “mandonismo” do poder local, geralmente existente e manifesto nos territórios rurais. (ASSIS, 2006).

Nesse viés:

A desconstrução dos modelos convencionais de desenvolvimento e agricultura, seguida da desmistificação do conceito genérico de desenvolvimento sustentável gerado no seio dos próprios organismos internacionais de desenvolvimento, tem por objetivo abrir caminhos para a compreensão de que os graves problemas socioambientais enfrentados pelo meio rural não podem ser resolvidos apenas com o desenvolvimento tecnológico, ainda mais sendo este empreendido pela mesma ciência que provocou tais problemas. (MOREIRA et. al. 2007, p. 513).

Outro fator de grande potencial em favor do desenvolvimento rural sustentável é a agroecologia<sup>2</sup>, em razão dela proporcionar uma produção agrícola que não expõe o meio natural aos danos provocados pela agricultura convencional, além de resgatar os “modos de vida” e sobretudo os conhecimentos das comunidades que trabalham e vivem basicamente da agricultura, agregando as propostas agroecológicas ao desenvolvimento da agricultura familiar. A readequação tecnológica para a transição agroecologia ocorre através da introdução de práticas que requerem basicamente a reorientação do trabalho dos agricultores familiares, portanto de baixa capacidade de investimento.

[...] A agroecologia não se limita ao enfoque técnico que dá base para o desenho de sistemas sustentáveis de produção orgânica de alimentos, ele procura evidenciar a agroecologia como uma ciência de caráter plurimetodológico e que se abre epistemologicamente, ressaltando as suas potencialidades para a elaboração de programas de desenvolvimento rural sustentável.

[...] A pesquisa agroecológica, juntamente com o ensino e a extensão rural agroecológica, devem articular as diversas forças sociais dos setores público e privado para consolidar a urgência de se aumentar o espaço da agroecologia na construção do desenvolvimento rural sustentável. (MOREIRA et. al. 2007, p. 513).

Entretanto, no que diz respeito a um maior acesso às informações no campo da agroecologia, constata-se a necessidade de fortalecimento de atuação das redes de Ater como facilitadoras desse processo, por meio de Organizações Não Governamentais (ONGs) de Ater, credenciadas e reconhecidas pelos seus currículos de trabalho junto às comunidades rurais. Nesse sentido, registre-se:

<sup>2</sup> A agroecologia é uma ciência surgida na década de 1970, como forma de estabelecer uma base teórica para esses diferentes movimentos de agricultura não convencional. É uma ciência que busca o entendimento do funcionamento de agroecossistemas complexos, bem como das diferentes interações presentes nestes, tendo como princípio a conservação e a ampliação da biodiversidade dos sistemas agrícolas como base para produzir autorregulação e, consequentemente, sustentabilidade. (Desenvolvimento rural sustentável no Brasil, ASSIS. 2006).

O discurso ambiental deu ensejo ao surgimento das Organizações Não Governamentais – ONGs, que com uma linguagem alternativa e pressionando fortemente os governos nacionais e organizações internacionais, assumiram uma importância muito grande no debate da problemática ambiental sob uma nova perspectiva (CARVALHO, 2016).

As redes de Ater de diferentes alcances – principalmente municipal – mas também estadual e nacional, deverão ser fortalecidas na perspectiva da agroecológica. Neste sentido, deverão ser intensificados os esforços junto ao poder legislativo para a construção de um Fundo de Custeio de Ater, destinado exclusivamente para serviços de extensão rural voltados para a agricultura familiar.

As atuações dessas redes junto aos agricultores familiares se expressam nesse segmento por meio da construção do conhecimento agroecológico, notadamente nos campos da Educação, da Ater e da Pesquisa, conservação e o uso sustentável da biodiversidade, protagonismo das mulheres, abastecimento alimentar e construção social de mercados, soberania e segurança alimentar, reforma agrária e direitos territoriais de povos e comunidades tradicionais, acesso e gestão das águas, questão dos agrotóxicos e dos transgênicos, normas sanitárias para produtos da agricultura familiar, crédito para financiamento da agricultura familiar (Pronaf), entre outros. (ANA, 2018).

A Economia Solidária<sup>3</sup> é outra importante vertente alternativa para fortalecer o “fazer econômico local”, que apresenta um favorável campo de expansão no seio do desenvolvimento sustentável, pois a natureza dessa economia se adapta aos mercados locais a partir de uma aproximação de interesses entre agricultores familiares, comerciantes e consumidores locais. Pode-se dizer que a economia liberal é o oposto da economia solidária:

A abordagem econômico-liberal de mercado aposta nas forças de “autorregulação do mercado”, e parte do pressuposto de que pressão de concorrência, crescimento econômico e prosperidade levariam automaticamente ao uso racional dos

<sup>33</sup> Economia Solidária “é um modo de produção que se caracteriza pela igualdade. Pela igualdade de direitos, os meios de produção são de posse coletiva dos que trabalham com eles – essa é a característica central.” (SINGER, 2008).



recursos naturais, ao progresso tecnológico e a novas necessidades de consumo compatíveis com as exigências do meio ambiente (FREY, 2001, p. 3).

Assim, observa-se uma ampliação e clara da Rede de Economia Solidária (RES) no país nos últimos anos, que conecta cooperativas, associações de produtores rurais e consumidores locais por meio de feiras, oficinas, redes, fóruns, programas e projetos que ocorrem em todo o país de maneira dinâmica e envolvendo variados grupos sociais.

A economia solidária se assemelha a premissa do desenvolvimento endógeno, que teria como condição a possibilidade de que os atores locais participem democraticamente do processo de produção e distribuição e que possam desfrutar dos rendimentos gerados como fruto de seus esforços.

Segundo dados da Agenda Institucional do Cooperativismo, a economia solidária no Brasil chega a movimentar anualmente R\$ 12 bilhões, conta com mais de 6,8 mil cooperativas, que geram 398 mil empregos formais, com base na solidariedade, igualdade e autogestão.

É nessa lógica que Gehlen (2004) entende que a noção de desenvolvimento local no Brasil se fortalece através de políticas públicas, de organizações locais formais e informais. Sua dinâmica se deve às metodologias de indução do desenvolvimento econômico e sustentável.

Assim, o desafio do desenvolvimento sustentável é, inicialmente, um problema político e de exercício de poder, que coloca em pauta a questão das instituições político-administrativas, da participação e do processo político (FREY, 2001, p. 02). Como se observa, é possível gerar riqueza sem o viés da competição selvagem do capitalismo, a economia solidária é prova desta forma de gerar renda e autonomia com respeito ao meio ambiente.

## VI. CONSIDERAÇÕES FINAIS

A título de considerações finais, é importante mencionar a grande complexidade do tema pelas razões conhecidas, analisadas e expostas nas seções anteriores do presente artigo, prenhe de diversas abordagens teóricas, conceitos polissêmicos e uma gama de eventos patrocinados pelos entes internacionais para dar cabo à crise ambiental.

Nessa perspectiva os organismos internacionais e órgãos oficiais patrocinaram o termo desenvolvimento sustentável em seus relatórios e agendas procurando gerar conciliação entre desenvolvimento (economia) e

conservação ambiental (ecologia) proposta pelo discurso do ambientalismo moderado, sem esclarecer como atingir esse objetivo e sem ações efetivas. Tal descompasso tem gerado somente contradições e incertezas que não dão suporte à sustentabilidade ambiental, pela própria manutenção de políticas desenvolvimentistas para o rural.

Noutro enfoque, a abordagem da ecologia radical encontra também limitações para articular um desenvolvimento rural sustentável pela sua própria temática parcial, primando as questões ecológicas em detrimento das questões sociais e econômicas.

Por assim dizer, o Desenvolvimento Rural Sustentável passa pela implementação do discurso da ecologia política que enfatiza o aspecto social, sem desprezar as estratégias das demais correntes ambientalistas, observando o território como relações de tensões socioambientais para formulação e execução de políticas públicas participativas por meio de organizações locais formais e informais.

Tal sustentabilidade rural depende nesse percorrer de mudanças profundas do modelo de desenvolvimento vigente na sociedade contemporânea, isto é, entre outros aspectos, na elaboração de estratégias de desenvolvimento territorial fundamentadas nas linhas local e regional, através da utilização de instrumentos de política agrícola, ambiental e sociocultural, que estimulem a adoção por parte dos agricultores familiares de modelos agroecológicos de produção.

Por derradeiro, é importante reafirmar que o caminho a ser trilhado para atingir esses objetivos é complexo, mas é um horizonte de luta política que jamais deverá ser abandonado.

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# Neurosciences and Education: An understanding of meaningful learning in Early Childhood Education

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**Keywords**—Neuroscience. Pedagogy.  
Meaningful Learning. Education.

**Abstract**—This research is a dissertation carried out in the Master's Program in Science, Technology and Education of the Vale do Cricaré Faculty in São Mateus in Espírito Santo, which investigated, through a bibliographic review and interview (focus group), the that Neuroscience can bring to the teachers, uniting science and education, to achieve meaningful learning in Early Childhood Education. This work aimed to highlight neuroscience applied to learning and its contributions to the teacher's work to generate meaningful learning in Early Childhood Education, due to the knowledge of the functioning neurological of cognition that neuroscience brings to the professional. Neuroscience is increasingly emphasizing the importance of neurological knowledge in the fields of education. The justification for this dissertation lies in the search for a deeper understanding of the issues that address neuroscience as a basis to assist the teacher (pedagogue) in teaching meaningful learning, which begins in Early Childhood Education. This research focused on the problem: "How do Neurosciences contribute to the achievement of meaningful learning in early childhood education?", Seeking reflections on such questioning. Thus, the questions proposed in this instrument enabled a discussion about the study that had its main objective the contribution of Neuroscience to the achievement of meaningful learning in Early Childhood Education. After a focus group interview, it was possible to verify the interest and knowledge of teachers in the Early Childhood Education segment on Neurosciences and meaningful learning.

## I. INTRODUCTION

This paper aims to highlight neuroscience applied to learning and its importance in the contribution of the teacher's work to generate significant learning in early childhood education, due to knowledge of the neurological functioning of cognition that neuroscience brings to the professional.

The educational task is based on a set of concepts that generate reflection and pedagogical practice within its strands and dimensions. Theorists like Sigmund Freud, Jean Piaget, Lev Vygotsky, are considered precursors of educational psychology studies. This segment (Educational Psychology) has studies and researches that aim to

describe the psychological processes present in education. It's a branch of psychology which studies the teaching/learning process and has its direct relationship with cognitive and developmental psychology, an area of investigation that examines questions about memory, attention, perception, knowledge representation, reasoning, creativity and problem solving. Cognition can be defined as the ability to store, transform and apply knowledge, being a wide range of mental processes. Based on these scholars, current educational models and practices have been thought out and organized. Thus, a large part of what neuroscience brings from studies on the same issues with a scientific basis can be observed. However, it is worth emphasizing the importance of some of these models and

practices that emerged positively in the area of learning. One of them is the significant learning, highlighted and well explored by David Ausubel who proposes that the students' prior knowledge be valued, in order to build mental structures using, as a means, conceptual maps that allow discovering and rediscovering other knowledge, thus characterizing a pleasurable learning and effective, especially in Early Childhood Education. Meaningful learning takes into account all the knowledge already acquired by the child, which is the basis for new knowledge acquisitions.

Early Childhood Education is the child's first contact with the world, building their social knowledge. It is at this time that they begin to explore, experiment, discover and rediscover. In Early Childhood Education, children begin to practice their emotional, social, physical, cognitive abilities, capacities and potential. According to the Ministry of Education's Comprehensive Education Portal (MEC), these practices must be intentionally planned, systematized and evaluated in a political-pedagogical project that must be collectively and democratically elaborated with the participation of the school community and developed by teachers (pedagogues). Therefore, it is important for the professional to work with intention and knowledge for this child so that he can have more and improved learning conditions within his reach.

The contribution of neurosciences, in their line of research on cognition, works in education, unraveling memory processes, problem solving, learning, among other factors. Education and Neuroscience not only share investigative research on the learning process of human beings, they also explain the different levels of complexity in which this process takes place. Thus, educators need specific training that allows them to learn and understand these processes. As a problem for this research, it is reflected: How do Neurosciences contribute to the achievement of significant learning in early childhood education? Faced with the need to identify and provide meaningful learning for children, in increasingly heterogeneous classes, this work seeks, through a bibliographic review, to reflect on these contributions and, through an interview, to research the interest and knowledge of pedagogues regarding this contribution to continuing education, combining pedagogy and neuroscience. Adding scientificity to early childhood education without losing affectivity.

Therefore, Neuroscience through research and studies is increasingly highlighting the importance of neurological knowledge in the field of education. Neuroscience brings the biological explanation of the functioning of the nervous system, so that the education professional can

better understand the processes we go through to learn. This research aims to demonstrate how neuroscience can contribute to the good performance of the work of the teacher (pedagogue) in the classroom and thus be important allies to expand the possibilities of meaningful learning in the context of Early Childhood Education, since this is the basis of education. It is in the initial training (Child Education) of human beings that we build the basis of our knowledge and our life in society. There is a need to look at pedagogy as a science, aiming at meaningful learning for all early childhood education students. The justification for this dissertation lies in the search for deepening the issues that address neuroscience as a basis to assist the pedagogue in teaching meaningful learning, which begins with Early Childhood Education.

Each day, Neurosciences unveil more about the nervous system and collaborate with other fields. Example: Education - Neuroeducation, Psychology - Neuropsychology, Biology - Neurobiology, Chemistry - Neurochemistry - Medicine - Neurology, among others; showing and affirming the importance and functional complexity of knowledge of the nervous system. Specifically, the Central Nervous System, in brain functioning. And according to Relvas 2012, these advances in neuroscience studies have brought about a new vision in understanding the functioning of the brain, in cognition, in thinking, in emotion, in learning and in behavior.

The development of modern techniques, such as: electroencephalogram (EEG), spectral diffusion imaging, Magnetic Resonance Imaging (MRI), Positron Emission Tomography (PET), for the study of the nervous system, brain activity in humans, during the performance of cognitive tasks, it has allowed a more precise investigation of the neuronal circuits during their functioning, which generate human intellectual capacities, such as language, creativity, reasoning (Rocha & Rocha, 2000).

Relvas (2009, p. 16 and 17) emphasizes "how important it is to know the functioning of brain stimuli [...] the study of development and the milestones of brain maturation, learning difficulties and brain plasticity". Thus, he highlights in his studies neuroscience as one that can:

"[...] meet the needs of teachers, with a neurobiological and multidisciplinary approach, dealing with normal learning and its disorders. [...] Neuroscience has been reviewing, through Cognitive Neurobiology, Behavioral Neuropsychology, Neurophysiology and Neuroanatomy, how the human

effectively learns and teaches in the processes of vital contexts". (RELVAS, 2009, p 17)

According to Carbonell (2002), we aim at innovation, in a broad definition, being a set of interventions, decisions and processes that, with a certain degree of intentionality and systematization, deal with changing attitudes, cultures, ideas, content, models and practices pedagogical.

Pimenta (1996, p 42) emphasizes that education is lacking as an area of investigation of a science, saying that "the 'sciences of Education' lend to educational investigation an apparent statute of scientificity.". Thus, we observe that the appreciation of the need for continued and specific studies, as cognitive neuroscience brings, enable educators to better understand the aspects related to pedagogical practice, thus helping their work. Highlighting here in particular in the teaching-learning process of children in Early Childhood Education.

Libâneo (2001, p.6) defines pedagogy as "a field of knowledge about the educational issue in its entirety and historicity and, at the same time, a guiding guideline for educational action." The pedagogue monitors and assesses the learning process and the skills of each student. It can also work with people with physical or intellectual disabilities, helping their learning and inclusion in society. And to meet this demand, it is necessary to search for specific knowledge and understand why they do not learn in the same way.

According to Nóvoa, 1995, p. 26: "Teacher training is probably the most sensitive area of the changes taking place in the education sector: here not only professionals are trained; here a profession is produced".

And with the collaboration of neurosciences, education has a scientific basis for the understanding and development of more meaningful learning; once we look at how complex and broad the brain's functioning is.

According to Relvas (2012), the educator, in his planning, must establish teaching strategies, sensitizing himself with the students; bearing in mind that they are beings constituted by a brain biology in constant movement and transformation, having nervous connections that never stop. Encouraging learning is an action and reaction for everyone committed to education. Also according to Relvas, there is a need to know the tripod of systems for the construction of knowledge. The first aspect is the information system, the second is the understanding of biological systems and the third is related to everyday life, cybernetics. In light of this tripod, it is a fact that learning difficulties can be resolved or at least minimized if educators focus on the classroom as a neuroanatomist. Therefore,

Studies related to neurobiological processes on learning and cognitive development show that these should be exposed to teachers in training, aiming to promote an understanding of the impact on their work in the classroom and on the brain development of students, as well as clarification on the neurological dysfunctions that generate little acquisition and/or retention of new knowledge. (CRESPI, 2017)

Neuroscience studies have contributed to the work in the classroom, in the understanding of cognitive, motor, affective and social structures. Teachers must know this immense universe that is the brain so that they can better define and organize their learning concepts, identifying more or less permanent processes and modifications through the CNS, allowing the individual to better adapt to their environment in response to these internal and/or external requests of the organism. When a stimulus is already known, it triggers a memory. When the stimulus is new, it generates change. Thus, we are able to understand learning from the point of view of neuroscience (RELVAS, 2012, p.20).

In her book *Neuroscience in Pedagogical Practice*, Marta Relvas explains the challenge of the modern educator in his role in the classroom through the vision of learning in the current world, having the understanding from the point of view of neuroscience when she says:

"Information is developed by the cognitive, emotional, motor, affective and social brain. However, new trends that point to this century are the development of the creative brain, author, inventive, intuitive, ingenious, which experiences uncertainties, managing daily frustrations, without losing self-esteem. An autopoietic, self-regulating and reorganized, adaptable brain." (RELVAS, 2012, p. 21)

Marilza Delduque (2016) already bets us that it is proven how much a classroom is different when you have a teacher with a different look in front of that class. A teacher willing to seek to learn can generate daily stimuli in their students. The current teacher moves from the authoritarian position to the position of mediator, inseparable from his group. And quoted by Delduque (2016), Feuerstein, 1989, said: "For brain development to operate, simple exposure to sources of stimulus is not enough, the presence of a mediating agent is necessary".

Understanding that the learner can and must have the opportunity to modify their cognitive abilities and that, for such success, the mediator teacher needs to improve their

knowledge and dedicate themselves to knowing the acquisitions and phases of each apprentice is the initial part of the entire process. Together with this, we combine knowledge of the main theories of Jean Piaget, Lev Vygotsky, Henri Wallon, Froebel, Reven Feuerstein and Maria Montessori, to create a link with the authors of the Neuroscience of Learning.

Relvas (2016) explains that knowledge and application of neuropedagogy evolve through a neuroscientific view of the process of teaching and learning. Contributes to the identification of a biopsychological and behavioral analysis of the student through studies of anatomy and physiology of the CNS. It explains, models and describes the neuronal mechanisms that support the perceptive, cognitive, motor, affective and emotional acts of learning.

And this entire process takes place in the classroom.

With neuroscience studies in recent decades, it has been possible to understand that the current student is the “brain subject”. It is he who argues, questions and who has autonomy to learn; having the teacher the role of promoting challenges, reflective actions and allowing the dialogue between emotions and affections in an organic and mental body that is the medium of these reactions. For information to be transformed into learning, classes need to be involved in emotion, because when information has meaning in the student's life and the student uses the path of emotion, the information will never be forgotten. Thus reminding the teacher that there are several ways to teach, as there are many ways to learn. (RELVAS, 2016).

This reason is explained by Neuroscience as follows: the prefrontal cortex, responsible for inhibiting some behaviors, is not yet completely formed. Thus, students, especially children, have a reduced time of concentration in such an explanation (moment).

Leonor Bezerra Guerra, physician, specialist in Neuropsychology, coordinator of the NeuroEduca Project, at the Federal University of Minas Gerais (UFMG), in the area of disseminating knowledge in neuroscience to professionals in the field of education, he says: “The brain does not give up relevance – one of the teacher's challenges is to contextualize the information in the student's daily life and make it interesting”. The journal Neuroeducação interviewed this doctor who explained why a better understanding of how the brain works can help the educator (pedagogue) in their teaching process.

The interview began with the following question: "How can knowledge of the brain bases of learning be useful for the work of educators?" And Dr Leonor Guerra replied:

“The educator works with learning, a process that depends on brain

functioning. When the student learns, there is a remodeling of the nervous system (SN), especially the connections that occur in the brain. The SN is much more than just the brain [...] When the teacher understands the neurobiological principles of this remodeling, he can better understand the potential and some limitations of learning. For example, the fact that the student is looking at the teacher does not mean that he is paying attention. You may be thinking about totally different things, like a football championship, or noticing the teacher's own clothes, etc. Anyway, if he is not paying attention to what is said, none of the information will be processed. Now suppose he is paying attention. He understands for the moment what is being said. I emphasize attention because it is a primary function of learning – and we don't pay attention for a long time unless we are very interested. In addition, to continue remembering information after leaving the classroom, it must have some relevance to the student. In order for there to be any remodeling, he (the student) needs to keep thinking about the subject. Hence, the usefulness of resuming content in the classroom or through other activities. Each day, during the sleep period, the brain remodels the connections between neurons. When we keep thinking about a subject, that thought is reprocessed during sleep. And the neurons that come into activity by reprocessing this information produce proteins that will participate in the remodeling of the SN. So there is a biological time for learning to take place. The teacher needs to pass on the content, ask the student to check if he has really learned and give him time to actually grasp that information” (GUERRA, 2015).

Thus, we verified through the answer what we mentioned above: the student needs to be interested and motivated.

Use the student's emotion and previous knowledge so that their learning is meaningful.

When asked whether neuroscience should be part of the initial training of educators, Dr. Leonor Guerra said that less than 10% of the pedagogy courses verified in 2001 had some content related to biology and neurobiology. There were 60 courses and several have in their curricular matrix subjects that relate brain and learning, but the theme is still not frequent in the initial training of educators. Leonor believes that every pedagogy student would ideally have knowledge about the neurobiological foundations of learning and cognitive and behavioral psychology bases. Without forgetting that it changes and influences its relationship with the environment and that theories on child development are relevant and complementary to the subject.

And if we think of researchers and educators, let's remember that one is in the laboratory and the other in the classroom. According to Guerra (2015) training is needed for those who study neuroscience about school contexts. On the educator's side, it is necessary that we do not generalize neuroscience and that we must understand that it does not have an answer for everything. There is still a lot to be learned and researched about the brain. Neuroscience explains some aspects of the learning process, taking into account biological factors and behavioral psychology. With advances in neuroscience, the understanding of pedagogical strategies gained new perspectives. Guerra (2015) points out: "I believe that neuroscience has made good contributions to education,

The educator must keep in mind that pedagogical practices are not altered in the face of information from neurosciences aimed at learning. The practices will be the same; what will change will be the intention and planning as they will be thought. It is important to remember that the student must feel involved with actions and learning. Because learning is a desiring act and this only occurs if the student is interested, willing to learn. Therefore, the teacher must move towards arousing interest in the student, through the affective and emotional connections of the limbic system; releasing serotonin and dopamine (chemical messengers) related to satisfaction, pleasure and mood. Happy, involved and interested child learns more.

Studying neuropedagogy is rereading the main theories of learning, but it is also recognizing that it is a science that studies learning in the context of the chemical, cellular, anatomical, functional, pathological, behavioral process of the nervous system, thus demonstrating an integral view of the student. A neuroscience approach applied to learning comprises the understanding of the formation of intelligence, emotion and behavior in the school context,

within the biological, psychological, affective, emotional and social aspects. And this is to generate the possibility for the educator to enable a new skill in the subject, maximizing the potential of brain functioning.

#### **EARLY CHILDHOOD EDUCATION: THE IMPORTANCE OF TEACHERS IN CHILDREN'S LEARNING**

Early Childhood Education is the first stage of basic education. It is the child's first contact with the social environment. The purpose of Early Childhood Education is the integral development of children up to 5 years of age, with the purpose of developing their physical, psychological, intellectual and social aspects, complementing the action of the family and the community (MEC - LDB, art.29).

This comprehensive treatment of the various dimensions of child development requires the combination of education and care in child care. According to the MEC, these practices must be intentionally planned, systematized and evaluated in a political-pedagogical project that must be collectively elaborated and democratically with the participation of the school community and developed by qualified teachers. For Piaget (1969/1970), the main objective of education is to help the child to develop intellectually and morally.

Only in 1988 early childhood education began to be recognized, when for the first time it was placed as an integral part of the Constitution, then in nineteen, like Child and Adolescent Statute (ECA, Federal Law 8069/90), among the rights was the provision of care in day care centers and preschools for children from 0 to 6 years of age.

Barreto (2008, p.24) states that attention to Early Childhood Education in Brazil is a result of the last two decades of reflection, as from the LDB onwards, Child education it became the beginning of Basic Education, seeking to abolish the welfare view and with a view to training professionals working in this area.

In this magical and engaging world of Early Childhood Education, with games, experiences, music, dances, steps, rhythms and games, the brain triggers information for specific areas. If he learns through experience, changes occur in his structures (Marilza Delduque, 2016).

With regard to school responsibility, related to learning, we must give due importance to Early Childhood Education, where the child's first life experiences are carried out. Thus, the link between theories of knowledge, the main concepts, the student's relationship with the world and the role of the teacher and the school will influence the student's profile. This student will leave school for the world.

According to the development of education over the centuries, the importance that an educator has in their society is well known. This importance is not always understood, valued and transmitted to others, but which has always been a reason for reflection by those who knew the weight of a society with good education.

The pedagogue works to guarantee and improve the quality of education and has two main fields of action: administration and teaching (in person or at a distance). When their work is carried out in the school environment, from Kindergarten to Elementary School, the pedagogue needs not only planning, but to carry out their actions with intention and knowledge. Libâneo (2006) points out that: "All teaching work is pedagogical work, but not all pedagogical work is teaching work". The Legislation with its Guidelines for the Pedagogy course points to the possible construction of the professional identity of the pedagogue, a document based on the role of teaching according to the authors Libâneo, Franco, Pimenta (2007).

## II. METHODOLOGICAL COURSE

For this work there will be, in addition to the bibliographical research, an interview with a focus group, where teachers who contemplate the framework of early childhood education in a school in the capital Vitória, in the State of Espírito Santo. The research with the teachers will be through an interview, without identification, photos or videos.

10 teachers will be interviewed (pedagogues) who contemplate their work for more than 05 years in the mentioned institution, directly linked with the Early Childhood Education segment. These teachers are trained in pedagogy and have specialization related to the segment. The teachers selected to participate in the research remain in different classes; which covers every year within Kindergarten, being children aged 2, 3, 4, 5 and 6 years old. These teachers were selected according to the class they teach in that year of 2019 within the school so that all ages that go through Early Childhood Education were part of the research, as well as the time they teach in this company.

The survey took place in November 2019 in a focus group format, where each professional answered the questions having the opportunity to express their points of view, experiences, professional path, interests and other contributions they thought relevant to what was interviewed.

This was semi-structured, enabling open responses that came to be opportune during the focus group. Analyzing its advantages and disadvantages, this was the

methodology applied for this research. So we had the result about the knowledge and interests on the subject, making it possible to program materials for the continued study of these professionals.

## III. RESULTS AND DISCUSSIONS

According to the focus group held on November 22, 2019, on the topic of Neuroscience and Meaningful Learning, there was great interest and understanding of their importance for the daily work of pedagogues in the classroom. With the first questions it was already possible to see that the majority sought specializations and/or courses that could expand their field of knowledge and thus help their work in the classroom. The 10 participating pedagogues will be named here by letters (A, B, C, D, E, F, G, H, I, J).

Our first question asked about content, training or specialization, which they came to do focused on basic knowledge about learning in Early Childhood Education. If they had done, which one or which ones would they be.

In this question, we started with the speech of participant I, who said:

"Yea. Most of them were geared towards that. Training course in Clinical Psychopedagogy, totally focused on this subject... Psychology for Educators; Philosophy for children; Kindergarten Education Pedagogical Mediation... Most of the courses I took were focused on learning in Kindergarten...".

The participant said:

"Yes, in college I had courses that dealt with this subject: Educational Psychology, Philosophy of Education, Games and Play, among others."

Participants B, C, D, F, G and J reinforced participant H's comment, saying that in higher education, in the pedagogy course, the subject was addressed in subjects like those mentioned, but in a superficial way.

The participant had her speech reinforced by participant E, where she said:

"In training, it was superficial, but in the postgraduate course in Psychopedagogy that we did together (I and I), we had the course in Developmental Psychology, which



addressed the content a little more broadly”.

Teachers I, A and E, who took specialization courses, reported that they were already working in the area and felt the need for a greater understanding of this stage of development, as well as the interventions and learning processes to carry out a more assertive intervention in the classroom.

Our second question was: among your studies and specializations in the area of Pedagogy, did any of them address learning disorders? If yes, which/which ones? With this question, several complaints and comments about the formation of the pedagogue were exposed.

One of these complaints discusses the importance of this knowledge for observing, identifying and evaluating the student in Early Childhood Education. Learning disabilities are problems that affect the ability to receive, process, analyze or store information. These disorders can make it difficult for the child to acquire reading, writing, spelling, and mathematical problem solving skills.

Even Marta Relvas (2018) shows that neuroscientific studies focused on pedagogy collaborate to the recognition that everyone is capable of learning in the school process.

Relvas mentions in the article on his website that in this decade the main teaching in the field of neuroscience is that the brain has a capacity to undergo changes much greater than was previously thought. He even refers to the adult phase, also saying that “... Today it is clear that, even before, the adult brain, which was thought to be immutable, can be the seat of renewal, starting from some areas with the capacity to generate new cells. ”.

This brain plasticity has been generating great hopes and expectations in several areas of knowledge, especially thinking about mental health. Furthermore, according to Relvas (2018), it generates research possibilities for the use of stimulation and rehabilitation techniques that enhance existing skills for the development of certain functions.

In the third question I approached about seeking guidance/information to understand the different forms of learning as professionals in the field of Early Childhood Education. And on this issue, despite the majority being positive, there was debate about the importance of having this posture while pedagogues.

We can observe through the speech of each participant such importance that must be given to the subject. Participant A stated saying:

“As a Child Education professional, I started to seek guidance on different forms of learning, when I started

teaching. This diversity is very common in school environments and ends up being the biggest challenge in the teacher's career. Faced with this challenge, it is up to the teacher to know each student well in order to create and guide strategies that awaken in the child their maximum level of learning.”.

Participant F replied:

“Yes, through lectures, seminars and courses offered in the area”.

Participant D said:

“No. I try to dedicate myself to the learning method in which the institution I work believes in.”.

Afterwards, participant C collaborated by saying:

“In my college days I always tried to read and learn more about the ways of learning and everything that was covered, trying to clarify doubts with my advisors. It always comes to my mind how the learning processes are interconnected, how each person organizes, learns and internalizes the information of a given reality. Unfortunately, in these two years after graduating, I still couldn't go deeper into the different forms of learning, but it's something I leave as a "stand-by", as it is a future plan that I have not discarded and is part of my continuing education as a teacher. ”.

Participant B said:

“Yes, books and research on the importance of affectivity, music and play in learning.”.

The other participants just said yes, they seek guidance whenever possible.

And given what was said, we reaffirm that "(...) the pedagogue is every professional who deals with the formation of subjects, whether in educational institutions or elsewhere." (LIBÂNEO, 2006, p.215).

Therefore, it is important that the educator understands that each subject is unique and that each one has its own identity, with its characteristics and knowledge.

The one who thinks like that will make the difference between the others. In addition to his own characteristics, as a pedagogical teacher, he has the pedagogical practice, where, along with theory, he will make the necessary intervention in the classroom so that there is true learning and understanding of the identity of his students and of them in the face of differences.

Participant I even mentioned several specializations among them one, even though it is not specific about neuroscience, she mentioned the approach and its relevance. She contributed by saying:

“I took a course with Argentinean Alicia Fernández on Clinical Psychopedagogy where I addressed neuroscience and learning disorders as a complement to the content. It was there that I heard a little more about neurosciences, but not in a specific way.”.

Participant A mentioned in this question saying that she likes to use social media, such as Instagram, to get more information about the content. And in the case of neuroscience, she follows the page @neurociencia\_e\_educação, where she said she finds most of what is published by the mediators of the page interesting.

Participant C said:

“I recently did a workshop on neuroscience and I was very interested. It was discussed how the brain processes the new things we learn and how learning becomes knowledge for life. As technology advances, it allows us to have contact (know it, how does it capture information? Why is that?) with our brain today, as 50 years ago we didn't have any of that. We can get an idea from the development of our ancestors, we were seeing physical change and the main development of our brain along this journey.”.

Grasses (2018) guides us saying that neuroscience together with Education promotes ways for the teacher to be a mediator capable of teaching with quality, using pedagogical resources that encourage the student to think about thinking. The author demystifies the relationship of more stimuli and more learning; explaining that it is not connected with the quantity, but with the qualities that these stimuli have. And it adds:

“That is why there is no “levelling” of learning, as we are different in biological, psychological, emotional, affective and social contexts. [...] If you are a teacher and educator, basic knowledge of Neuroscience is essential for your work, since your objective is to provide learning for your students and, preferably, in the most optimized way possible.”. (MARTA RELVAS – Article: Studies of Neuroscience applied to school learning).

Guerra (2015) emphasizes that neuroscience makes good contributions to education, providing a foundation for much of what is already being done in the field of pedagogy and also clarifying aspects of human behavior, reaffirming and suggesting strategies for more effective learning.

Finally, in the tenth question, I asked if they would like to be part of a continuing education course that addressed the contributions of neuroscience aimed at meaningful learning in Early Childhood Education.

Participant F said:

"I am interested in the subject and yes, it would be my pleasure to acquire more knowledge on the subject." Participant C contributed by saying: “Yes, I was very fascinated with neuroscience, I'm reading it and trying to find out more about it.”.

França (2018) confirms the importance of giving continuing education to teachers, saying:

“The continuing education of teachers has been understood today as a permanent and constant process of improving the knowledge necessary for the activity of educators. It is carried out after initial training and aims to ensure an increasingly high quality education for students.”.

Participant E at the end collaborated and gave us a great reflection when she said:

“The teacher's great exercise is to carry out in practice what is brought about by theory. In the end, the biggest challenge for the teacher is to carry out significant learning in a class with students at different levels

of knowledge and as distinct as individuals.”.

All participants have this interest and believe it to be very valuable for complementing their work and a great help for their classroom planning.

#### IV. FINAL CONSIDERATIONS

With this work, we could see that Education and Neurosciences are distinct areas of knowledge, but they share the interest and search for understanding the learning process. While Neurosciences investigate the neurological structure and functioning that underlie several processes, including learning, Education, in turn, seeks to create conditions for individuals to develop their skills and competences within the school environment. Thus, the link between these areas has enabled investigation and dissemination through scientific research on learning.

Not long ago, this was only addressed in academia, leading educators to a series of reflections. Today, with neuroscience studies, it is possible to know more about brain functioning and thus its learning process, which helps educators and researchers to understand the structural properties of the Nervous System, the neural processes that serve as an intermediary for learning, and the stimuli that enable the cognitive development of students. The set of bibliographies analyzed in this work indicates that the approach of Neurosciences to educational practices in the school environment seems to present promising contributions to the learning processes, in particular the possibility of expanding meaningful learning.

According to what was aimed, I could in my specific goals verify the importance of neuroscience in the process for meaningful learning in early childhood education, bearing in mind that it is in early childhood that the greatest cognitive development and acquisition of knowledge occur. In the first 02 years of life, millions of synaptic connections strengthen learning and assemble the first concepts to be recorded in that individual. In the second specific objective, it was possible to describe about meaningful learning as well as early childhood education as a complement so that we could have a better understanding of the neuroeducational contributions in this segment with this focus.

In my third specific objective, I identified possible needs, interests and knowledge of pedagogues from a private school in the city of Vitória in relation to the contributions of neuroscience and meaningful learning in early childhood education through a focus group. In this research, it was also possible to perceive that the great

challenge of the pedagogue is to unite theory with practice. And so, according to the interview (focus group), a final product was imaginable with the objective of proposing a continuing education course for these teachers/pedagogues, in partnership with the school, so that they can expand the field of information and have access to the knowledge and contributions of Neurosciences applied to learning.

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# **Eating disorders, Body Image, obesity and Non-Pharmacological Inventions with Emphasis on Physical Exercise: An Integrative Review and Clinical Implications**

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**Keywords— Anorexia, Body Composition, Bulimia, Eating Binge, Overweight, Obesity.**

**Abstract—** *Background: Eating disorders, obesity, and body image has a relationship with health outcomes along the life, however the prescription of physical exercise as tool against eating disorders need to be further explored. Objective: To investigate the relationship between eating disorders, obesity, and body image distortion and discuss non-pharmacological interventions based on physical exercise and their clinical implications. Methods: The search conducted in Medline and Scopus databases, in English and Portuguese of the last 10 years involving studies with human approaches, integrative and systematic reviews with free full text resulted in 2049 manuscripts, after the application of all exclusion criteria 1992 articles were excluded, and 57 articles were used in this review. Results: The results suggest that binge eating anorexia and bulimia are the most common disorders with increasing worldwide prevalence. Additionally, it was verified that physical exercise can be considered a non-drug intervention as an adjunct measure in this respecting necessary care. Therefore, although not all people have the whistles to receive exercise as an intervention the prescription of physical exercise, when done by a multidisciplinary team, with slow progression and strictly monitored can be a valuable to the treatment of eating disorders. Conclusions: The physical exercise is a valuable tool against several eat disorders, improve the body image, fight against the obesity due their power of decrease the eat binge. Nonetheless, the increasement of caloric expenditure during and after the session leading to a fat loss and could be a central non-pharmacological invention in this scenario.*

## I. INTRODUCTION

Obesity, the main health burden of the 21st century, is a chronic disease that affects individual quality of life physiologically, economically and psychologically, regardless of cultural, financial or ethnic origin (Blüher, 2019). An excessive amount of body fat not only reduces the quality of life with regard to physical states, but also psychological, this condition is therefore associated with the development of a large number of health disorders, including diabetes, cardiovascular complications, cancer, asthma, sleep disorders, liver dysfunction, renal dysfunction, diabetes and eating disorders (Manna & Jain, 2015). Public health concerns about the increased cost caused by weight disorders or malnutrition have become increasingly evident.

The World Health Organization (WHO) defines overweight as a body mass index (BMI) of 25.0 to 29.9 kg/m<sup>2</sup> and obesity as a BMI of  $\geq$  30kg/m<sup>2</sup> (OMS/WHO, 2016). However, as a defining parameter, BMI has limitations, as it does not distinguish the difference between lean mass and fat or identify the distribution of fat both critical to stratify and classify (Blüher, 2019). Recent studies have shown that the risk factors associated with obesity depend not on excess body weight itself, but on the regional distribution of excess body fat (Swainson et al., 2017).

Epidemiological studies have shown that the prevalence rates of DA are around 0.5% to 1% for the general population, and may increase when considering syndromes called EDNOS (Ruscitti et al., 2016). These studies also provide relevant information on the distribution of ED, showing that these are clearly more prevalent in women than in men, in a ratio of 10:1 (Phillips, 1997). Individuals who develop AT use an arsenal of methods to control body mass, including excessive physical activity.

Although there is an increased concern with eating disorders and lack of control of body weight, the ratio of the simultaneous cost of these health conditions is commonly ignored, although the links between physical and mental health are well described. Binge eating, eating disorderly, is an important and perpetuating factor of obesity, usually mediated by psychological states such as bad mood or negative affect. Similarly, psychological concomitants of high body mass index, such as body dissatisfaction and stigma of high weight, contribute to the

increase in the burden of eating disorders worldwide, as well as increased dissatisfaction with body image (G. L. de Oliveira, de Oliveira, de Pinho Gonçalves, et al., 2017).

Regarding non-drug interventions that can compose the treatment of eating disorders, psychotherapeutic treatment is one of the most assertive indications, however, physical exercise is also one of the interventions that most successfully bring when used as a main or adjuvant intervention, being, therefore, the subject of discussion of this manuscript. In view of what had been exposed, the objective here was to conduct an integrative literature review to investigate the relationship between eating disorders, obesity, and body image distortion and discuss non-pharmacological interventions based on the effect of physical exercise on disorders with their clinical implications.

## II. METHODS

Research strategy in the English language and Portuguese in the electronic databases PubMed and Scopus were conducted from the beginning until February 1 to May 15, 2020. The articles were retrieved from electronic databases using the following research criteria: "aerobic exercise and eating disorders" OR "resistance exercise and eating disorders" OR "high intensity intermittent exercise and eating disorders" OR "diet and eating disorders" OR "physical exercise and obesity" OR "diet and malnutrition" And Humans.

Initially, titles and abstracts of the identified studies were verified by relevance by two reviewers (AAM and JRVS). Additionally, studies were identified through manual search and review of reference lists of relevant documents. All these steps were performed for 4 weeks.

Inclusion and exclusion criteria: participants, interventions, comparators, and results Studies with participants of all ages and genders, who directly or indirectly studied eating disorders, body image and exercises. Studies were excluded based on the following types of articles: letters to the editor, books, book sections, theses, films / broadcasts, opinion articles, observational studies and abstracts without adequacy data or analysis. Figure 1 shows the flow of articles during the selection process and the studies.

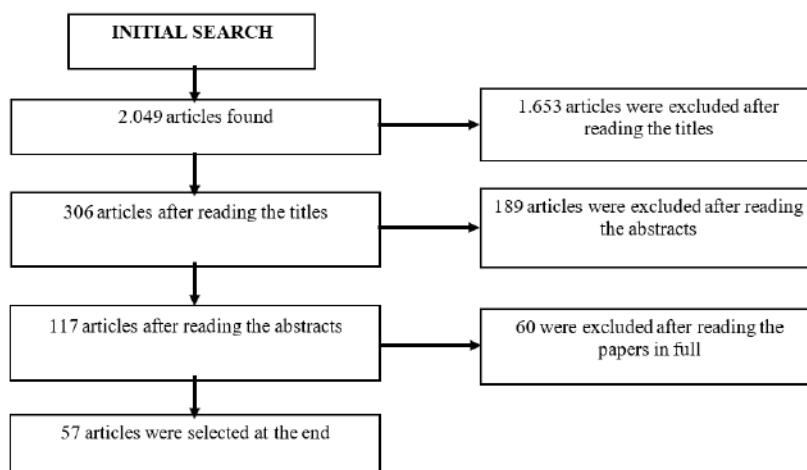


Fig.1: organization of the search process and selection of the articles used for this review.

### III. OBESITY AND ITS EPIDEMIOLOGY

The World Health Organization (WHO) defines overweight and obesity as abnormal or excessive accumulation of fat that presents health risk (World Health Organization, 2015). Body mass index (BMI), calculated by dividing body weight in kilograms by the square of height in meters, is a simple metric used to indicate general body fat (Marques et al., 2018). For adults, current guidelines from the U.S. Centers for Disease Control and Prevention (CDC) and WHO define a normal BMI range of 18.5 to 24.9, while a  $BMI \geq 25$  kg/m<sup>2</sup> is considered overweight and a  $BMI \geq 30$  kg/m<sup>2</sup> is classified as obese, with severe obesity defined as  $BMI \geq 40$  kg/m<sup>2</sup> (World Health Organization, 2015). Despite this relatively simplistic definition obesity is a multifactorial disease that results from chronic positive energy balance, that is, when energy intake exceeds its caloric expenditure, the body does not despise it, it accumulates.

Excess energy is converted into triglycerides, which is stored in fat tissue deposits that increase in size, increasing body fat and causing weight gain. The globalization of food systems that produce more processed and affordable foods, and promote passive excessive consumption of energy-dense, nutrient-poor foods and beverages, has been identified as the main factor in the obesity epidemic, although a decrease in physical activity is also due to lifestyle modernization being involved, the idea of a coherent factor consonance (Manferdelli et al., 2019).

Obesity can occur at any age. Previous studies evaluating obesity trends have found that its prevalence increased in adults and children of all ages, regardless of geographic location, ethnicity or socioeconomic status (Chooi et al., 2019). In low-income countries, obesity is generally more prevalent among middle-aged adults from rich and urban environments (especially women) while in high-income countries it affects both sexes and all ages,

but its prevalence is disproportionately higher among disadvantaged (Chooi et al., 2019). These facts show the importance of this condition for world public health due to its prevalence, costs generated to the public health system directly or indirectly.

### IV. OBESITY AND ITS EPIDEMIOLOGY

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## V. EATING DISORDERS

Eating disorders are severe psychiatric disorders characterized by abnormal eating or inappropriate behaviors for weight control. Errant attitudes errant towards weight, body shape and way of eating play a key role in the origination and maintenance of AD. The form of these concerns varies by gender, in men, for example, body image concerns can focus on muscle, while in women these concerns can focus more on weight loss. Obesity itself is not framed only as an eating disorder. All eating disorders considerably harm physical health and impair psychosocial functioning (Márquez & Molinero, 2013). The DA refers to a persistent disturbance of food or related behavior that causes a change in food consumption and that actually impairs the physical health the psychosocial stability of the individual, aggravating the condition of this disorder (Treasure et al., 2020).

Anorexia nervosa and bulimia nervosa are the most evident syndromes of this alteration in eating behavior and are directly related because they present as common symptoms the possible altered representation of the body shape, pathological fear of gaining weight and excessive concern with the loss of body mass. When in athletes, exercise compulsion exceeds the volume of training normally prescribed, resulting in health damage (Treasure et al., 2020).

The word anorexia originates in Greek (ann= without; orexis= desire or appetite), but in reality there is no loss of appetite in the early stages, only in the course of morbidity that anorexia manage to abolish it, so several authors consider the term anorexia inappropriate. The origin of the word bulimia is from the Greek (bous= oxen; limos= hunger), referring, therefore, to hunger as great as that of an ox animal or that is able to lead someone to eat an ox, which would justify the constant exaggerated episodes of food intake among people with this disorder. Bulimia nervosa is characterized by a large and rapid intake of foods with a feeling of uncontrollable, immediately

accompanied by inadequate compensatory methods for body mass control, such as self-induced vomiting, use of medications (diuretics, appetite suppressants, laxatives), severe diets and strenuous physical exercises, among others (Keski-Rahkonen & Mustelin, 2016).

Both the diagnosis and the Manual (DSM-5) and the International Classification Of Diseases (ICD-11) cover six main eating disorders (Udo & Grilo, 2019). This includes the family diagnosis categories of anorexia nervosa, bulimia nervosa and binge eating disorder. In addition, three disorders - previously seen mainly as childhood disorders were included. The DSM-5 also provides subtype qualifiers, severity indicators and remission definitions (Márquez & Molinero, 2013).

Anorexia nervosa is a highly distinct serious mental disorder disease characterized by an intense fear of weight gain or altered body image, or both, that motivates severe eating restriction or other weight loss behaviors (e.g., cleanliness, excessive physical activity). Concerns about weight and form distinguish anorexia nervosa from the restriction disorder or from preventing food intake. In addition, markedly disturbed cognitive and emotional functioning (Muñoz et al., 2018). Medical complications of anorexia nervosa affects all organs and systems and are usually due to malnutrition and weight loss (Gibson et al., 2019).

Gastrointestinal symptoms, affecting the total gastrointestinal tract, are particularly common and uncomfortable (Schalla & Stengel, 2019). Bulimia nervosa can occur with normal or high weight (if the weight is less than the threshold of bulimia nervosa, then a diagnosis of anorexia nervosa is given with excessive purging subtype as specifics). Bulimia nervosa is characterized by recurrent episodes of binge eating (i.e., eating large amounts with loss of control) and compensatory behaviors to prevent weight gain. The most common compensatory behavior is self-induced vomiting, but inappropriate use of medications, fasting or extreme exercise are also used. These behaviors are driven or by negative self-assessment related to weight, body shape or appearance. Binge eating disorder is characterized by distressing, recurrent episodes of binge eating, with fewer compensatory behaviors than in bulimia nervosa (Wade, 2019). Bulimia nervosa and binge eating disorder are often accompanied by, or lead to, obesity (30-45%) and metabolic diseases related to the disorders.

Other specified eating or eating disorders (DSM-5 and ICD-11) are a residual category. The disorder of restrictive food intake or avoidance of foods is now recognized as a neutral age disorder in DSM-5 and ICD-11. The main symptoms are avoiding or restricting food (in relation to volume or variety), along with one or more poor weight

loss or growth, nutritional deficiencies, dependence on tube feeding or nutritional supplements for sufficient intake, and psychosocial impairment. Symptoms may arise in the context of a general lack of interest in food and food selectivity based on sensory sensitivity and fear of negative consequences of eating related to aversion experiences such as asphyxia or vomiting (Eddy et al., 2019). The intake of non-nutritive or non-food substances for a period of a month or more where the main triggers are the taste of substance, boredom, curiosity, or psychological behavior tension. Rumination disorder involves regurgitation of food after eating in the absence of nausea, involuntary nausea, or disgust.

Psychiatric comorbidities are the norm in people with eating disorders (> 70%). The most common psychiatric comorbidities include mood and anxiety disorders, neurological developmental disorder, alcohol use disorders, and substances, and personality disorders (Udo & Grilo, 2019) people with diabetes have an increased prevalence of eating disorders (Wisting et al., 2019). This high prevalence produces an increased risk of diabetic complications and premature death, especially if insulin omission is used to compensate for feeding. Bidirectional associations were observed between eating disorders and autoimmune disorders, such as celiac and Crohn's disease (Hedman et al., 2019).

## VI. UNDERSTANDING THE NEUROSCIENCE OF EATING BEHAVIORS AND BODY WEIGHT

Articles and reviews frame these phenomena in four major research areas: first, an understanding of the neuroscience of eating behaviors and body weight in the bio psychosocial and cultural spectrum; second, an exploration of the relationships between eating disorders and obesity risk; third, new and integrated approaches in the treatment of obesity and eating disorders; and fourth, evaluation in clinical and research domains.

Longer electroencephalographic reaction times (EEG) were found associated with eating disorder symptoms in individuals with high BMI (Edwards et al., 2018). A preliminary study reported associations between weight status and changes in EEG patterns, which correlated with general impulsivity and eating behavior (Schmidt et al., 2018). Furthermore, the differential neuronal regulation of binge eating by a new mechanism, The Neuromedina U Receptor 2 (NMUR2), which points to future treatment research. Other studies support a neural and biofeedback-based approach to disordered eating behaviors, such as food craving or rumination, with a neurocognitive logic (modulation of brain reward mechanisms) supported by empirical research (Smith et al., 2019).

## VII. EPIDEMIOLOGY

Eating disorders can affect individuals of all ages, genders, sexual orientations, ethnicities, and geographies. Adolescents and young adults are particularly at risk, with anorexia nervosa starting earlier than bulimia nervosa or binge eating disorder. Onset after 30 years of age is rare and the age of onset of anorexia nervosa seems to be decreasing dramatically, leading to it being a health problem still in childhood (Jensen & Steinhausen, 2016; Litmanen et al., 2017).

In adult populations, the clinical profile is dominated by disorders of the eating compulsion spectrum with fewer gender differences between sexes than in adolescents and an above-average risk in ethnic minorities and overweight individuals. At the primary care level, incidence rates have remained stable in recent decades for anorexia nervosa, stable or declining for bulimia nervosa and increased binge eating disorder and unspecified eating disorders (Litmanen et al., 2017).

Overall, the prevalence of eating disorders increased by 25%, but only about 20% of affected individuals are treated. Duration of untreated eating disorders before the start of the first treatment is variable, but shorter for anorexia nervosa than for bulimia nervosa or binge eating disorder (i.e., 29.9 months for anorexia nervosa, 53.0 months for bulimia nervosa and 43.8 months for binge eating) and shorter for children than for adolescents or adults (i.e., 9.8 months for children and 34.7 months for children) adolescents or adults (Treasure et al., 2020).

Long-term follow-up studies (> 20 years) of patients with anorexia nervosa or bulimia nervosa show that about one third of these patients have a persistent eating disorder, with a median disease duration of about 10 years for anorexia nervosa. The standardized mortality rate for anorexia nervosa is 5.9%, for bulimia 1.9% and for binge eating disorder 2% (G. L. de Oliveira, de Oliveira, de Pinho Gonçalves, et al., 2017; Radici et al., 2020; Treasure et al., 2020).

## VIII. BODY IMAGE AND EATING DISORDERS

Dissatisfaction with body image and shape resulting from the attempt to adjust to establish standards can lead an increasing number of people to adopt extreme and harmful measures to health with the aim of controlling their body mass. Without professional guidance, people tend to adopt inadequate eating practices, such as severe dietary restriction (diets), extreme compulsion to physical exercises associated or not with the indiscriminate use of laxative and diuretic, which are considered precursor behaviors of eating disorders (AD) (Gonçalves et al., 2017).

Studs affirm that the multifactorial model is the most accepted etiological model today to explain the genesis of AD. This model is based on the hypothesis that biological, genetic, psychological, sociocultural and family factors contribute to the development and maintenance of AD. Although there is interaction between these factors, some authors have highlighted sociocultural factors such as those that exert greater influence on the etiogenesis of this syndrome (Towne et al., 2017).

## **IX. MEDICAL COMPLICATIONS ASSOCIATED WITH EATING DISORDERS (ADS)**

The medical complications of ADs have been well described. In general, medical complications are the result of physiological adaptations to the effects of malnutrition or a consequence of behaviors harmful to weight control. Young people who have lost large amounts of weight or lost weight very quickly may develop hypothermia, bradycardia, hypotension and excess body weight and obesity in orthostasis eating disorders, even if their current weight is in the normal range. Rapid weight loss may be associated with acute pancreatitis and the formation of gallstones (M. et al., 2020).

Electrolyte disturbances can occur secondarily to self-induced vomiting or the use of laxatives or diuretics, or they can occur when food is reintroduced after prolonged periods of food restriction (the so-called feedback syndrome). Dietary restriction can lead to primary or secondary amenorrhea in adolescent girls, even with normal weight, as a result of suppression of the hypothalamic-pituitary-ovary axis, which is partly mediated by leptin (Chou & Mantzoros, 2014). Prolonged amenorrhea results in a low estrogen state, which can contribute to osteoporosis (Golden et al., 2015).

## **X. THE INTERACTION BETWEEN EATING DISORDERS, OBESITY, AND CONSIDERATIONS ABOUT EXERCISE**

Most people who develop AD are not overweight. However, it is not uncommon for a DA start with a teenager "trying to eat healthily" (Schreiner, 2018; Treasure et al., 2020). Some adolescents and their parents misinterpret obesity prevention messages and begin to eliminate foods they consider "bad" or "unhealthy" (Smink et al., 2016). The nutritional data required by the US Food and Drug Administration (FDA) on food labels list daily percentage values based on a 2000 kcal diet. Moderately active adolescent girls require approximately 2200 kcal/day, and moderately active adolescent boys require 2,800 kcal/day for normal growth and development. Adolescent athletes require even higher caloric intake (Le et al., 2017; World Health Organization, 2015).

Strict adherence to a 2000 kcal/day diet can lead to an energy deficit and weight loss for many growing teens. Overweight people may adopt disordered eating behaviors when trying to lose weight. In cross-sectional studies, it demonstrated that overweight people practice self-induced vomiting or laxative use more often than their normal weight peers (Mitchison et al., 2019).

People who were overweight or obese may develop AD. In a study conducted seeking treatment for AD, 36.7% had a previous weight higher than the 85th percentile for age and (Lebow et al., 2015). Initial attempts to lose weight by eating healthily can progress to severe dietary restrictions, skipping meals, prolonged periods of freshening, or the use of self-induced vomiting, diet pills, or laxatives. Initial attempts to increase physical activity can progress to compulsive and excessive exercise, to the point of waking up at night to exercise or continuing to over-exercise despite injuries. People with AD who develop in the context of previous obesity may present challenges that delay treatment (Koo et al., 2016). The onset of weight loss is praised and reinforced by family, friends and health professionals, but excessive and continuous concern with weight loss can lead to social isolation, irritability, difficulty concentrating, deep fear of regaining lost weight and distortion of body image (G. L. de Oliveira, de Oliveira, Gonçalves, et al., 2017; Gonçalves et al., 2017).

## **XI. NON-DRUG TREATMENTS AGAINST EATING DISORDERS**

### **11.1 Psychological treatments for eating binge spectrum disorders**

In adolescents with bulimia nervosa, family-based therapy is one of the first-line recommended treatments National Institute of Excellence in Health and Care of the United States (INESC) (NICE, 2017). Cognitive behavioral therapy (CBT) is an alternative therapy and, given in the form of guided self-care produces an improvement in binge eating than family therapy, and has the advantage that the manual can be shared with parents (Agras, 2019).

In adults with bulimia nervosa, INESC guidelines recommend guided self-help or therapist administering CBT as the treatment of choice. A meta-analysis found that more than 60% of patients were unable to fully abstain from the central symptoms of bulimia nervosa, even after receiving the best available treatments. In binge eating disorder, a comprehensive meta-analysis found great effects for abstinence from binge eating in CBT trials compared to a waiting list, while structured self-help treatment produced sizes of medium to large (NICE, 2017).

A reference study made a direct comparison of CBT with self-help guidance. In this large study, it was found that CBT is more effective and more expensive than guided self-help (König et al., 2018). Several behavioral therapies have been adapted for eating disorders, such as acceptance commitment therapy, dialectical behavioral therapy, compassion-focused therapy, mindfulness-based interventions, and schema therapy. Several small trials, mainly in binge eating disorder, were done to examine efficacy in terms of remission. A meta-analytical review showed that these treatments were not superior to comparison treatments (such as CBT) in terms of reduction of binge eating (Linardon et al., 2017). Other promising treatments include integrative cognitive-affective therapy for bulimia nervosa (Wonderlich et al., 2014).

### 11.2 Physical exercise as medicine in eating disorders

The suggestion to include exercise in the treatment of AD can be seen as provocative and controversial. However, there is a growing body of evidence suggesting that monitored exercise and nutrition are safe and can bring multiple benefits to individuals with AD. For example, previous research showed that the exercise has had an effect on attitudes and behaviors like symptoms reduction of the extreme thinness, and decrease body dissatisfaction (Cook et al., 2016; T. A. P. de Oliveira et al., 2018; Gonçalves et al., 2017), facilitate weight gain in anorexia nervosa, increase strength (Fernandez-Del-Valle et al., 2014) among other benefits to physical and mental health. This area of research suggests that substantial help may be possible with an appropriate exercise protocol as part of the treatment of people with AD.

Literature overviews concluded that exercise is safe for all variants of AD, if nutritional needs are met. In addition, the carefully performed therapeutic exercise may reflect the initiative of the American College of Sports Medicine "Exercise as Medicine" in patients with AD. However, the lack of a comprehensive list of guidelines that can explain how to effectively use exercises during a part of AD treatment demonstrates the need for additional review and synthesis of the literature, which may imply clinical considerations (Holland & Tiggemann, 2017; Moola et al., 2013).

Based on this, the following main strategies on exercise efficacy were identified as part of a treatment of AD (Cook et al., 2016). The team's approach, including an exercise program in the treatment of AD requires specific knowledge related to exercise prescription, physiology, and nutrition, as well as medical and psychological factors relevant to the treatment. Therefore, a multidisciplinary team of specialists in exercise, nutrition and mental health, medicine and physiotherapy should work collaboratively

to develop individualized exercise programs, with participation dependent on adherence to AD therapy.

It is recommended to start with mild intensity with a slow transition to moderate intensity. A primary objective should be to limit individuals with AD to small periods of light intensity activities that will allow the gradual conditioning of physiological systems. Aerobic and resistance exercises included in an exercise program should be adapted to the physiological and psychological needs of the patient. For example, successful programs have described resistance training for weight restoration in individuals with anorexia (Muñoz et al., 2018) and aerobic activity for weight loss, reductions in movement and bulimic symptoms and body dissatisfaction in individuals with bulimia nervosa (Ayuzo-Del Valle & Covarrubias-Esquer, 2019).

In addition, exercise should not be performed until the individual with AD has made sufficient progress in weight stabilization (for those with bulimia nervosa) and in caloric and nutritional intake to support the chosen activities (S. Bratland-Sanda & Vrabel, 2018; Solfrid Bratland-Sanda et al., 2010). Analyzing, preferably during the exercise session, but certainly after, the individual should be 'analyzed' in relation to sensations, emotions and thoughts evoked by the exercise. Here will be presented principles of the use of exercise as a treatment modality, they are:

1. Include a team approach with rigorous monitoring.
2. Ensure that adequate knowledge is available to oversee the nuances of proper delivery of exercise therapy and distinction when exercise needs to be modified or interrupted if the patient's medical or psychological status deteriorates.
3. Shall provide a set of rules, program goals, written in conjunction with results, expectations and contingencies for the progression and regression of exercise activity and provide a transparent example of treatment and exercise goals.
4. Help clinicians challenge the distorted beliefs and gears about exercise that are commonly observed in individuals with AD. For example, potential areas of content that are related to exercise in AD and therefore can be emphasized include the following: a. appropriate use of exercise for health benefits, b. recognize when exercise is becoming problematic, c. develop healthy attitudes and exercise behaviors, d. promote body awareness (i.e., understanding physiological states, injuries, and pain) , e. learn to enjoy exercise and exercise for fun, instead of having a functional role attached, f. identify factors related to overtraining or Burnout, e.g. focus on positive reinforcement;
5. Help change the exercise function in the AD. Specifically, exercise is a highly reinforcing activity for

some individuals, and the strength of this reinforcing value may be the reason for overuse or excessive exercise patterns associated with the severity of AD, and consequently the emphasis should be placed on making exercise appropriate to treatment compliance and success, rather than leaving exercise monitored and up to the individual with AD;

6. Start with moderate intensity and developing slowly to moderate intensity.

7. Emphasize the proper use of exercise, understanding body responses to exercise, and "listening to one's own body" when physiological resources are being exhausted. Therefore, exercise treatment should emphasize slow progression, so as not to leave exercise uncontrollable. A physiotherapist can provide the necessary knowledge to provide this guideline. So starting with small amounts of low intensity exercises, for example, starting with stretching or a half mile walk at a slow pace. The amount and intensity of exercise can be gradually increased as the patient demonstrates progress with standard Treatment of AD, weight restoration and any other predetermined therapeutic outcome. The recognition of body states related to physical exercise may continue to impair, even after weight restoration, because impairment in the recognition of other sources of pain (e.g., hunger, fullness, and exercise) often occurs during the development and maintenance of DA.

These guidelines correspond to the recommendations for the use of exercise as a complement to treatment for other mental health conditions and the beginning of activity in an individual without much knowledge of healthy exercise routines (Garber et al., 2011; Hayashi, 2016; Polman et al., 2018). In summary, the physical exercise effects is displayed in figure 1.

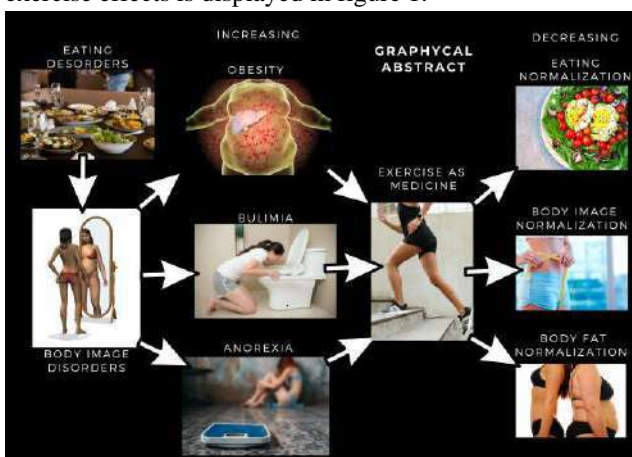


Fig.2: Summarized effects of physical exercise. After the installation of eating disorders, the body image are injured which can lead to obesity, bulimia, and anorexia, and after the physical exercise approach, all symptoms decrease in prevalence and severity.

## XII. CONCERNS AND AGAINST MEDICAL INDICATIONS

Although there is a critical mass that testifies in favor of exercise as part of the treatment of AD, not all whistles, that is, exercise is not appropriate for all individuals with AD. However, evidence can guide clinicians and researchers to adapt health benefits to the type of exercise, its amount and intensity to support physiological and psychological changes that can improve the effects of other AD treatments.

Safety is the main concern when adding exercise to AD therapy, and all precautions should be taken to prevent damage. The beginning of an exercise routine usually poses minimal health risks; however, patients with AD present additional psychological concerns in addition to an individual without AD (Holland & Tiggemann, 2017).

The identification of individuals who endorse pathological attitudes and behaviors in relation to exercise (e.g., exercise dependence, and compulsive exercise) may indicate the need for closer supervision. Creating a written contract detailing the program's rules, goals, outcomes, expectations, and contingencies for progression and regression of exercise activity should be agreed upon by all members of the treatment team and by the patient to promote an inclusive and collaborative exercise program that complements standard treatment for AD.

It is necessary to include a psych educational component that is the main component of cognitive behavioral therapy. In this sense, it is necessary to focus on positive reinforcement. However, unsupervised exercise can result in excessive behavior due to negative consequences of overtraining and exhaustion (Cook et al., 2016). Thus, programs need to identify and manage excessive or unhealthy exercise patterns, thus making exercise an available component for treatment adherence. Thus, the careful and incremental application of exercise is fundamental in the successful management of the exercise performed in therapy. Thus, graduate exercise programs that begin with small amounts of low intensity exercises should be emphasized (Ayuzo-Del Valle & Covarrubias-Esquer, 2019; Joy et al., 2016).

Therefore, it should be emphasized the understanding of physiological feedback and body states, distinguishing appropriate feelings of muscle effort from pain and/or injury, heart rate and respiratory rate, recovery, rest and body acceptance. To this end, additional time beyond what is necessary to obtain physical conditioning should appear at each level of exercise after the occurrence of physiological conditioning.

In summary, the figure 1 display the physical exercise effect on eating disorders, body image, obesity in a schematic overview.

### XIII. CONCLUSIONS

This literature review resulted in a comprehensive list of guidelines for the use of exercise in the treatment of ADs. These guidelines reflect the general objectives of an "exercise as medicine" approach, adapting exercise to maximize the health effects of a specific population. Of importance when applying these guidelines, the general objectives of an exercise program as adjuvant treatment of ADs should be developed "from the beginning" by a multidisciplinary team of specialists. The specific content should focus on safety by re-educating patients about the appropriate methods for performing exercises, motivation-related attitudes and transparency about health benefits and possible impairments resulting from increased exercise.

The approach advocated here begins with low intensity exercises (i.e., walking at a slow pace and stretching) for a short period. Progression to increased tension and amounts of exercise should occur only when the individual understands body sensations, psychological motivations and health outcomes related to exercise at low levels. The specific content of a therapeutic exercise program can also be adapted to amateur athletes and elite athletes with AD, focusing on the relationships between the athletes' body, exercise, psychological characteristics and foods (nutrition) used to promote athletic performance. Thus, our suggested approach to the inclusion of exercise in the treatment of AD is to empower the individual with exercise as a tool for a healthy life.

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# Reforestation Allied to APP's Areas and Certification to Maximize Profits in Rural Properties

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**Keywords— Environmental management.  
Carbon credit. Viability. Sustainability.**

**Abstract—** *The reduction in the emission of gases that cause the greenhouse effect and the promotion of sustainable development brought an investment opportunity, since companies, currently, must have commitments and targets for reducing the emission of gases according to international agreements. Based on this principle, a large market niche for Brazilian agribusiness is found here, since developed countries have large productive chains, through their industries, which are pillars of the market and world economic development, the need arises to combine productivity, gain and environmental responsibility, which often fail to maintain a perfect balance. The objective of the work is to disseminate the certification for the emission of carbon credits, through reforestation and preservation of APP's areas as a new way to increase profits in the Brazilian agribusiness rural sector. The proposed methodology was based on a theoretical and documentary review, to deepen the idea and provide a better understanding of the subject. Dissertations and theses were read to understand how carbon credit certification works. At the end of the study, the economic viability of investments in reforestation was verified, together with the areas of APP's to expand the income of the rural producer.*

## I. INTRODUCTION

As a result of the global mobilization on reducing the emission of gases causing the greenhouse effect and promoting sustainable development, there is an investment opportunity, since companies, currently, must have commitments and targets for emission of gases according to international agreements.

From this principle, there is a large market niche for Brazilian agribusiness, as developed countries have large production chains, through their industries, which are pillars of the world market and economic development, there is a need to combine productivity, environmental gain and responsibility, which often fail to maintain a perfect balance.

At this moment, underdeveloped countries such as Brazil, holders of large territorial areas, where it has great potential for the production of carbon credits, can take advantage using the certification process.

When analyzing the main economic activity in Brazil, which is agribusiness, which has a fundamental role in terms of our trade balance, as it brings balance and also great development potential, we find a market that is little explored and unmotivated, due to Brazilian producer.

It is known that every rural property has its productive area, which largely supports the business. However, it has within its total area APP's (Permanent Preservation Area), which are seen, often, with bad eyes by producers, because it is a preservation area and seems unproductive.

By analyzing the APP's areas and preservation on a rural property, these areas can be turned into productive and extremely profitable business, by combining rural production, whatever it may be, with certification for the emission of CO<sub>2</sub> credits (dioxide of carbon) in part of its property and APP's.

The carbon credit market has a lot of space to be worked on in rural properties, since, by investing in the necessary certifications, it becomes a new source of income for the producer, allied to a market that is constantly increasing. Due to the development of large global economies, even economically efficient, they are unable to meet their CO<sub>2</sub> emission targets, as it generates growing demand in the market. Thus, due to the great appreciation of these assets, it has even been traded on capital markets (stock exchanges).

From the above, the principle of demand and supply is observed, thus, Brazil and its rural producers have a large market that still needs to be explored further. It is believed that this fact is linked to the lack of information, which led us to carry out this work to try to understand and show that the use of APP's areas with reforestation of part of the property, when added together, can bring environmental return, through certification for carbon credit. Therefore, data was collected to respond to the inconveniences:

- ✓ What are the difficulties encountered by agricultural producers to take advantage of APP's areas?
- ✓ How relevant is it to understand the processes of certification and negotiation of carbon credits?
- ✓ How important is it to set aside a percentage of your rural property for reforestation?

## II. JUSTIFICATION

The work is justified on the basis of environmental preservation combined with the profitability generated through carbon credits. Considering that the object of research is the areas of APP's and reforestation, the proposed approach can help agribusiness managers to use natural resources to maximize environmental profits through APP's and reforestation.

The general objective of the work was to spread the certification for the emission of carbon credits, through the reforestation and preservation of APP's areas as a new way to increase the environmental profits in the rural producers sector of the Brazilian agribusiness.

For the study, it was specifically necessary to: analyze how the carbon market works for agricultural producers; propose the implementation of reforestation and

certification for the issuance of carbon credits; show possible paths for certification, and negotiation of credits generated by APP's and reforestation areas of the property.

## III. BRIEF BACKGROUND ON ENVIRONMENTALLY FRIENDLY MOVEMENTS

Early in the 19th century, environmental movements began as a response to industrialization. In the 20th century, from the 1960s onwards, the discussion began to receive greater prominence, due to the following factors, such as: the increase in polluting gas emissions, the greater use of agricultural pesticides and the strengthening of nuclear energy. With this, several scientists highlight the need to respect the ecosystem we live in to protect human health and the environment.

In this way, new visions gain strength on the subject and begin to be put into practice. Below we see the main movements brought by the authors João Carlos Moreira and Eustáquio de Sene (2019):

- ✓ Year 1972-

1st United Nations Conference on the Human Environment – Stockholm (Sweden)

- ✓ Year 1983

World Commission on Environment and Development

- ✓ Year 1985

Vienna Convention for the Protection of the Ozone Layer.

- ✓ Year 1986

Brundtland Report on “Sustainable Development” (Our Common Future); current development that allows the use of natural resources without harming the rights of future generations

- ✓ Year 1987

Signed the Montreal Protocol with the objective of eradicating substances harmful to the ozone layer, such as CFCs. The goal of this protocol was fulfilled, as between 1987 and 2008 there was a reduction of 99.7% of these gases.

- ✓ Year 1992

Rio-92, Eco-92 or Earth Summit. – Participation: more than 170 countries present, brought together more than 100 heads of state; 2400 representatives of NGOs (Non-Governmental Organizations); more than 17,000 people attended the NGO Forum (an event parallel to the United Nations Conference). – Main Theme: Sustainable Development – Final Documents: Agenda 21 (a document that established the importance of each country to commit to reflect, globally and locally, how all sectors of society

could cooperate in the study of solutions to socio-environmental problems); Rio Declaration on Environment and Development; Declaration of Principles relating to Forests; Convention on Climate Change; United Nations Convention on Biodiversity. – The main objectives of these initiatives are:

I. Promote development without destroying nature;

II. Create a fund to help developing countries to protect the environment;

III Seek a solution to the relationship between excessive consumption in developed countries and the destruction of the environment in 3rd World countries, pressured by external debts.

✓ Year1997

Created in 1997, the Protocol entered into force on February 16, 2005, during the first period (between 2008 – 2012) developed countries commit to reduce greenhouse gas (GHG) emissions by at least 5% relative to 1990 levels. In the second commitment period, Parties committed to reduce GHG emissions by at least 18% below 1990 levels over the eight-year period 2013-2020. Each country negotiated its own emission reduction target based on its vision of the capacity to achieve it in the period considered. Brazil ratified the document in 2002, but developing countries such as Brazil and China do not have reduction targets. Among the main emitters of greenhouse gases, only the United States has not ratified the Protocol. However, they continued with responsibilities and obligations defined by the Convention.

✓ Year2002

Known as Rio + 10 or World Summit on Sustainable Development) – Main objective: to discuss solutions already proposed in the primordial Agenda 21 (Rio 92), so that they could be applied in a coherent way not only by the government, but also by the citizens. It was decided to reassess goals and prioritize issues related to Global Warming.

✓ Year2009

Copenhagen, was the 15th conference held by the UNFCCC (United Nations Conference on Climate Change). – Main objective: establish a climate agreement to replace the Kyoto Protocol. – Participation: 192 nations were represented at the conference, making it the largest UN conference on climate change.

✓ Year2012

Known as Rio + 20: – Gathered 193 member countries, but frustrated the expectation of what awaited targets or agendas of commitments. One of the main reasons for the expectation was the success of the conference held in 1992, the Conference on the Environment and Development, the Eco 92, or Rio 92, which was one of the most productive in the history of the United Nations.

✓ Year 2015

Paris Agreement: for the first time in history a universal agreement, defined measures to reduce carbon emissions and contain the effects of global warming and which was approved by almost all countries (195 countries). The agreement enters into force from the year 2020, being essential to limit global warming below 2°C by 2100, compared to before the industrial age.

Source: Moreira; Sene (2019). Organized by the authors.

In this last agreement, Brazil undertakes to reduce its greenhouse gas emissions by 37% by 2025 and 43% by 2030 compared to 2005 values. Thus, the commitments assumed by Brazil are:

- End illegal deforestation;
- Restore more than 10 million hectares of forest;
- Integrate 5 million hectares of crop-livestock-forests;
- Guarantee 45% of renewable sources in the total energy matrix;
- Expand other renewable energy sources;
- Increase the share of ethanol to 16%.

It is noted that Brazil is committed in the agricultural area to restore 12 million hectares in restoration and reforestation, 5 million hectares in crop-livestock-flo integration



Source: JornalO Estado de São Paulo, 2016

### 3.1 Carbon market

The carbon market arose from the need for effective measures to reduce the emission of gases that cause the greenhouse effect, with this the world scenario brought several protocols as measures to reduce and preserve our planet. Today, the way the carbon credit is measured, each ton of carbon dioxide (CO<sub>2</sub>) is sequestered, corresponds to a carbon credit that is most often issued by developing countries to developed countries. In the Brazilian domestic market, we already find a good demand for credits by companies that have emission/reduction targets and are unable to meet them, where, in turn, they resort to purchasing credits to suit their needs.

According to Martins et al. (2012, p. 2), “Carbon credits arose from the concern of society in general with the future of the planet”. As shown in Table 1, it is interesting to implement project activities in developing countries to reduce GHG gases.

A emissão de 1 tonelada de:	Nome:	Equipara-se à emissão de:
CO <sub>2</sub>	Dióxido de Carbono	1 tCO <sub>2</sub> e
CH <sub>4</sub>	Metano	21 tCO <sub>2</sub> e
N <sub>2</sub> O	Óxido Nitroso	310 tCO <sub>2</sub> e

Fonte: Adaptado de Limiro (2012).

In Brazil, there are no rules that regulate the trade of credits, however there are projects for flexibilization mechanisms (CDM - clean energy mechanism). Although there is no regulation, Brazil applies to integrate the carbon market. Of the 3,219 projects that were in some phase of the CDM, 280, that is, 9%, were from Brazil. This number

of projects gave Brazil the 3rd position in number of projects (LIMIRO, 2012). At the international level, in 2003, there were some credit classification focuses.

The International Accounting Standards Board (IASB) issued, through its International Financial Report Interpretations Committee (Ifric), the Ifric Draft Interpretation D1 Emission Rights, on July 14, 2003, a first draft for interpretations relating to the issues accounting of emission rights (permissions). The draft treated permits as an intangible asset, to be recorded at fair value upon receipt of permit, at the beginning of each year. For companies that complied with the reduction, the impact on the result would be zero; for those who did beyond the permits, it would be positive. In addition, the company would obtain credits for the following year or would sell them to those who did not meet the target defined in the permissions received (PELEIAS et al., 2007, p. 84).

With regard to credit rating, in Brazil, opinions diverge. Many companies classify carbon credits in the way that best suits them, given the lack of accounting standards. Peleias et al. (2007) carried out a study to find out how companies that participated in the CDM project process in Brazil accounted for carbon credits. As a result, the companies demonstrated that they are hardly dealing with the matter in the accounting sphere, as there are

disagreements about the accounting treatment applicable to carbon credits.

#### IV. METHODOLOGY

This work was based on exploratory research, in order to better understand how APP's areas work, reforestation of rural properties and certifications for carbon credits (CO<sub>2</sub>). Because it is a relevant topic.

Legal documents and oriented to carbon credits were selected. Also, from these documents, a bibliographic review of articles by researchers with extensive knowledge of the subject in question was carried out. According to Severino (2002):

Once the theme of the work has been established and mastered and the problems and hypothesis formulated, the next step is the survey with existing documentation on the subject. Already a heuristic, science, technique and art phase of document search. A series of procedures is triggered for the methodical search and location of documents that may be of interest to the topic discussed. (p.76)

After the selection and studies carried out in the area, through monographs, scientific articles, dissertations, theses and books, we sought to highlight the aspects that guaranteed and guided the implementation of the APP's areas. In this theoretical analysis process, the understanding of how to carry out the implementation of APP's and reforestation in agricultural properties was used, emphasizing the profits and benefits for the environment. Thus, it was understood that:

[...] the main advantage of bibliographic research lies in the fact that it allows the investigator to cover a much broader range of phenomena than what he could research directly. This advantage becomes particularly important when the research problem requires data that is widely dispersed across space. For example, it would be impossible for a researcher to travel across the entire Brazilian territory in search of data on population or per capita income; however, if you have an adequate bibliography at your disposal, you have no major obstacles to having the required information. Bibliographic research is also indispensable in historical studies.

In many situations, there is no other way to know past facts than based on bibliographic data. (GIL, 2002, p. 3).

#### 4.1 Results analysis

The main basis of the Carbon Credits market was the Kyoto Protocol, and from these many movements were initiated so that a market related to GHG emissions could actually take place.

This market has a particularity, as for its functioning, sellers trade the lack of production, that is, the absence of production of the gas in question.

This dynamics of the carbon market shows an organized structure, highlighting the main elements: buyers interested in buying carbon credits; the sellers; and, the intermediary agents who are responsible for the negotiation process between buyers and sellers. As Manfrinato (2005) points out, intermediary agents are companies specialized in specific stages of the carbon credit trading chain.

It was found that in Brazil, there are no rules that regulate the trade of credits, however, there are projects for flexibilization mechanisms (CDM - clean energy mechanism). Although there is no regulation, Brazil applies to integrate the carbon market. Of the 3,219 projects that were in some phase of the CDM, 280, that is, 9% were from Brazil.

Also, the bureaucratic process is questioned, which for Valente (2012), bureaucracy is important when it comes to GHG reduction. For him, the credibility of the processes is paramount, as this is the only way for the Carbon Market to be global and consolidated. However, many points can and should be improved, especially when the process goes through certifiers registered by the UN (United Nations Organizations).

In the view of Freitas (2012), global warming forecasts are a little exaggerated. He claims that it is proven that there are natural cycles of the planet's heating and cooling, however, he has no doubt that man has the power to accelerate these processes.

The fact that there is a certain sensationalism in the media helps to make people reflect, but habits will only be changed when it is not just for the environmental cause, but for bringing some benefit to them. He prefers to be optimistic and believes that in the future it will be possible to find a balance with the environment again. Thus, it is common in the opinions of scholars that many problems must be resolved for the financial viability to be real.

#### V. FINAL CONSIDERATIONS

It is noteworthy that the main objective of the Carbon Credit Market is to negotiate the non-production of a product, as this is an intangible asset, which makes it different from normal commodities. As it is a new market and presents a different scenario, this brings a lot of uncertainty for investors.

Despite this, both organizations and some countries that are concerned with environmental and social issues will also have a greater financial return regardless of the Carbon Market. Companies will have a competitive advantage if they produce products with low carbon emissions, as this attitude will probably bring many opportunities in the future.

To conclude, it can be said that this work achieved the proposed objectives, which had as its main goal to demonstrate how the trade in Carbon Credits works and to identify people's vision.

It can be said that this market is still uncertain, but with great chances of evolution with positive results for the various organizations and countries that operate in them. Another important point to emphasize is that the imposed bureaucracy brings credibility to its functioning. Although this commodity is not easy to obtain, some speculators can take advantage of gaps in the operating structure of this market to obtain only financial advantages.

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# The alternative use of medicinal plants in the treatment of depression caused by pesticide: A literature review

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**Keywords** — Agrochemicals, Depression,  
Farmers, Phytotherapy, Plants.

**Abstract**— In the last decade, Brazil has expanded the pesticide market by 190%, becoming to be the first place in the world ranking of consumption since 2008. This way, the negative impacts for the environment and human health, because of the exposure to chemical inputs, are diverse. Among the disorders caused, depression stands out, due to the exposure of field workers to pesticides. As a possibility to an alternative treatment there is the use of plants to control depression. Therefore, the objective of this study was to evaluate the profile of publications in the last five years about plants that can be used in the alternative treatment of depression. This is a bibliographic search, in the integrative review modality. Thus, nine papers were selected from scientific studies with medicinal plants used to control depression. Among the mentioned plants that were used in the antidepressant treatment there is the *Hypericum perforatum*, *Crocus sativus*, *Valeriana officinalis*, *Lavandula officinalis* e *Rosmarinus officinalis*. Given to the exposure of farmers and the surrounding populations to agrochemicals and also to the repercussion, such as depression, the alternative use of medicinal plants in the treatment of this disease, it is shown as an important alternative. Therefore, this review brought the knowledge of a diversity of plants with mediated antidepressant activity.

## I. INTRODUCTION

In the last decade, Brazil has expanded the pesticide market by 190%, becoming to be the first place in the world ranking of consumption since 2008. In the 2010 and 2011 harvest alone, 936 thousand tons of pesticides were consumed (RIGOTTO et. al., 2014). The agri-food system has been one of the biggest factors of environmental imbalance, and the discussion that permeates health and

environment must consider this fact, expanding the discussions related to the pesticides use (AZEVEDO & PELICIONI, 2011). According to the Program for Analysis of Pesticide Residues in Food (Programa de Análise de Resíduos de Agrotóxicos em Alimentos - PARA) of the Brazilian Health Regulatory Agency - ANVISA (2011) 1/3 of the food consumed daily by Brazilians is contaminated by pesticides, according to the

analysis of samples collected in all 26 states of Brazil (CARNEIRO, 2015). Still according to ANVISA, the use of one or more than one pesticides in crops, for which they are not authorized, especially those in reassessment or scheduled discontinuity phase due to its high toxicity, shows negative consequences on human health and to the environment. One of the consequences is the increase of food insecurity to the consumers who eat contaminated food with Active Ingredients (AI).

Conforming to ANVISA (2011) the AI with high degree of proven acute toxicity may be triggers of health problems, like for example: neurological, reproductive, hormonal dysregulation and even cancer.

Therefore, the negative impacts of the exposure to the chemical inputs are diverse to the environment, animals, ecosystems as well as for human health. These repercussions affects, directly, farmers, rural workers and the population surrounding the crops, especially pregnant women and children who are part of the most vulnerable risk group to the harmful effects of these chemicals (CARNEIRO, 2015). This exposure is justified by the fact that only 30% of the pesticides are sprayed in the "target", the remnant is disseminated in the ecosystem, contaminating, for example, soil and rivers (PIGNATI et. al., 2014). Regarding the environmental aspects, it also can be highlighted the soil degradation, waste and excessive use of water, environmental pollution, dependence on external inputs and loss of genetic diversity. About the factors involving human health, it is associated with the emergence of imbalances such as infertility, hormonal disorders, depression, suicide, cancer, among others (COSTA et. al., 2017; JOO & ROH, 2016; STROPARO & BRAGUINI, 2011).

Among the disorders caused by the chronic exposure of pesticides to rural workers, depression stands out with a high incidence and important repercussion, as it is associated with suicide. Depression is a severe mood disorder, with significant loss of mental function and distortion of the way the person experiences and understands reality (BARBOSA, 2016). It is understood as a mood disorder with a decline, to varying degrees, of interest in everyday facts, lowering of attention, impairment of memory and suicidal ideation. Depression compromises daily activities in such a way that it results in a lower quality of life, which may lead the affected person to withdraw from work (ELY, 2014).

In this context, the medicinal plants have been widely used as an alternative for the treatment of various diseases and this practice is also known as phytotherapy or herbal medicine often symbolizing the only therapeutic resources of many communities and ethnic groups, even with the

encouragement of pharmaceutical industry and use of industrialized drugs (LACERDA, 2013). Based on this, it is justified the relevance of this study, which aimed to discuss the objective of evaluating the profile of publications in the last five years about plants that can be used in the alternative treatment of depression, from the perspective of the authors Qin et. al. (2017), Chen et. al. (2019), Perviz et. al. (2016), Rabiei & Rabiei, (2017), Lopes-Rubalcava & Estrada-Camarena, (2016), Kourosh Saki et. al., (2014), Lee & Bae (2017), Jeanette Martins (2018), Hosseini & Hosseini (2018).

This is a bibliographic research, based on the integrative review modality, where it was selected 09 scientific papers about medicine plants used to control depression. From these nine, seven had the profile of literature review of plants used in the treatment of this pathology and two were experimental studies with models of depression in rats testing an herbal formula and an active ingredient.

Lastly, knowing the strong association between pesticides and the development of depression in rural workers and exposed populations and that herbal medicine is a possibility in the treatment of depression, the main results analyzed point to the mechanism of action proposed for the antidepressant activity that involves antioxidant action of the nervous system, inhibition of apoptosis through ROCK/Akt, synaptic regulation of serotonin, noradrenaline, dopamine, regulatory activity by the hypothalamus-hypophysis-adrenal axis.

## II. METHOD

This study is a bibliographic research, based on the integrative review modality of the developed literature, respecting the following phases: elaboration of a guiding question, sampling the literature, data collection, critical analysis of the included studies, discussion of results and presentation of the integrative. So, according to Marconi & Lakatos (2011) the bibliographic research, or secondary research source, resumes all scientific production that has already been made public in related to the topic of the study.

The integrative literature review is one of the research methods that allows the evidences' incorporations in clinical practice. It consists in the construction of a broad analysis of the literature, contributing to discussions about research methods and results, as well as reflections about the realization of future studies. The initial purpose of this research method is to gain a deep understanding of a particular phenomenon based on previous studies. (BROOME, 2000).



So, the guiding question was: What is the profile of publications in the last five years about plants that can be used in the alternative treatment of depression? The study was carried out in the databases Science Direct, Coordination for the improvement of Higher Education Personnel (CAPES), Latin-American and Caribbean Literature in Health Sciences (LILACS), Publisher Medline (PubMed), Scientific Electronic Library Online (SciELO). From the association between terms, in English: Depression, phytotherapy, plants selected as Descriptor in Health Science (DeCS) of the BVS portal. The terms were crossed as subject descriptors following Boolean logic in the following ways: ((Depression) AND (phytotherapy) AND plants). After reading the titles and abstracts, it was included the papers that fitted in the proposed theme and discussed about medicinal plants used in the alternative treatment of depression during the last five years.

An average of 195 papers were found at the first search, which after applying the selection criteria were restricted to 09 papers. The inclusion criteria were publications that treated directly about medicinal plants or active principles focused on the treatment of depression (both review, clinical and experimental studies) in the last five years. Given to the great number of publications, editorials, letters to the editor, books and duplicated publications were excluded from the study.

### III. RESULTS AND DISCUSSION

Thus, it was selected 09 scientific papers about medicine plants used to control depression. From these 09, seven had the profile of literature review of plants used in the treatment of this pathology and 02 were experimental studies with models of depression in rats testing an herbal formula and an active ingredient. The publications are concentrated on countries such as China, India, Bangladesh, Iran, Pakistan, and Mexico, between the years 2014 to 2019.

Several plants used on the treatment of depression have been mentioned in publications among them there is the *Hypericum perforatum* (popularly known as erva-de-são-jão), *Crocus sativus* (real Saffron), *Valeriana officinalis* (minor valeriana, wild valeriana), *Lavandula officinalis* (Alfazema) e *Rosmarinus officinalis* (Rosemary) present in almost all studies. It is important to highlight that some of these plants acted in the treatment of depression as well as anxiety.

So, given the side effects that the conventional medications have provided, there is an increase in the consumption of drugs of phytotherapeutic origin and medicinal plants. According to Hosseini & Hosseini (2018) it has been seen that many phytochemicals, such as

saponins, alkaloids, polyphenols, triterpenoids, essential oils, fatty acids and flavonoids, have anxiolytic and antidepressant effects.

In Perviz's et. al. (2016) work it was seen the antidepressant effect of several isolated alkaloids plants, such as *Psychotria myriantha*, which has as active ingredient the stridosidinic acid, by the serotonergic system (5-HT) in the hippocampus of rats. There is also the *Beberis aristata* (berberina) which significantly decreased the immobility of rats and increased the climbing behavior in the forced swim test. However, there was no effect on swimming time, while increased the exploration of open arms in the elevated plus maze test that confirmed the activity similar to depression medication. Just like the alkaloids from *Annona cherimolia*, including 1,2-dimethoxy-5,6,6a, 7-tetra-hydro-4H-dibenzoquinoline-3,8,9,10-tetraol, anonain, liriodenine e nornuciferin and the  $\beta$ -carboline, such as harmana, norharmana e harmine produced an effect similar to an antidepressant (PERVIZ et. al., 2016).

Also, in the previous study, it was seen that the acute administration of lyophilized extract of *Rhazya stricta*, (active ingredient: akuammidine, rhaziminin and tetrahydrosecamine) resulted in an antidepressant effect in experimental animals. Such activity was also seen in the following species: *Mitagyna spicosa*, *Peganum harmala*, *Ziziphus apétala*, *Aconitum baicalense*, *Boerhaavia diffusa*, *Evodia fructus*, *Sceletium tortuosum*, *Piper nigrum*, *Piper laetispicum* e *Dactylicapnos scanens*. The mechanism of action of these plants was due to the monoaminergic system (serotonergic, noradrenergic and dopaminergic), inhibitory action on monoamine oxidase, decrease in plasma levels of corticosterone and inhibitory of the 11- $\beta$ -hidroxisteroid deshydrogenase.

The Hipérico, scientific name, *Hypericum perforatum* is a plant which has antioxidant property, anxiolytic activity and it is very used in the treatment of depression. Its extract is used both in the therapy of this syndrome and also to prevent its recurrence. Thus, its action is longer drawn out than the citalopram. Given its wide dissemination as an antidepressant, many studies have been developed to identify its active principles and mechanisms of action (HOSSEINI & HOSSEINI, 2018; SINGER et. al., 2011; BUTTERWECK, 2003).

The *H. perforatum* is a weak inhibitory of monoamine oxidase, but it acts on synaptosomal reabsorption of serotonin, dopamine, and norepinephrine. As it also has a little effect on beta- adrenergic and it is more potent on serotonin receptors (BUTTERWECK, 2003). Its antidepressant activity is as effective as the medication imipramine (SABZHAH et. al., 2009).

A follow-up study of Sabzhah et. al. (2009), in long term, recruited 426 patients and subjected them to administration of extract of *H. perforatum* ( $3 \times 300$  mg / day) to be evaluated for remission rates of depression. The results showed a beneficial effect of the extract in preventing relapse, while long-term maintenance and tolerability was comparable to placebo (SABZHAAH et. al., 2009).

*Crocus sativus* is a spice better known as Saffron, which is produced from parts of the flower, rich in secondary metabolites such as flavonoids, anthocyanins and tannins (BABAEI et. al., 2013). The bitter taste is due to the presence of a substance called picocrocina. Other carotenoids, such as beta-carotene, lycopene and zeaxanthin, and vitamins, especially riboflavin and thiamine, are found in the Saffron. Crocetin, crocetin and Saffron are active principle of Saffron (ASISHIRAZI et. al., 2017).

In two randomized clinical trials using the saffron (30mg/day), patients showed a significant improvement from depression compared to placebo. As well, in three independent randomized clinical trials using the Hamilton Rating Scale for Depression protocol, it was observed equivalent effects when comparing saffron to imipramine or fluoxetine (LEE & BAE, 2017). In a limited meta-analysis, it was possible to conclude that the saffron supplementation may improve the symptoms of depressive patients and other literature review indicated that it helps in mild or moderate depression (HAUSENBLAS et. al., 2013; LOPRESTI & DRUMMOND, 2014). The authors propose that the saffron action mechanisms occur by serotonergic, antioxidant, anti-inflammatory, neuroendocrine and neuroprotective pathways.

The valerian, scientifically known as *Valeriana officinalis*, belongs to the Family of Valerianaceas and acts in diseases of central nervous system, such as insomnia and anxiety (ROOZBEHI et. al., 2015). In studies with valerian, sedative, hypnotic and antidepressant effects were noticed, with isovaltractin, valproate and didrovaltro as active ingredients (REZVANI et. al., 2010). Its antidepressant activity occurs through serotonin, GABAergic and adenosine systems (CARRETTIERO et. al., 2009). Besides, the results of a study show that this effect occurs by acting on the biosynthesis of serotonin neurotransmitters in the brain (DIETZ et. al., 2005).

The lavender, scientifically called by *Lavandula officinalis*, is a plant from the Lamiaceae family. It is one of the most used herbs in traditional medicine that is effective in the treatment against diseases related to the central nervous system, helping to better reconcile sleep and in the treatment of anxiety (AKHONDZADEH et. al.,

2003). Researchers attribute that its anxiolytic effect is similar to the benzodiazepines and is also due to the increased amount of neurotransmitter GABA (CAVANAGH & WILKINSIN, 2002). In Rezaei's et. al. (2010) work, the sedative and anxiolytic effects of lavender have been attributed to the binding to GABAA and it is believed that this effect is superior to the effects of diazepam. Studies have revealed the antidepressant effects of this plant and that the association with the medication imipramine improves the action of it (AKHONDZADEH et. al., 2003). Hritcu et. al. (2012) reported that the chronic exposure to lavender oil markedly inhibited depressive behaviors in rats when evaluated in the forced swim and elevated plus maze tests.

The rosemary, scientifically known as *Rosmarinus officinalis*, is from the Labiatae Family and it has uncountable pharmacological effects, including hepatoprotective, antibacterial, antiulcer, anticoagulant, diuretic, antidiabetic, antioxidant e antidepressant (RABIE et. al., 2016). The antidepressant activity is justified by the monoaminergic system (MACHADO et. al., 2009). It was noticed in Machado's (2013) studies that the ursolic acid, an important compound of rosemary, is an antidepressant effect at a concentration of 0,1 mg / kg in rats. This activity is increased in the presence of agonists from the dopamine receptors and impeded in the presence of their antagonists (MACHADO et. al., 2013).

The polyphenols effects of *R. officinalis*, constituted by carnosic acid, rosmarinic acid and luteolin, on depression and on PC12 cells, in studies of in vitro, were observed in mice. In the proteomic analysis of PC12 cells, it was seen that the extract caused a positive regulation on the tyrosine, hydroxylase and pyruvato carboxylase (the genes involved in the GABAergic, serotonergic, and dopaminergic systems). These polyphenols also protected the nerve cells against the toxicity introduced by the corticosterone (SASAKI et. al., 2013).

The plant Danggui-Shaoyao-San exerts therapeutic effects on depression induced by chronic stress. In a study Kou et. al. (2005) this herb caused an increase in the monoamine neurotransmitters on the brain of elderly mice. *Chamaemelun nobile* is from the Asteraceae/Compositae family. It has diuretic, transpiratory, gastrotonic, carminative, stomach, digestive, anti-inflammatory, antispasmodic, and calming properties. An experimental study demonstrated antidepressant effects on the extract of the *C. nobile* on the progesterone induced major depressive disorder. The Mexican *Cristactinia* is used on the treatment of fever, rheumatism, diuretic, sexual stimulant, and anticonvulsant. On the pharmacological antidepressant activity of the aqueous extract of the Mexican *C.*, it was seen in mice applying the

forced swim test and the tail suspension test; it was found out that these activities were similar to a conventional antidepressant like clomipramine (RABIEI & RABIEI, 2017; JÄGER & SAABY, 2011; CASSANI et. al., 2015).

*Magnolia officinalis* is a plant in the Magnoliaceae family which is used to treat neurological disorders such as convulsions, depression, and anxiety. It also can be used as sedative and analgesic. Magnolol and honokiol are two active principles identified in these vegetables. It was related that these compounds cause antidepressant effects because they activate the serotonergic system. The oral use of magnolol e honokiol (20 and 40 mg / kg) caused a decrease in the duration of immobility on the forced swim test and an increase on the preference for sucrose (RABIEI & RABIEI, 2017).

*Salvia Sclarea*, the *sálvia*, is considered the most important genus of the Lamiaceae family. The antidepressant effects of several species of this genus have been confirmed. An experimental study showed that the activity of *S. sclarea* was sharper than the *Rosmarinus officinalis*, *L. angustifolia* and *Anthemis nobilis*. And the action mechanism of *S. sclarea* is exerted through the dopaminergic system (SEOL et. al., 2010).

The ginger scientific-named *Zingiber officinale*, from the Zingiberaceae family, is one of the plants very used in traditional medicine, in addition to food supplementation. Its pharmacological activities are antioxidants, antitumor, anti-apoptotic, anti-inflammatory, anti-hyperglycemia, antitussive and anti-flu. It has been reported in diabetic patients an increase in insulin secretion and a reduction of glucose levels in blood after the administration of ginger extract and that such mechanisms are justified by the serotonin, receptor 5HT-3. For these reasons, the ginger extract can improve symptoms of diabetes and associated depression (HOSSEINI & HOSSEINI, 2018).

*Schinus molle*, from Anacardiaceae family, exerts certain pharmacological properties, including anti-inflammatory, antitumor, antifungal, anticonvulsant and analgesic (MACHADO et. al., 2007). The injection with extract of n-hexano *S. molle* (3-600 mg / kg) significantly decreased the duration of immobility in the tail suspension test in mice with comparable efficacy to fluoxetine (10 mg/kg). The antidepressant effects of the extract of n-hexano *S. molle* can be exerted by the serotonergic, dopaminergic, and noradrenergic (HOSSEINI & HOSSEINI, 2018).

Beside the mentioned plants at this work, it was seen in the review mexican herbs such as *Annona* sp; *Byrsonima crassifolia* (L.) Kunth; *Casimiroa edulis* La; *Annona cherimola*, *Justicia spicigera* which have antidepressant actions. Still in the data search, it was seen that *Rhodiola*

*rosea*, *Echium amoenum* (borage), *Albizia julibrissin* (mimosa), *Nelumbo nucifera* e *Papaver rhoeas* also present such action and mediated by monoaminergic systems.

In a study by Neto et al. (2018) it was discussed the association between pesticide poisoning and the emergence of depression in agricultural workers in a clinical case study with a rural worker with a history of absence from work by depression. It was seen that the exposure of the rural worker was to the pesticides Deltametrina, Pendimetalina and Metalaxil-M. Although, in the pesticides directions there was no association with chronic exposure to these and to emergence of mental disorders. However, in the worker's family history, he states that there was suicide in his family members and that they worked in the same activity he did, dealing with the same chemicals. When asked if in the absence periods from work his depressive symptoms underwent any change, the respondent stated that after a few months of leave, he felt an improvement in his mood, slept better and did not feel suicidal ideation that had previously disturbed him (FILHO NETO & FÉLDEN, 2018).

Malekirad et. al. (2013) studied the anxiety/insomnia and severe depression indices and noticed that these were much higher in rural workers when compared to control groups ( $p=0,015$ ;  $p<0,001$ ) (MALEKIRAD et. al., 2013). Thus, the conclusion of this last study was that farmers exposed organophosphorates are prone to neuropsychological disorders and that the longer the exposure time, the greater clinical symptoms.

In Brazil a study of Beseler et. al. (2008) reported that the exposure in high acute intensity as well as cumulative pesticides may contribute to depression in pesticide applicators. In a work with 229 elderlies who lived in the urban and rural zones in Cachoeira do Sul (RS) city, it was identified a high prevalence of the use of pesticides 35,8%, being significantly higher ( $p<0,001$ ) among elderly people living in rural areas (60,2%) (SILVA et. al., 2013).

Thus, given the link between chemical inputs and depression in rural workers and exposed populations, these plants mentioned in the review are seen as a possibility of alternative treatment for depression caused by chronic pesticide poisoning.

In the analyzed Works it was observed that plants are used in the treatment of depression as well as anxiety, like some studies reported. Among these, active ingredients already isolated could be seen, such as umbelliferone, herbal formulas, plants rich in alkaloids, *H. perforatum*, *C. sativus*, *V. officinalis*, *L. officinalis* e *R. officinalis*, as also other herbs mentioned in the text. As it was seen that the main action mechanisms that were elucidated were due to the antioxidant action of the nervous system, inhibition

of apoptosis by the ROCK/Akt pathway, synaptic regulation of serotonin, noradrenaline, dopamine, regulatory activity by the hypothalamic-pituitary-adrenal axis.

Through the specific analysis of the chosen papers to compose this study, it was understood the importance of the medicinal plants in drugs production for the treatment of depression, especially because of its efficiency, potency and security, since the conventional treatment present a percentage of the therapeutic failure and side effects. As well as it was noticed the necessity to elaborate new researches about this thematic (medicinal plants) used on the treatment of depression, since there is too little studies about it; by this way it is possible to have a better understanding of effectiveness of these active principles.

#### IV. FIGURES AND TABLES

Table 1 – Studies of plant species with antidepressant pharmacological activities.

Species Vegetables/ chemical compounds	Results	Origin Country	Authors
Daucus carota, Coriandrum sativum e Angelica archangelica(umbeliferons)	The treatment with umbelliferons (15mg/kg) significantly improves depressive behaviours Induced by CUMS ( experimental model)	China	Qin et al.,2017.
Panax ginseng Angelica sinensis Polygala tenuifolia Ziziphi spinosa (PAPZ)	Together, the PAPZ has therapeutic effects in a depression model of rats, increasing the proteic expression of the brain-derived neurotrophic factor (BDNF) and improving the brain anti-oxidance	China	Chen et al.,2019
Berberis aristata (Beberina) Psychotria myriantha (Ácido estrictosidina) Annona cherimolia (Anonaine e Liriodenina) Rhazya stricta (Akuammina) Mitagyna speciosa (Mitaginina) Peganum harmala (Norharmana, Harmana e Harmina) Ziziphus spetiale (Mauntina A) Acorium saicalense (Gongrina) Boemsaiva diffusa (Punamsvina E) Evodia fructus (Evodamina) Scellitium tortuosum (Mesembrina) Piper nigrum (Piperina) Piper leetispicum (Leatispicina e Leatispamidia A) Dactylicapnos scanens (protopina)	Strong potential of plants rich in alkaloid for the formulation of new medications for treatment of depression	Pakistan	Pervez et. Al., 2016.
Danggui-Shaoyao-San Epimedium brevicornum Chrysoactinia mexicana Chamaemelum nobile Magnolia officinalis Hypericum perforatum Lavandula officinalis Salvia sctarea Rosmarinus officinalis Schinus molle	Antidepressant effects through synaptic regulation of serotonin, norepinephrine and dopamine, regulatory activity of the hypothalamic-pituitary-adrenal axis, antioxidant activity and by decreasing inflammatory mediators.	Bandaglas h	Rabiei & Rabiei, 2017.
Annona sp Byronima crassifolia Casimiroa edulis Matricaria chamomilla Annona cherimolia Justicia spicigera	Species used on the treatment of anxiety and depression disorders.	Mexico	Lopes-Rubalcava & Estrada-Camarena, 2016.
Hypericum perforatum Crocus sativus Rhodiola rosea Lavandula spp. Echium amoenum Panax ginseng Albizia julibrissin	Possible to use in the treatment of anxiety and depression.	Iran	Kourosh Sakiet al., 2014.
Crocus sativus Camellia sinensis Echium amoenum Piper methysticum Rhodiola rosea Lavandula angustifolia Nelum bo nucifera	Anti-depressant effect by action mechanisms acting in the hypothalamic-pituitary-adrenal (HPA) axis. Monoamine neurotransmitters and mechanisms of neurogenesis/neurotrophic factors (such as inhibition of apoptosis and neuronal cells)	Republic of Korea	Lee & Bae, 2017.
Albizia julibriss in Canavalia brasiliensis	Antidepressant ation mechanisms	India	Janette Martins, 2018.

#### V. CONCLUSION

Given the exposure of farmers and populations around agrochemicals and its repercussions, such as depression,

and the alternative of medicinal herbs in the treatment of this disease, this study is a very important contribution, especial for the social vulnerable communities who do not Always have access to conventional treatment. Based on the literature reviewed it was possible to know various mechanisms of action, as mentioned in the context of this study. Being potential candidates to be used in alternative therapy for this disease. However more preclinical and clinical studies are necessary.

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# Design of a Rotary System for Fish Smoking Equipment to Improve Smoking Efficiency with Smoke Filtration Method Using Cyclone Separator in Sorong West Papua

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**Keywords** — Design, Cyclone Separator,  
Rotary, Fumigation Equipment.

**Abstract**— The design of the smoking device made in this study is 120 cm long, 60 cm in diameter, the material used is iron plate (Fe) with a thickness of 2 mm, the smoking rack is made of stainless steel stirrups with a size of 8 mm with a capacity of 15 kg of fish that can be accommodated smoked and the fumigation device is portable. LxPxT (40x40X50) cm fuel furnace equipped with a 2" (inch) exhaust fan to push hot steam from the combustion furnace into the smoking chamber, 45 cm high cyclone, 11 cm diameter, liquid smoke distillation pipe using 1 inch Stainless steel. Roller module as a rack player automatically every 30 minutes, 2 minutes of rotation is connected to an electric motor HP (1400 RPM) 300 watts, 220 Volts, Gear-Box as a rotation reducer with a rotation ratio of 1:50 rpm. In testing the instrument, the parameters observed were the temperature of the smoking furnace, the temperature of the cyclone separator, the temperature of the smoking room, and the smoking time. The heat used to raise the temperature is 2.898 kj/kg, the heat used to evaporate the product water (fish), is 33.8904 kj/kg, the heat used to raise the product temperature (fish) is 21.942 kj/kg °C, the total energy consumed is used by the product is 58,704 kj/kg.

## I. INTRODUCTION

Fish is one of the food products that has a fairly high water content of around 60 to 70%, therefore fish undergoes the process of decay very quickly. So good handling is needed so that the quality of fish is maintained until it reaches consumers, one of which is through smoking which has the aim of obtaining a long-lasting fish storage time, giving a distinctive brownish aroma and color to smoked fish (Wibowo, 1996). Smoking is a process of penetrating volatile compounds in fish produced from burning wood and producing products with specific tastes and aromas. Isamu Kobajashi, (2012).

Processing of smoked fish in Sorong is generally still done traditionally, namely with an open smoking system in which the fish to be smoked is placed on racks arranged above the furnace with a distance of  $\pm$  40 to 50 cm, The process of processing smoked fish, which is still traditional, has to turn the fish over the stove so that the fish cooks evenly, and of course it produces hot steam and a large volume of smoke that can disturb the business actors themselves such as sore eyes and interfere with breathing, so that over time it can lead to respiratory tract infections and disrupt the environment and cause air pollution. Fumigation tools with a closed system are more effective than open systems (Maripul, 2004).



The development of fish smoking equipment technology is currently very much needed along with the times and the increasing need for environmentally friendly, safe, comfortable, easy to use, inexpensive, and affordable smoking equipment. with various factors supporting the availability of local material sources that can be utilized, and can be combined with technology that can be applied to the local community. Based on previous studies, various kinds of smoking devices have been made such as the performance test of the "Efhilink" smoking device (maritaikajoesidawati, et al 2018), Integrated Design of Furnaces, Heat Exchangers, Cyclone Separators and Material Rooms for Fish Smoking (Muh.Tahir 2018) , Smofim: Solar Photovoltaic-Based Fish Smoke Machine (MahdaEnja Al Hudha et al 2018),

The fish smoking device made in this study is a Rotary System Fish Smoker With Smoke Filtration Method Using Cyclone Separator, 120 cm long, 60 cm in diameter, the material used is iron plate (Fe) with a thickness of 2 mm, the smoking rack is made of 8 mm stainless steel, and uses a 1/4 HP motor with 220 V electric power, 1400 RPM motor rotation, and is connected to the Gear-Box as a reducer. motor rotation with a rotation ratio of 1:50 rpm, and connected to the Pully and V-belt to rotate the smoking rack slowly (Low Speed) every 30 minutes and the rotation time is 2 minutes, so there is no need to flip the fish in the smoking room. The fumigation device has a cyclone separator with a height of 45 cm, a diameter of 11 cm, which functions to separate particles such as tar, ash, and soot from the furnace before entering the fumigation chamber.

## II. RESEARCH METHODS

The research method used is the experimental method, namely conducting trials on the performance of the rotary system fumigation device with smoke filtration using a cyclone separator, referring to the modified Tahir (2018). Implementation of this experimental research was carried out in the machine workshop owned by the Sorong Middle School of Fisheries Business. The research includes the design and manufacture and assembly of tools as well as testing the performance of fumigation tools.

### Tools and Materials

The equipment used in the design and manufacture and assembling of fumigation tools is workshop work equipment such as: Welding machine and welding wire, grinding machine, drilling machine, tape measure, angle ruler, pliers, scraper, vise, wrench, and pin. Supporting equipment used are: timer roller module, 1 phase HP electric motor, gear box Type FC A50 Ratio 1: 50, 2 inch blower, pulley and V-belt. The materials used to make the

fumigation tool are: 2 mm iron plate (Fe), 4x4 galvanized hollow iron, 2 inch galvanized pipe, 19 mm stainless shaft/axle, 1 inch stainless steel pipe, 8 mm stainless iron, bearing pillow block. The raw materials used in this study were skipjack tuna and yellow fin tuna weighing 300 grams - 500 grams/per head, while the fuel used for smoking was biomass fuel, namely wood charcoal and coconut shell.

### Design

Pressman, (2002). Design is a process of creating a new system or replacing an existing system in whole or in part. Whitten et al, (2004), build information systems and components based on design specifications.

Design Results in 3D Drawings Using the Google Sketch up Pro 8 Application

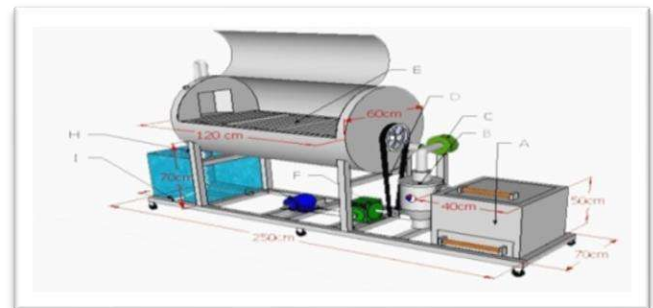


Fig.1: Fish Smoking Device Design Rotary System Cyclone Separator Method

Information :

- A. Combustion Furnace
- B. Cyclone Separator
- C. Blower
- D. V-Belt
- E. Smoking Rack
- F. Gear Box
- G. Electric Motor
- H. Liquid Smoke Distillation Pipe
- I. Liquid Smoke Output

## III. RESULTS AND DISCUSSION

The design of the rotary system of smoking fish using the smoke filtration method using a cyclone separator is carried out on the basis of consideration of input data in the form of literature studies obtained from books, journals and previous research results, and field observations are then analyzed and equipped with theoretical calculations. The results of the design of the rotary system of automatic

fish smoking using the smoke filtration method using a cyclone separator can be seen in Figure 2.



Fig.2: Fish Smoking Equipment with Smoke Filtration Using Cyclone Separator.

**Furnace**

The combustion furnace functions as a place for the combustion process or the decomposition of fuel, namely charcoal and coconut shells to produce hot smoke through the combustion process. thus causing the decomposition process, namely the thermal decomposition of chemical elements, from the initial temperature in the first 30 minutes, namely at a temperature of 300°C to 360 minutes (6 hours) the fumigation process reaches a temperature of 470°C. The material used for the furnace is iron plate (FE) with a plate thickness of 2 mm. The furnace has a capacity of 19 kg of charcoal and coconut shell. Specifications of the fuel combustion furnace can be seen in table 1.

Table.1: Combustion Furnace Specification

Section	Dimension	Size
Furnace	Height	50 Cm
	Length	50 Cm
	Width	40 Cm

**Cyclone Separator**

Cyclone Separator serves to separate tar, ash, and soot, so that the hot smoke that enters the smoking chamber and hits the fish's body is already clean smoke so that the smoke no longer contains these particles. This is in accordance with the function of the cyclone separator according to EkaMaulana at.al (2018) which states that the function of the cyclone separator is a particle separator from gas streams that is able to work over a wide operational range. In this cyclone separator, hot smoke from the furnace is processed or filtered before entering the smoking chamber by gravity system and particles such as tar ash and soot will not enter the smoking chamber but will fall to the bottom and be accommodated in the bottom container of the cyclone separator. The specifications of the cyclone separator can be seen in table 2.

Table.2: Cyclone Separator Specification

Section	Dimension	Size
Cyclone Separator	Height	45 Cm
	Diameters	11 inch

**Fumigation Room**

The fumigation chamber unit is in the form of a tube or cylinder with a horizontal position having a connecting line and an air outlet that is directly connected to the liquid smoke distillation, so that the smoke that comes out is not wasted into the environment but can be converted into other products in the form of liquid smoke. The dimensions of the smoking chamber are 120 cm long with a diameter of 60 cm and a fish smoking rack length of 113 cm and a width of 57 cm. The smoking rack is made of food-safe stainless steel material with a size of 8 mm. This smoking rack is also supported by stainless steel axles with a size of 19 mm so that the fish rack does not bend when loaded with fish weighing up to 15 kg. The material used for the fumigation chamber is iron plate (FE) with a plate thickness of 2 mm. fish rack made of stainless steel with a size of 8 mm Specifications for smoking rack space can be seen in table 3.

Table.3: Specification of Fumigation Room And Rack

Section	Dimension	Size
Fumigation room	Diameters	60 Cm
	Length	120 Cm
smoking rack	Width	57 Cm
	Length	113 cm

**Liquid Smoke Distillation**

Distillation is a process of changing the form of gas from direct or indirect combustion into a liquid form by lowering its temperature through a device called a condenser. The condensation process helps the water vapor molecules become liquid, so that the hot smoke from the burning process of charcoal and coconut shells is not wasted into the environment but can be converted into other products in the form of liquid smoke. The material used in the distillation container is iron plate (FE) with a thickness of 1.5 mm. for the distillation pipe made of spiral stainless steel pipe with a spiral diameter of 30 cm. the distillation container can accommodate 50 liters of cooling water which serves to absorb heat from the distillation pipe which is flowed by hot smoke/fumigation gas coming out of the fumigation chamber. The specifications for the container and distillation pipe can be seen in table 4.

Table.4: Product Specification Liquid Smoke Distillation Containers and Pipe

Section	Dimension	Size
<b>Distillation Container</b>	Height	50 Cm
	Length	50 Cm
	Width	40 Cm
<b>Distillation Pipe</b>	Diameters	1 Inchi
	Length	300 Cm

**Heat energy calculation analysis**

Initial weight of fish ( $m_{mib}$ ) = 15 kg

Temperature of smoking room temperature ( $T_m$ ) = 75 °c

Temperature Outdoor temperature ( $T_s$ ) = 29 °c

Initial water content ( $K_{aib}$ ) = 68.18% = 0.68

Total charcoal fuel ( $m_t$ ) = 19 kg

The calorific value of merbau fuel (charcoal) ( $Q$ ) = 19,526728 kj/kg

Smoking time ( $T$ ) = 6 jam

Hot type of water ( $C_p\ air$ ) = 4,2 kj/kg°c

latent heat of water vapor ( $L_w$ ) = 2.260 kj/kg

The initial water mass of the fish ( $m_c$ ) can be determined by calculating using the following equation:

$$m_c = m_{mib} \times k_{aib}$$

Where :

$m_c$  = initial mass of fish water, kg

$m_{mib}$  = initial mass of fish, kg = 15 kg

$k_{aib}$  = Initial water content of fish, kg = 68.18% = 0.68

Then obtained:

$$\begin{aligned} m_c &= 15 \times 68.18.\% \\ &= 15 \times 0,68 \\ &= 10.2 \text{ kg} \end{aligned}$$

The heat used to raise the temperature of the water content ( $m_{air}$ ) can be calculated by:

$$m_{air} = m_c \times C_p\ air \times \Delta T$$

Where :

$m_{air}$  = temperature of water content

$m_c$  = initial water mass of fish = 10.2 kg

$C_p\ air$  = specific heat of water = 4.2 kj/kg

$\Delta T$  = temperature difference = 46 °c

Then obtained:

$$\begin{aligned} m_{air} &= m_c \times C_p\ air \times \Delta T \\ &= 10,2 \times 4,2 \times 46 \\ &= 1,970.64 \text{ kj/kg} \end{aligned}$$

The mass of water evaporated during the drying process ( $m_e$ ) can be calculated by:

$$m_e = m_{mib} - m_{ik}$$

Where :

$m_e$  = mass of water evaporated during the smoking process, kg;

$m_{mib}$  = initial mass of fish = 15 kg

$m_{ik}$  = mass of dry/final fish = 10.2 kg

Then obtained:

$$\begin{aligned} m_e &= 15 - 10.2 \\ &= 4.8 \text{ Kg} \end{aligned}$$

The energy value for evaporating fish water ( $Q_t$ ), using the equation:

$$Q_t = m_e \times L_w$$

Where :

$Q_t$  = energy value for fish water vapor

$m_e$  = mass of water evaporated = 4.8 kg

$L_w$  = latent heat of water vapor = 2.260 kJ/kg

Then obtained:

$$\begin{aligned} Q_t &= m_e \times L_w \\ &= 4.8 \times 2.260 \text{ kj/kg} \\ &= 10.848 \text{ kj/kg} \end{aligned}$$

The heat used to raise the temperature, using the equation:

$$Q_{air} = m_{mib} \times c_{pair} \times \Delta T$$

Where :

$Q_{air}$  = heat energy to raise the temperature (kJ)

$m_{mib}$  = Mass of fish (Kg) = 15 kg

$C_p\ air$  = Specific heat of water (kJ/Kg°C) = 4.2 kJ/Kg°C

$\Delta T$  = temperature difference (°C) = 46 °C

Then obtained:

$$\begin{aligned} Q_{air} &= m_{mib} \times C_p\ air \times \Delta T \\ &= 15 \times 4.2 \text{ kj/kg } ^\circ\text{c} \times 46 \\ &= 2.898 \text{ kj/kg} \end{aligned}$$

The heat used to evaporate the product water (fish), using the equation:

$$Q_{uap\ air} = m_{mib} \times C_{uap\ air}$$

Where :

$Q_{uap\ air}$  = heat energy to evaporate water (kJ)

$m_{mib}$  = Mass of fish (kg)

$C_{uap\ air}$  = Heat of water vapor (kJ/Kg) = 540 Cal = 2.25936 kJ/kg.

Then obtained:

$$\begin{aligned} Q_{uap\ air} &= m_{mib} \times C_{uap\ air} \\ &= 15 \times 2,25936 \\ &= 33.8904 \text{ kJ/kg} \end{aligned}$$

Specific heat used to raise the temperature of the product (fish), the specific heat ( $C_p$ ) of fish is 3.18 kJ/kg°C. (Syamsulbahriwidodo, 2015)

The heat used to raise the temperature of the product (fish) using the equation:

$$Q_{ikan} = m_{mib} \times C_p\ ikan \times \Delta T$$

Where :

$Q_{ikan}$  = heat energy to raise the temperature of the product (kJ)

$m_{mib}$  = Fish Mass (Kg)

$C_p\ ikan$  = Specific heat of product (kJ/Kg°C)

$\Delta T$  = Change in temperature (°C)

Then obtained:

$$\begin{aligned} Q_{ikan} &= m_{mib} \times C_p\ ikan \times \Delta T \\ &= 15 \times 3.18 \times 46 \\ &= 21.942 \text{ kJ/kg}^\circ\text{c} \end{aligned}$$

So the total energy used by the product is:

$$Q_{total} = Q_{air} + Q_{uap\ air} + Q_{ikan}$$

Where :

$$Q_{total} = \text{Total energy used by the product}$$

Then obtained:

$$\begin{aligned} Q_{total} &= 2.898 \text{ kJ/kg} + 33.8904 \text{ kJ/kg} + \\ &\quad 21.942 \text{ kJ/kg}^\circ\text{c} \\ &= 58.7304 \text{ kJ/kg}^\circ\text{c} \end{aligned}$$

#### IV. CONCLUSION

With the design of a rotary system fish smoking device with a smoke filtration method using a cyclone separator with a fuel furnace specification of LxPxT (40x40X50) cm, exhaust-fan 2" (inch), cyclone height 45 cm, diameter 11 cm, liquid smoke distillation pipe using 1 inch Stenlist steel, rack player 30 minutes 2 minutes long, electric motor HP (1400 RPM) 300 watts of electric power , 220 Volts, Gear-Box rotation 1:50 rpm, heat obtained 2,898 kJ/kg, The heat used to evaporate the product water (fish), is 33.8904 kJ/kg, the heat used to raise the temperature of

the product (fish) is 21.942 kJ/kg °C, the total energy used by the product is 58.704 kJ/kg.

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## Case Study of Personnel Expenditures in the States of the Legal Amazon in Brazil

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**Keywords**—Fiscal Responsibility Law, Legal Amazon, Limits, Personnel expenses.

**Abstract**—The main objective of this article was to verify, over a historical period of three years (2016/ 2018), whether the states that make up the legal Amazon have fulfilled what is established by the Fiscal Responsibility Law n°. 101/2000, as spending limits for the executive branch in terms of personnel. Ruled by art. 22 of that law, the spending limits are three: alert limit: 44.1%; prudential limit: 46.55%; and the upper limit: 49% of net revenue. It was a multiple case study with a qualitative and quantitative approach with documentary research such as: Books, articles, journals, theses, dissertations, laws, allowing a wide search for information. For data compilation, the tabulation was performed in Excel. It was noticed during the analyzes that the states of Acre, Pará, Amazonas, Roraima, Mato Grosso, Tocantins and Maranhão, exceeded the prudential limit of 46.55%. Of these seven, the states of Acre, Tocantins and Mato Grosso exceeded the upper limit of 49%. Thus, the states of Amapá and Rondônia were the only ones that remained within the limits established by law during the research period.

### I. INTRODUCTION

Adequate financial management is of paramount importance for a quality public administration. Fioravante; Pinheiro and Vieira (2006) tell us that excessive spending and indebtedness controls are an important step in terms of public administration [...]. Correlated to this reasoning, on

May 4, 2000, Complementary Law no. 101, known as the Fiscal Responsibility Law (LRF), appearing to regulate the expenses of public entities, both at federal, state and municipal levels.

Giuberti (2005) brings, that the LRF has two limits of public spending: the limit of indebtedness and limit of

spending on personnel, the latter being what is treated in this work. The meaning of personnel expenses, for Araújo and Arruda (2004) is “ *the sum of the expenses of the Federation entity with the assets, the inactive and the pensioners, related to elective mandates, positions, functions or jobs, civil, military and members of power, such as any remuneration, fixed and variable, subsidies, retirement benefits, reforms and pensions, including additional ones, bonuses, overtime and personal benefits of any nature, as well as social charges and contributions paid by the entity to the pension entities.* ”

The means used by the law are the requirement to meet targets for income and expenses, and compliance with the limits for personnel expenses, conditions and limits for public debt, among others (CRUZ; NETTO; PETRI, 2002).

Understanding that the limit is established, the Union, States and Municipalities should treat it as a priority, so that expenses that do not exceed the allowed amount will occur. From now on, the question arises: Are the spending limits in the executive branch established by the LRF for the states that make up the legal Amazon being met? In order to find the answer to the problem, the article will be based on some specific objectives, which are: Conceptualize the Law of Fiscal Responsibility and its consequences and present the results of personnel expenses.

**II. THEORETICAL REFERENCE**

**2.1. Concepts of the LRF (Law of Fiscal Responsibility)**

LRF 101 was created in 2000 to combat high personnel costs, thus creating limits for each of the three branches (Executive, Legislative and Judiciary). According to Araújo (2015, p. 743) The LRF was formulated and justified as a fiscal stabilization program, based on the principles of planning, transparency, control and responsibility.

Based on studies carried out by Santolin, Júnior and Reis (2009), the LRF was implemented in order to end the well-known “political electoral cycle” where, taking advantage of the end of each term, the responsible

politician will not be able to make requests for emergency packages , (save unforeseen and urgent requests) as specified in art. 167 item XI, paragraph 3.

According to information Barbosa, Luna, Souza and Mantovani (2014).

The law aims to define public finance rules for accountability in tax management, creating planning and transparency to prevent risks and correct deviations. These actions aim at the balance of public accounts and the achievement of goals for results between revenues and expenses including limits and conditions for the waiver of revenue, expenses. totals with personnel and social security, consolidated and securities debt, the acquisition of credit and the granting of guarantees on leftovers to be paid, finally, consolidating the financial health of the State.

And in order to better understand what is spent on personnel, complementary law 101, art. 18 says:

[...] Total personnel expenses are understood as the sum of the expenses of the Federation entity with the assets, the inactive and the pensioners, related to elective mandates, positions, functions or jobs, civil, military and members of Power, with any type of remuneration, such as fixed and variable salaries and benefits, subsidies, retirement benefits, reforms and pensions, including additional ones, bonuses, overtime and personal benefits of any nature, as well as social charges and contributions paid by the entity to social security entities.

Starting from the database of complementary law 101, art. 18, personnel expenses are not only linked to active employees, but also to retired employees who are already inactive.

This law is based on four main points of support, namely: planning, transparency, control, and accountability (KHAIR, 2000). Being explained below, in table 01.

Table.1: Main Pillars Supporting LRF

CORNERSTONE	DESCRIPTION
PLANNING	According to Cruz et al. (2001) has as objective, to generate through the processes, presenting possibilities in the internal control. And yet, being divided into 03 instruments: Pluriannual Plan, Budget Guidelines Law and Annual Budget Law;
TRANSPARENCY	For kopits and Craig (1998) and Cruz et al. (2012) is the process of publicizing information on government structure, fiscal policy, reports and projections. They are reliable, clear, correct and

	timely so that interested parties can evaluate and compare them;
<b>CONTROL</b>	It is admitted that the quality of an internal control system can contribute to the issuing of favorable prior opinions, due to the lack of evidence that indicates improprieties in the management of resources and compliance with laws and regulations (CRUZ et al, 2015);
<b>RESPONSIBILITY</b>	Santos (2010) considers that responsibility in fiscal management is to know how to administer taxes; monitor the financial; render accounts; examine budget execution; control public spending; finally, do tax planning.

Source: Adapted from KHAIR (2000)

With transparency and planned action, as well as some control mechanisms, for Cruz et. Al. (2015) are these, then, the necessary conditions for there to be a balance in public accounts. Santos (2010) also says that these pillars, if used, may repress illicit acts allowing for better public management, thus allowing for better administration of the acquired revenues.

**2.1.1. Current Net Revenue**

Current Net Revenue (RCL) from art. 2, item IV, presents the calculation basis, to compare it with personnel expenses. This being shown in table 02.

Table.2: RCL Calculation Base

Calculation basis of Net Current Revenue	
(+)	Tax revenue
(+)	Contribution revenue
(+)	Heritage fears
(+)	Industrial revenue
(+)	Agricultural revenue
(+)	Service revenue
(+)	Current transfers
(+)	Other current revenues
(+)	Amount received from FUNDEF
(-)	Amount paid to FUNDEF
(-)	Contribution of civil servants to their own regime
(-)	Revenue from financial compensation between pension schemes

SOURCE: Adapted from Silva, Lopes, Pederneras and Paulo (2012)

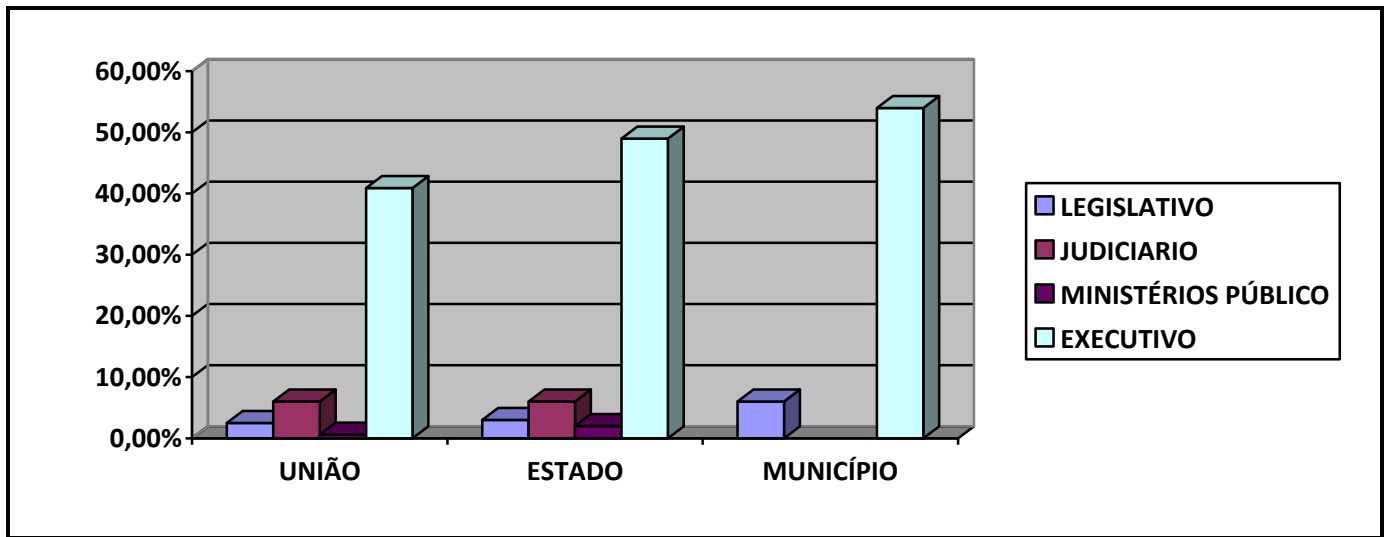
It then employs setting spending limits at the federal, state and municipal levels. In the Federal sphere, the spending limit cannot exceed 50%, whereas in states and municipalities this limit is 60%. Thus, reaching 95% of this limit, the LRF prohibits any movement that may cause an increase in expenditure (SENADO, 2013).

- **UNION** : 2.5% will be distributed to the Legislative, 6% to the Judiciary, 0.6% to the Public Prosecutor's Office and 40.9 to the Executive;
- **STATE** : 3% will be distributed to the Legislative, 6% to the Judiciary, 2% to the State

Prosecutor's Office and 49% or 48.6% to the Executive;

- **MUNICIPALITY** : 6% will be distributed to the Legislative, including the Court of Auditors, and 54% to the Executive

Graphic 01 - Limits Pre-established by LRF



SOURCE: Prepared by the author

In view of art. 22 of the LRF, we pay attention to the three pre-established limits. The maximum limit, alert limit and prudential limit, the first one pictured above. Subsequently, the alert and prudential limit are for notorious notices, namely, the alert limit is 44.1% (90% of the “Maximum Limit”) and the prudential limit 46.55%, (95% of the maximum) . And surpassing them, they suffer punishments demonstrated by art.22 and 23 of the aforementioned law.

**2.1.2. Punishments / Infractions**

Failure to comply with such obligations will result in tax and criminal penalties. The fiscal punishment consists of the suspension of voluntary transfers (excluding those destined to health, education and social assistance actions) (KHAIR, 2000).

In this same line of reasoning, in 2001, NASCIMENTO (finance and control analyst at the National Treasury Secretary, of the respective year) together with DEBUS (budget consultant) brings that the fiscal punishments, which correspond to the impediment of the entity to the receipt of voluntary transfers, contracting credit operations and obtaining guarantees for their contracting; and, criminal sanctions, which involve the payment of a fine with own resources (which may reach 30% of annual salaries), the disqualification for the exercise of public function for a period of up to 5 years, the loss of public office and the impeachment term of office, and finally the arrest.

Then, at the conclusion of each four-month period, the limits will be checked, and then in art. 22, single paragraph states that:

If the total expenditure on personnel exceeds 95% (ninety-five percent) of the limit, the Power or body referred to in art. 20 that has incurred the excess:

- I - Granting of an advantage, increase, adjustment or adjustment of remuneration in any capacity, except those derived from a judicial decision or from a legal or contractual determination, except for the review provided for in item X of art. 37 of the Constitution;
- II - Creation of a position, job or function;
- III - change in the career structure that implies an increase in expenses;
- IV - Provision of public office, admission or hiring of personnel in any capacity, except for the replacement resulting from the retirement or death of civil servants in the areas of education, health and safety;
- V - contracting overtime, except in the case of subsection II § 6<sup>th</sup> art. 57 of the Constitution and the situations provided for in the budget guidelines law.



Table.3: Infringement / Penalty Provided for BY LRF

INFRINGEMENT	PENALTY
Exceed the limit of total personnel expenses in each calculation period (LRF, Art. 19 and 20).	Termination of mandate (Decree-Law No. 201, art. 4, item VII)
Issue an act that causes an increase in personnel expenses that is not in accordance with the law (LRF, Art. 21).	Nullity of the act (LRF, art. 21); One to four years' imprisonment (Law No. 10,028 / 2000, art. 2)
Issue an act that causes an increase in personnel expenses in the one hundred and eighty days prior to the end of the mandate of the holder of the respective power or body (LRF, Art. 21).	Nullity of the act (LRF, art. 21, sole paragraph); One to four years' imprisonment (Law No. 10,028 / 2000, art. 2)
Failure to adopt the measures provided for in the LRF, when the total expenditure on personnel of the respective power or body exceeds 95% of the limit (LRF, Art. 22).	One to four years' imprisonment (Law No. 10,028 / 2000, art. 2). Prohibitions provided by law (LRF, art. 22, sole paragraph).
Failure to adopt the measures provided for in the law, when the total expenditure on personnel exceeds the maximum limit of the respective power or body (LRF, Art. 23).	One to four years' imprisonment (Law No. 10,028 / 2000, art. 2).
Maintain expenses with inactive and pensioners above the limit defined by law (LRF, articles 18 to 20; Art. 24, § 2; Art. 59, § 1, item IV).	Termination of mandate (Decree-Law No. 201, art. 4, item VII).
Failure to comply with the total personnel expenditure limit in up to two years, if the power or agency was above that limit in 1999 (LRF, Art. 70).	Prohibition of receiving voluntary transfers, contracting credit operations and obtaining guarantees (LRF, art. 23, § 3). Termination of mandate (Decree-Law No. 201, art. 4, item VII).

SOURCE: Adapted from the LRF Infractions framework and its Penalties from the National Treasury Secretariat (STN)

A summary delivered by table 03, on sanctions and penalties imposed on public managers applied by the LRF. Thus, in cases of non-compliance with the limits established by law, there will be appropriate punishments for each infraction.

### III. METHODOLOGY

For Prodanov and Freitas (2013), methodology is a way of thinking, to solve a problem and thus study or explain it.

#### 3.1. Characterization of the method

The research design is the multiple case study, Yin (2001) states that these studies tend to be more convincing and according to Gil (2009) it can be characterized as a deep study of objects allowing a wide knowledge.

#### 3.2. Data Collection and Analysis Techniques

A quali-quantitative approach with documentary research which, for Godoy (1995) the union between the

two, even though it seems strange, documents become a great ally for data sources.

The methodology was chosen, because it gives us tools to understand the participants' perception in a deep (qualitative) way and presents, on this application, important statistical data that will serve as the basis for the reformulation of the methodology (LEFEVRE; LEFEVRE, 2012).

Bibliographies such as: Books, articles, periodicals, theses, dissertations, laws and research bases, such as *Scientific Periodicals Eletronic Library (Spell)* and *Scientific Eletronic Library Online (SciELO)*, are available for the search result. data with free access, enabling a wide search for information. And the Siconfi base - National Treasury (Accounting and Tax information system of the Brazilian Public Sector), used to search for accounting data (values).

Descriptive analysis carried out through the data which were collected between the period of August to the

beginning of December 2019, compiled and tabulated using Excel formulas.

**3.3. Population and Sample**

Then composed of the states that make up the legal Amazon, totaling 09 Brazilian states and realized about the executive power of both.

**3.3.1 Legal Amazon**

A tropical forest in which Menezes (2005) says that being a continuous tropical forest, the Amazon Forest is considered the largest on the planet, and is located in a

large part of the Brazilian territory. It is formed by the seven states in the northern region: Acre, Amapá, Pará, Amazonas, Rondônia, Roraima and Tocantins, in addition to Mato Grosso (Midwest Region) and Maranhão (Northeast Region).

In this way, conceived in the face of law no. 1,806 / 53 the term Legal Amazon, with the objective of improving the development planning of this region, having approximately 5.5 million square kilometers corresponding to 60% of the Brazilian territory.

Table.4: History

Year	Report
1953	Through law no. 1806, the Legal Amazon was created then, encompassing the States of Pará and Amazonas, the federal territories of Acre, Amapá, Guaporé (current State of Rondônia) and Rio Branco (current State of Roraima) and also part of the States of Mato Grosso, part of the state of Goiás (current state of Tocantins) and Maranhão;
1966	By law no. 5,173, the Amazon Development Superintendence (SUDAM) is created, distinguished by the states of Acre, Pará and Amazonas, federal territories of Amapá, Roraima and Rondônia, in addition to part of the states of Mato Grosso, Goiás and Maranhão;
1977	With complementary law no. 31/1977, the Legal Amazon has its limits extended. Now having the entire state of Mato Grosso;
1988	Changes caused by the Federal Constitution. The state of Tocantins was created and the states of Amapá and Roraima were transformed into federated states, which were federal territories;
2001	By provisional measure no. 2.157-5, SUDAM is extinguished, replaced by the Amazon Development Agency (ADA);
2007	In view of complementary law no. 124, there is the extinction of ADA, and the recreation of SUDAM;

SOURCE: Adapted from Eco - What is the Legal Amazon and related laws

Understanding then the history of the Legal Amazon, we can highlight the importance obtained before society, both Brazilian and worldwide, with their care. Knowing then of its relevance, it was naming the population, the states that make up the Legal Amazon.

**IV. ANALYSIS AND RESULTS**

**4.1 Analysis of the Current Net Revenue of each state (RCL)**

In the following topics, the respective data taken from the Siconfi platform with access in 2019 are presented, and placed in tables for a better understanding of the information exposed. Table 05 shows whether the current net revenue of each state, in the respective years studied.

Table.5: Net Current Revenue (RCL) 2016 TO 2018

STATES	2016 RCL (R \$)	2017 RCL (R \$)	2018 RCL (R \$)
ACRE	4,442,141,070.90	4,471,916,240.14	4,846,051,636.63
AMAPÁ	4,872,773,878.98	4,369,061,858.47	4,854,795,872.77
AMAZON	11,395,630,934.00	12,052,493,121.73	13,222,390,940.79

<b>MARANHÃO</b>	12,480,062,588.49	12,536,618,595.33	13,294,049,568.66
<b>MATO GROSSO</b>	12,522,756,874.44	13,389,766,593.46	15,226,929,608.40
<b>PARÁ</b>	17,922,201,695.92	18,017,134,313.51	18,818,401,698.91
<b>RONDONIA</b>	6,502,106,330.05	6,500,433,453.02	6,943,539,791.00
<b>RORAIMA</b>	3,376,579,222.11	3,199,536,328.85	3,591,914,511.61
<b>TOCANTINS</b>	7,293,584,929.36	7,198,140,237.26	7,190,329,051.43

SOURCE: 2019 survey data

It should be noted that in the three-year period studied there was no exorbitant difference, realizing then that in 2016 and 2017 in most states there was an insignificant increase in RCL. Highlighting that only in four cases there was a decrease in its revenue, they are the states of Amapá, Rondônia, Roraima and Tocantins, although this value is insignificant. And in 2017/2018, we emphasize that in all the states analyzed, there were small increases, and in some states an increase of around 10%, as we can mention the state of Amapá, which in 2017 had a revenue of R \$

4,369 .061,858.47, already in 2018 it obtained 11% more in relation to the previous year, being the amount of R\$ 4,854,795,872.77.

**4.2 Results of Personnel Expenses**

Using as a base, a survey with nine states, therefore, we expose in three tables, the situation of the states, the expenditure on personnel in correlation with their due revenue.

Table.6: Percentage of Expenses with RCL (2016)

<b>STATES</b>	<b>RCL(R\$)</b>	<b>Personnel expenses (R\$)</b>	<b>Percentage of RCL (%)</b>
<b>ACRE</b>	4,442,141,070.90	2,008,305,920.02	45.21
<b>AMAPÁ</b>	4,872,773,878.98	1,899,031,391.16	38.97
<b>AMAZON</b>	11,395,630,934.00	5,380,417,767.55	47.21
<b>MARANHÃO</b>	12,480,062,588.49	4,864,604,143.54	38.98
<b>MATO GROSSO</b>	12,522,756,874.44	5,675,960,966.95	45.33
<b>PARÁ</b>	17,922,201,695.92	7,996,754,105.37	44.62
<b>RONDONIA</b>	6,502,106,330.05	2,709,777,981.11	41.68
<b>RORAIMA</b>	3,376,579,222.11	1,441,098,733.09	42.68
<b>TOCANTINS</b>	7,293,584,929.36	3,525,630,539.15	48.34

SOURCE: 2019 survey data

Considering table 06, it appears that some states have exceeded both the alert limit and the prudential limit (90% and 95% respectively). Five states had the limit extrapolated, exceeding the alert limit of 44.1%: Acre,

Amazonas, Mato Grosso, Pará and Tocantins. And two of these, had the prudence limit of 46.55% exceeded, being: Amazonas and Tocantins.

Table.7 Percentage of Expenses With RCL (2017)

<b>STATES</b>	<b>RCL</b>	<b>Personnel expenses (R\$)</b>	<b>Percentage of RCL (%)</b>
<b>ACRE</b>	4,471,916,240.14	2,408,736,386.43	53.86

<b>AMAPÁ</b>	4,369,061,858.47	1,866,731,621.06	42.73
<b>AMAZON</b>	12,052,493,121.73	5,758,117,398.79	47.78
<b>MARANHÃO</b>	12,536,618,595.33	5,187,542,638.45	41.38
<b>MATO GROSSO</b>	13,389,766,593.46	6,385,477,846.52	47.69
<b>PARÁ</b>	18,017,134,313.51	8,121,551,739.28	45.08
<b>RONDONIA</b>	6,500,433,453.02	2,815,868,758.17	43.32
<b>RORAIMA</b>	3,199,536,328.85	1,567,381,053.74	48.99
<b>TOCANTINS</b>	7,198,140,237.26	3,958,079,109.54	54.99

SOURCE: 2019 survey data

In 2017 represented by table 07, we deal with most of the states analyzed, having a percentage above the alert. Six states exceeded the warning limits, two thirds of those studied. Acre, Amazonas, Mato Grosso, Pará, Roraima and Tocantins. Some of them had already exceeded limits in the previous year (as shown in table 06) but there was no care, and precaution not to keep the same

problem. The state of Pará had its alert limit exceeded. The states of Amazonas, Mato Grosso and Roraima, had their prudential limit exceeded. And the states of Acre and Tocantins had the maximum limit of the law, exceeded (limit of 49%).

Table.8: Percentage of RCL Expenses (2018)

<b>STATES</b>	<b>RCL</b>	<b>Personal expenses (R\$)</b>	<b>Percentage of RCL (R\$)</b>
<b>ACRE</b>	4,846,051,636.63	2,327,189,203.53	48.02
<b>AMAPÁ</b>	4,854,795,872.77	1,945,139,506.20	40.07
<b>AMAZON</b>	13,222,390,940.79	6,390,089,433.24	48.33
<b>MARANHÃO</b>	13,294,049,568.66	6,225,982,864.65	46.83
<b>MATO GROSSO</b>	15,226,929,608.40	8,813,069,563.12	57.88
<b>PARÁ</b>	18,818,401,698.91	8,865,485,652.02	47.11
<b>RONDONIA</b>	6,943,539,791.00	2,910,339,177.69	41.91
<b>RORAIMA</b>	3,591,914,511.61	1,631,768,325.91	45.43
<b>TOCANTINS</b>	7,190,329,051.43	3,846,130,627.03	53.49

SOURCE: 2019 survey data

Understanding table 08 representing the last year studied, most of the states analyzed exceeded the limits (alert, prudential and maximum). The state of Roraima has spent its spending on an alert limit, the states of Acre, Amazonas, Maranhão and Pará exceeded the prudential limit, and the two states Tocantins and Mato Grosso had the maximum limit of the law exceeded.

Then analyzing the states during the 03 years established by the survey, we can see states that were below spending and states that were above spending. Then through the ranking below in table 09, each state is mentioned in an increasing way.

Table.9: Ranking of personnel expenses (2016-2018)

Placing	2016(percentage RCL%)	2017(percentage RCL%)	2018(percentage RCL%)
01 °	Amapá (38.97)	Maranhão (41,38)	Amapá (40.07)
02 °	Maranhão (38.98)	Amapá (42.73)	Rondônia (41.91)
03 °	Rondônia (41.68)	Rondônia (43.32)	Roraima (45.43)
4th	Roraima (42.68)	Pará (45.08)	Maranhão (46.83)
05 °	Pará (44.62)	Mato Grosso (47.69)	Pará (47.11)
06 °	Acre (45.21)	State of Amazonas (47.78)	Acre (48.02)
07 °	Mato Grosso (45.33)	Roraima (48.99)	State of Amazonas (48.33)
08 °	State of Amazonas (47.21)	Acre (53.86)	Tocantins (53.49)
09 °	Tocantins (48.34)	Tocantins (54.99)	Mato Grosso (57.88)

SOURCE: 2019 survey data

Analyzing table 09, we first observed 02 states (Amapá and Rondônia), in which both during the 03 years studied mentioned above, remained among the 03 placed. Rather, giving an emphasis on the state of Amapá, which was in 02 of the 03 years studied, in first, being the state that had the lowest expenditure on personnel.

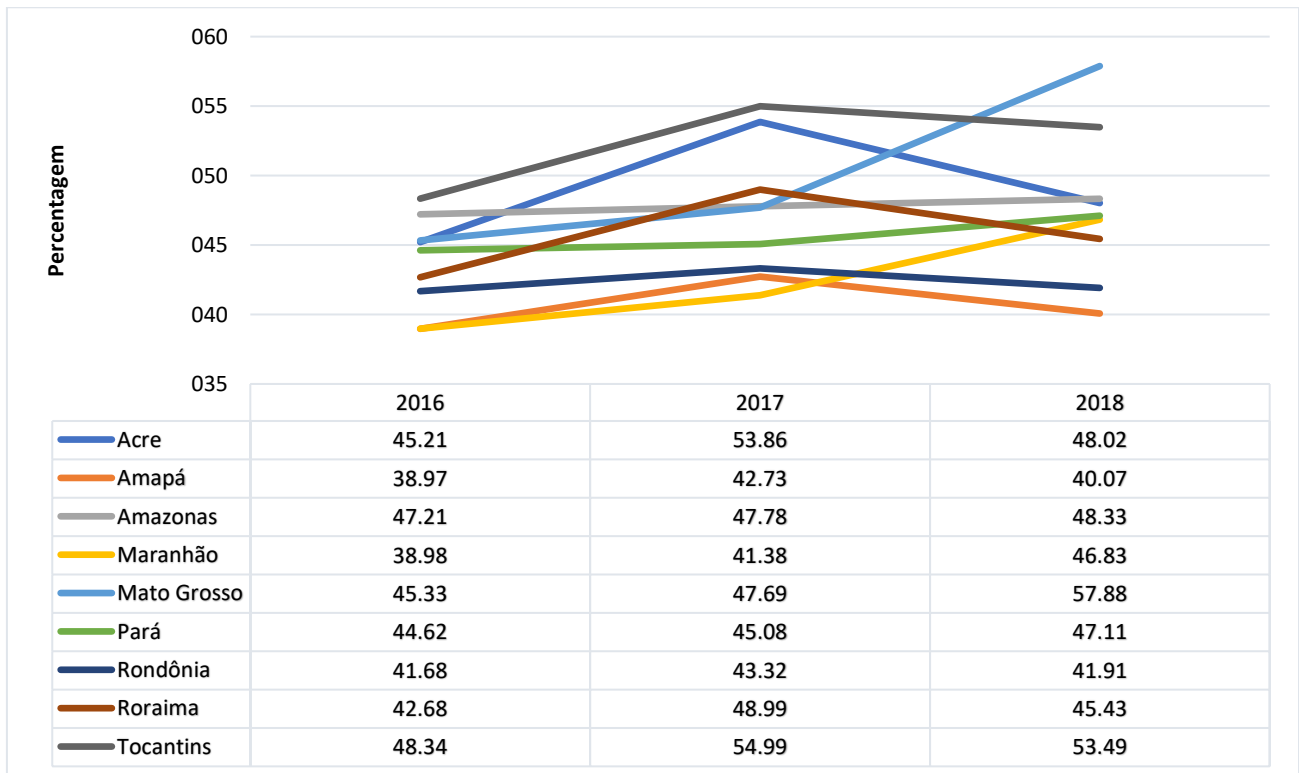
In contrast, we see 03 states that were above the maximum ceiling. The states of Acre, Mato Grosso and

Tocantins. Being the last state mentioned, the state of Tocantins, which was during the 03 years, among the last two placed in the ranking of states.

**4.3 Analysis of States**

After collecting data from all states, it will be exposed below based on the studied triennium (2016 to 2018).

Graphic.2: Percentage of Staff Expenses (2016 to 2018)



SOURCE: Research data, 2019.

After analyzing the graph above, there is a wide variation between the years, in exorbitant values, in consideration of personnel expenses.

Starting in 2016, we verified 02 states (Amapá and Maranhão) with 10% below the limit established by law. In contrast, the state of Tocantins appears to be missing only 0.66% to exceed the maximum limit, but the prudential limit has already been exceeded.

Now in 2017, the state of Maranhão and Amapá, remain with their spending below the 03 limits of the law. Contrary to the now 02 states (Acre and Tocantins) that exceeded 50% of the expenses in relation to the RCL.

For 2018, the state of Amapá is pointed out, maintaining the lowest amount of personnel expenses. And now, the state of Mato Grosso, with almost 9% above the limit predestined by the LRF.

Through the graph, it is noted that it has a great variation, which should not occur. Thus, if it did not exceed the limits of 44.10%, the lines of the graph would not be oscillating in the same way as it is presented.

## V. FINAL CONSIDERATIONS

The Fiscal Responsibility Law has emerged as an important tool for better management. Having as personnel expenses a large portion of expenses, and the transparency required by law, helping both managers and the population. The main objective of the research was to analyze the expenditure on personnel (executive) at the state level, of the states that integrate the region established as Legal Amazon, according to the complementary law 101 (Fiscal Responsibility Law) of 2000, which was concluded satisfactorily with success.

However, transparency, one of the 04 main pillars dealt with in this article, there has been a reluctance towards transparency in some government portals. And as one of its objectives is to deliver the accounting documents with easy access and each state would need to expose to the population, in the end, if even to the academic population, such information is not clearly accessible, the difficulty encountered by the lay population with certainty will be bigger. Against the lack of transparency on the part of some states, the national treasury platform (Siconfi) has free access, and is more accessible, with information delivered by the states.

After analyzed data, it was verified that only two states (Amapá and Rondônia) fulfilled the goal established by the law. Verifying through the studied triennium (2016 to 2018), the gradual increase of expenses in a good part of the states, while their revenues do not follow the same

progress. Thus, the states of Acre, Pará, Amazonas, Roraima, Mato Grosso, Tocantins and Maranhão, exceeded one of the two limits established by law (Alert and Prudential Limit), which, according to art. 22 and 23 may receive sanctions already described by law. And of the 07 states, 03 states (Acre, Tocantins and Mato Grosso) were at least one year above the maximum limit of 49%. Being the state of Tocantins, the state that in two subsequent years (2017-2018) was above the maximum limit of the law of 49%.

The research was limited and focused on executive expenses related to personnel, in the states that make up the Legal Amazon, with no intention of addressing possible punishments related to expenses beyond pre-established limits. Entering then as recommendations for future research, an approach before the states of the Legal Amazon, where they have their personnel expenses above that allowed by the LRF.

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# Epidemiologic Analysis of Malaria Cases Notified in the Municipality of São Gabriel da Cachoeira, Amazonas, Brazil

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**Keywords**— *Epidemiology, Malaria, Notification, Plasmodium.*

**Abstract**— *Malaria is one of the main public-health issues in the state of Amazonas. The aim of this study was to carry out an epidemiologic analysis of malaria cases in the municipality of São Gabriel da Cachoeira, Amazonas, from 2014 to 2018. The study is a descriptive, ecological study with secondary data collected in the Malaria Epidemiologic Surveillance Information System. The variables of interest were autochthonous cases of malaria; annual parasite incidence (API); sex; age; race & skin color; years of schooling; and Plasmodium species. The results for the number of positive malaria cases per year were: 4,533 cases (2014); 5,071 cases (2015); 10,415 cases (2016); 12,274 cases (2017); and 15,371 cases (2018). The API for malaria varied from 115.9 to 393.2 cases. In 2014, 2015 and 2016, Plasmodium vivax was associated with 99% of positive cases, in 2017 with 92% and in 2018 with 63%. The results of this study show that there is a need to intensify epidemiologic surveillance measures in order to raise awareness of and prevent malaria. Preventive measures should be implemented constantly and intensified so that the population can be protected from malaria even in areas of the municipality where the disease is not endemic.*

## I. INTRODUCTION

Malaria is responsible for high morbidity and mortality rates throughout the world. The worst affected regions are Africa, South America and Asia<sup>(1)</sup>. Nearly all malaria cases in Brazil (99%, or 315,809 cases) are reported in the Legal Amazon, where geographic, economic and social factors favor transmission of the disease and limit the extent to which standard control measures can be applied. The incidence of malaria is lower in areas where rubber is extracted and higher in areas that were settled in the last ten years as well as in open-pit mining areas. Some peripheral urban areas also have a high incidence of

malaria, largely as a result of human migration from abandoned agricultural settlements where malaria is present<sup>(2,3,4)</sup>.

Mortality due to malaria varies according to the species of *Plasmodium*, *P. falciparum* being the most lethal. In Africa, which accounts for 91% of mortality due to malaria worldwide, 99.7% of cases are caused by this parasite. In the Americas, the predominant species is *P. vivax*, which accounts for 64% of cases of malaria in the region. The Americas has the highest number of malaria cases involving this parasite, followed by the Eastern Mediterranean, where it is responsible for 42% of cases. In



the Americas, there were 650 deaths in 2016 compared with 407,000 in Africa<sup>(5)</sup>.

Brazil has a long history of fighting malaria. The first anti-malaria campaign was launched in 1905 during the construction of the port of Santos<sup>(6)</sup>. Some 10,000 people, including immigrants, are estimated to have died of malaria during construction of the Madeira-Mamoré Railroad in the state of Rondônia between 1907 and 1912<sup>(7)</sup>.

Malaria is considered a major public-health problem in the Amazon region, where the number of cases reported corresponds to 99% of all cases in the country. The high incidence of malaria has a significant impact on the economic growth and development of the affected populations, most notably those in the states of Acre (AC), Amazonas (AM), Amapá (AP), Pará (PA), Rondônia (RO) and Roraima (RR). The states of Maranhão (MA), Mato Grosso (MT) and Tocantins (TO) account for only around 1% of all cases in the Legal Amazon region<sup>(8)</sup>.

In the Amazon region, the main vector is *Anopheles (Nyssorhynchus) darlingi*, which is highly anthropophilic, a factor that helps to maintain the endemicity of this disease even in situations where there is a low mosquito population density. An efficient vector of both *P. vivax* and *P. falciparum*, *An. (Nyssorhynchus) darlingi* is active at night with peaks of activity at dawn and dusk. This characteristic enables it to adapt to habitats with and without light<sup>(9)</sup>.

The state of Amazonas is notable for its high incidence of malaria, and the municipality of São Gabriel da Cachoeira, on the Upper River Negro, is considered vulnerable because of the high transmissibility of malaria and significant annual parasite incidence (API) in the municipality. In 2005 and 2006, respectively, 2,568 and 2,541 cases were reported<sup>(10)</sup>.

As malaria is an important infectious disease that is classified as one of the most common in the state of Amazonas and as the municipality of São Gabriel da Cachoeira has been experiencing a high incidence of this disease, the aim of this study was to carry out an epidemiologic analysis of malaria cases notified in the municipality from 2014 to 2018.

## II. METHOD

The study is a descriptive, ecological study with secondary data from the Malaria Epidemiologic Surveillance Information System (SIVEP-Malaria). The analysis unit was the municipality of São Gabriel da Cachoeira in the state of Amazonas. The study population

consisted of individuals living in the municipality diagnosed with malaria between 2014 and 2018.

Information about the number of cases of malaria notified between 2014 and 2018 was collected from secondary data in SIVEP-Malaria and then processed in a DBF file. The sociodemographic data for the population of the municipality of São Gabriel da Cachoeira, Amazonas, were collected from the census carried out by the Brazilian Institute of Geography and Statistics (IBGE) in 2010 using the IBGE Automatic Recovery System (SIDRA)<sup>(11)</sup>.

According to this census, the state of Amazonas has a population of 3,483,985, making it the second largest in the Northern region of the country, with approximately 1.8% of the population of Brazil<sup>(11)</sup>. Amazonas covers an area of 1,559,161.682 km<sup>2</sup> and consists of 62 municipalities. The capital, Manaus, the largest city in the Northern region, has a population of 2.1 million<sup>(11)</sup>.

São Gabriel da Cachoeira is the third largest municipality in Brazil in terms of its area. It covers 109,184.896 km<sup>2</sup> and has a population of 46,303<sup>(11)</sup>. Some 81.66% of the territory in the municipality is demarcated indigenous land that has been regularized since the 1990s<sup>(12)</sup>. The municipality is a largely indigenous population with possibly the largest concentration of different indigenous ethnicities in Brazil.

The variables of interest in the present study were the number of notified malaria cases in the municipality of São Gabriel da Cachoeira, Amazonas, between 2014 and 2018. The API per 1,000 inhabitants was calculated using the number of slides that were positive for malaria and the at-risk population. The variables sex, marital status, race & skin color, age, years of schooling, number of autochthonous cases of malaria and *Plasmodium* species were also selected.

Descriptive statistics were used to analyze the data, and the initial exploratory analysis included an estimate of the relationships between autochthonous malaria cases and sociodemographic variables. SPSS was used for the data analysis and handling. The study complied with the guidelines in Resolution 466/2012 of the National Health Council at the Ministry of Health<sup>(13)</sup>. Approval from the Research Ethics Committee was not required as the secondary data used in the study are in the public domain and the study participants are not identified.

## III. RESULTS AND DISCUSSION

The municipality of São Gabriel da Cachoeira has the highest number of malaria cases in the state of Amazonas, making this disease one of the most important public-health issues in the state. The numbers of malaria cases per

year diagnosed as positive were: 4,533 cases (2014); 5,071 cases (2015); 10,415 cases (2016); 12,274 cases (2017); and 15,371 cases (2018). There was a significant increase in malaria cases between 2014 and 2018 and an increase of 5,344 cases from 2015 to 2016. These figures are a cause for concern and highlight the limited effectiveness of the malaria-control program in the municipality (Figure 1).

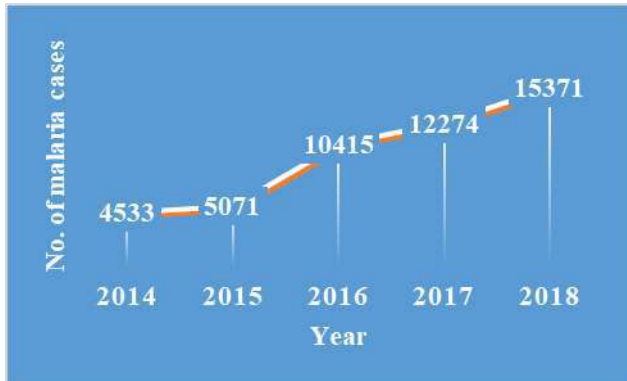


Fig. 1: Distribution of malaria cases registered from 2014 to 2018.

Source: Santos, (2021).

The API for malaria in the municipality varied from 115.9 to 393.2 per 1,000 inhabitants in the period 2014 to 2018 (Figure 2.) There was a significant increase in the API in the years analyzed, particularly in 2016 (266.4 cases per 1,000 inhabitants), 2017 (313.9 cases per 1,000 inhabitants) and 2018 (393.2 cases per 1,000 inhabitants).

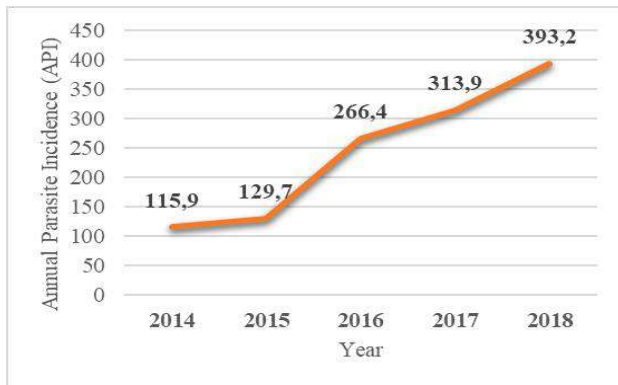


Fig. 2: Annual Parasite Incidence (API) for malaria in São Gabriel da Cachoeira, Amazonas, in the period 2014 to 2018.

Source: Santos, (2021).

This progressive increase in the API can be attributed to the transmission dynamics of the disease, which have been affected by the extensive anthropogenic environmental changes and expansion of fish farming in the region, factors which probably expanded the vector's habitats and density, rendering vector-control strategies

ineffective. Human migration between municipalities, states and countries can also be an important factor<sup>(14)</sup>.

The distribution of malaria cases by sex shows that the only year in the study period when there was a greater proportion of cases among females was 2015 (3,060 cases) (Figure 3). These results are consistent with the findings of a study in Tocantins which reported a larger percentage of notified malaria cases among males (77%)<sup>(15)</sup>.

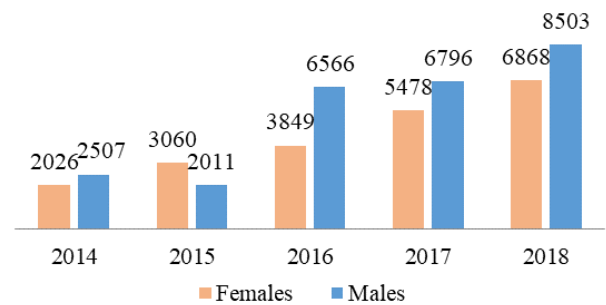


Fig. 3: Distribution of malaria cases registered from 2014 to 2018 by sex.

Source: Santos, (2021).

Another study, in the municipality of Boca do Acre in the state of Amazonas, also found that males were more affected by malaria. The authors reported that throughout the whole study males were more affected by malaria<sup>(16)</sup>. The greater number of cases in males can be attributed to the fact that they spend more time in areas where they come into contact with the vector as a result of extractive activities such as hunting, fishing and rubber tapping<sup>(17)</sup>.

The distribution by age group is shown in Figure 4. The years are represented by the following colors: blue (2014), orange (2015), gray (2016), yellow (2017) and red (2018). The age group with the largest number of positive malaria cases was the 20 to 29 years age group followed by the 30 to 39 years age group. Both groups had their highest values in 2017 and 2018. These results show that malaria is more common among the economically active younger population in the municipality.

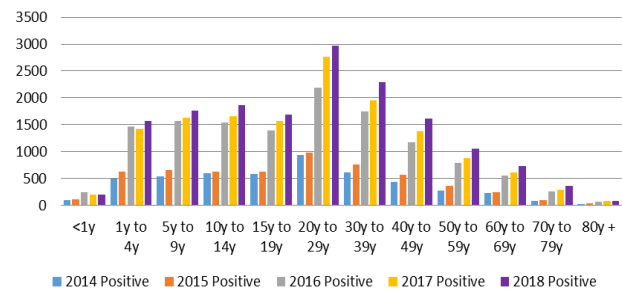


Fig. 4: Distribution of positive malaria cases registered from 2014 to 2018 by age group.

Source: Santos, (2021).

Worthy of note are the < 1 year and > 80 years age groups, for which the incidence of malaria was much lower than for the other groups. However, individuals in these two age groups are more likely to contract severe forms of the disease and to develop complications as well as a deteriorating clinical condition because of decreased immune response to infections. According to data reported by the Pan American Health Organization (PAHO), children under the age of five years are particularly susceptible to infection, disease and death; more than two thirds (70%) of all deaths due to malaria occur in this age group<sup>(18)</sup>.

The distribution of the species of *Plasmodium* analyzed during the study period (2014 to 2018) is shown in Figure 5, where pink represents *P. vivax*, orange *P. falciparum* and green *P. malariae*. The highest percentages of *P. vivax* positive cases were in 2014, 2015 and 2016 (99%). *Plasmodium vivax* is the commonest causative agent of malaria in Brazil and the least aggressive.



Fig. 5: Distribution of positive malaria cases registered from 2014 to 2018 by *Plasmodium* species.

Source: Santos, (2021).

In 2017 and 2018, the corresponding percentages for *P. vivax* were 92% and 63%, respectively, and in 2018 *P. falciparum* accounted for 37% of cases. The number of *P. falciparum*-positive cases increased significantly, particularly in 2018. This is a worrying finding as this species is more common in Africa and causes the more severe type of malaria. There were no cases associated with *P. malariae*, the least common species in Brazil.

Studies have shown that *P. vivax* and *P. falciparum* circulate in most areas in Brazil where malaria is endemic and that recurrences of *P. vivax* malaria follow a different temporal pattern<sup>(19)</sup>. *P. vivax* is more difficult to control and eliminate than *P. falciparum* because of the tendency for a relapse to occur after the primary infection<sup>(19,20,21)</sup>. This is reflected in the total number of malaria cases and the relationships between the variables as the number of cases due to *P. vivax*, the principal causative agent of

malaria in the state of Amazonas, is associated more with relapses than with environmental characteristics<sup>(22)</sup>.

#### IV. CONCLUSION

This study has reported high values of API between 2014 and 2018 in the municipality of São Gabriel da Cachoeira, Amazonas. The study findings show that malaria is a serious public-health issue in the municipality and that there is a need to intensify epidemiologic surveillance measures in order to help raise awareness of and prevent malaria. The findings can also be used by health managers and professionals to support the development of malaria-control measures and to assist decision-taking with a view to enhancing the effectiveness of public-health policies and awareness strategies.

Preventive measures should be implemented constantly and intensified so that the population can be protected from malaria even in areas of the municipality where the disease is not endemic. A variety of methods, both individual and collective, for reducing the number of malaria cases should be adopted, including the use of mosquito nets, repellents and clothes that protect the arms and legs, as well as drainage and cleaning of rivers and *igarapés* (small, narrow, navigable rivers). Educational measures are also needed to raise awareness of and prevent vector-borne diseases.

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## Physiological quality of seeds from traditional and new recommended groups of Arabic coffee cultivars to highland regions

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**Keywords**— *Coffea arabica*, germination, seed, vigor.

**Abstract**— The quality of a seed lot is an essential factor in the planning and implementation of any agricultural production program. Quality seeds provide strong and uniform plant growth. This study aims to analyze the physiological quality of seeds from different groups of Arabica coffee cultivars recommended for planting in the Brazilian highland regions. The seeds were picked from an Arabica coffee seed production field, accredited by the Brazilian Ministry of Agriculture, Livestock, and Supply, located in the municipality of Marechal Floriano, state of Espírito Santo (ES), Brazil. The experimental design was completely randomized, with four replications of 50 seeds each. The treatments were composed by traditional cultivars and new Arabica coffee recommendations from Catuaí (Catuaí IAC-62, Catuaí IAC-81), Caturra (Caturra IAC-479), Catucaí (Catucaí-785/15, Catucaí-2SL/CAK, Catucaí-24/137, Japi), Mundo Novo (Mundo Novo IAC-379/19), and Sarchimor (Acauã, Arara) groups. The seeds were manually harvested in sieves, at the point of physiological maturation, processed, and dried until reaching a humidity of  $35\% \pm 1\%$ . Immediately following this, the seeds were taken to the Seed Analysis Laboratory, Department of Agronomy, Center for Agricultural Sciences and Engineering, Federal University of Espírito Santo (CCAUE-UFES), Alegre-ES, Brazil. The parameters analyzed were germination (%), germination speed index (GSI), length of shoot and root, and the fresh and dry mass weight of the seedlings. The rust-resistant cultivars of the Catucaí group, particularly Catucaí-785/15 and Catucaí-24/137, showed higher values of germination and seed vigor, which suggested a higher physiological quality of the seeds. These cultivars should have lower seedling disposal in the nursery, and a higher yield in the final seedling production. Cultivar Caturra IAC-479 showed the lowest performance.

## I. INTRODUCTION

Coffee has an important socioeconomic function in Brazil, and Arabica coffee (*Coffea arabica* L.) is grown in approximately 13% of the Brazilian area. This requires intensive labor throughout the year, which generates employment and distribution of income (Barbosa et al., 2012). The state of Espírito Santo is the second major Brazilian coffee producer, and this crop has been the main agricultural economic activity in 80% of the municipalities. Arabica coffee has been cultivated predominantly in the sloping areas and at high altitudes, ranging from 600 m to 1,200 m above sea level (asl). The average productivity in this Brazilian state is around 1,727 kg ha<sup>-1</sup>, and the total production of Arabica coffee in 2020 has been circa 270.42 thousand tons, involving 26,313 small rural properties and 53 thousand families in the production system (Schmidt et al., 2004; Conab, 2020).

In the last ten years there has been a significant increase in the demand for seeds from the tolerant/resistant cultivars compared to the coffee-rust, with good adaptation, productivity, and quality of the drink being observed. Cultivating Arabica coffee with these characteristics needs less pesticides, and reduces the risk of poisoning to the applicator and to the environment, and also reduces production costs. An improvement in the productivity, resistance to disease, quality of the coffee, and diversity in the sensory and organoleptic profiles of the beverage has been observed (Carvalho et al., 2012; Matiello et al., 2020). Traditionally, the cultivars used belonged to the Mundo Novo, Catuaí, and Caturra groups. However, several Brazilian research institutions have developed and indicated new Arabica coffee cultivars for use in different Brazilian regions. Particularly, those cultivars that have rust-tolerance/resistance, high productivity, and high quality of drink, mainly from the Catucaí and Sarchimor groups (Carvalho, 2012; Krohling et al., 2018; Matiello et al., 2020).

The quality of a seed lot is an essential factor in the planning and implementation of any agricultural production program; good quality seeds provide strong and uniform plants. The physiological quality of the seeds has been characterized by their strength and energy for germination, these being the sum of attributes that give them the potential to quickly transform into normal seedlings (Carvalho; Nakagawa, 2000). Use of high-quality seeds is essential for rapid and uniform establishment of plants in the field, particularly for coffee growing. The germination capacity and the real physiological potential of the seeds are essential qualities for making decisions involving the commercialization and use or disposal of a seedling lot (Reis et al., 2010). Coffee seeds have slow and variable germination, making it

difficult for the process of seedling production. A germination test is used to determine the seed potential and evaluate its quality during the storage period, and also to estimate the success of seedling production in a nursery (Wibowo et al., 2019).

Coffee seedling producers have to purchase coffee seeds from seed producers accredited by the Brazilian Ministry of Agriculture, Livestock, and Supply (MAPA). The quality of seeds must be in accordance with the standards of normative instruction N. 35 of November 2012 (Brasil, 2012). This physiological quality is influenced by the genotype and reaches the maximum value during its maturity, and is considered to be the maximum potential of seed quality, such as germination and seedling vigor, which are genetically controlled (Espindula et al., 2018).

Researches to determine the physiological quality of coffee seeds of different cultivars, available in the market, have a lot of significance, as they provide accurate information to seed producers and coffee seedling producers on the uniqueness of the germination and vigor of each cultivar. The inadequate management of seeds in the coffee nursery affects the formation of seedlings, causing irregular development of the coffee plantation, delay in the start of the productive phase, and reduction in the crop yield (Macêdo et al., 2011; Matiello et al., 2020). This study aims to analyze and compare the physiological quality of seeds of different groups of Arabica coffee cultivars recommended for planting in the Mountain region, in the state of Espírito Santo (ES), Brazil.

## II. MATERIAL AND METHODS

The Arabica coffee seeds were harvested in a coffee seed production field accredited by the MAPA, located in the municipality of Marechal Floriano (altitude 670 m; -40°46'03"W; -20°26'30"S), Mountain region of Espírito Santo State, Brazil. Ten liters of fruits at stage 88-BBCH coffee scale (complete physiological maturity) (Arcila-Pulgarin et al., 2002) of each cultivar were manually picked in July 2020, from the middle-third of the plants. The fruits were processed in a separator-washing machine, with the aim of eliminating the coffee fruits that floated (malformed) from the ripe ones. The fruits were processed in a manual pulp remover, and soon after, were submitted to a natural fermentation process for 24 hours, using clean water to remove the mucilage; 30% of water, in relation to the coffee volume, was used. Subsequently, the fruits were dried on a black polyethylene mesh suspended 1 m from the soil (Alixandre et al., 2019) until it had a moisture content of 35% ± 1% (bu). It was later sent to the Laboratory of Analysis of Seeds, Department of

Agronomy, Center for Agricultural Sciences and Engineering, Federal University of Espírito Santo (CCAUE-UFES), Alegre-ES, Brazil.

The experimental design used was completely randomized with four replications, using 50 seeds per plot. Cultivars (cv) that constituted the treatments were grouped into: Group 1. Catucaí: Cv Catucaí-785/15, Catucaí-2SL/CAK, Catucaí-24/137, and Japi (all selected from the cross between the groups Icatu x Catuaí) — coffee-rust tolerant; Group 2. Sarchimor: Arara (cross between yellow Icatu 2944 x Sarchimor 1669/20), and Acauã (cross between Mundo Novo IAC-388/17 x Sarchimor IAC-1668) — coffee-rust tolerant; Group 3. Others: Catuaí IAC-81 (cross between Mundo Novo x Caturra), Catuaí IAC-62 (cross between Mundo Novo x Caturra), Mundo Novo IAC-379/19 (cross between Sumatra x Bourbon Vermelho), and Caturra IAC-479 (mutation of Red Bourbon) — coffee-rust susceptible cultivars. Under laboratory conditions, the seed endocarp (parchment) was initially removed, and immediately seed asepsis was done by immersion in 70% alcohol (v/v) for 2 minutes, in 2% sodium hypochlorite solution (v/v) for 3 minutes, and then in a captan solution (2.5% w/v). After each phase of this procedure, the seeds were washed in distilled water, with the aim to remove any residue of chemicals used (BRASIL, 2009). Seed quality analysis were performed using the following procedures:

Seed water content: Was determined in an oven at  $105 \pm 3^\circ\text{C}$ , using two sub-samples of 50 seeds (Brasil, 2009).

Germination test: Was performed with four replications of 50 seeds for each treatment; rolls of three Germitest® papers, previously dampened with distilled water in a proportion of 2.5 times the dry weight of the papers, were used as the substrate. The seeds were kept in a germination chamber [Biochemical Oxygen Demand (B.O.D.)] at a constant temperature of  $30 \pm 1^\circ\text{C}$ , in a 24-hour dark phase. Seed germination was monitored daily and evaluations consisted of two counts of normal plants: Fifteen days after the start of the test, evaluation was for radicular protrusion ( $\geq 2$  mm), and 30 days after the tests began, evaluation was for the number of developed healthy seedlings (Brasil, 2009). The results were expressed as the germination percentage (%TG).

Germination speed index (GSI): Was determined together with the germination test, by adding the number of seeds that showed protrusion of the primary root ( $\geq 2$  mm), daily (Maguire, 1962). The count was done up to the thirtieth day after sowing. The GSI was calculated daily, by adding the number of seeds germinated and dividing it by the number of days between sowing and germination:  $\text{GSI} = G1/N1 + G2/N2 + \dots + Gn/Nn$ , where GSI = germination

speed index; G1, G2, and Gn = number of seedlings obtained in the first, second, third, and last counts; N1, N2, ... Nn = number of days after sowing, in the first, second, and last counts.

Root length and aerial part of the seedlings: The measurement was performed after 30 days of sowing, wherein the normal seedlings of each repetition were measured with the aid of a graduated ruler (cm), from the tip of the root to the apex of the aerial part, and the results were expressed in cm seedling<sup>-1</sup>.

Fresh and dry mass of seedlings: The seedlings, after the previous analysis were weighed in an analytical balance (0.0001 g) to obtain the fresh weight. Subsequently, they were packed in Kraft paper bags, kept in an oven, with the temperature set at  $65 + 2^\circ\text{C}$  for 48 hours (until reaching constant weight). The samples were then weighed and the results of the dry mass weight was expressed in g seedling<sup>-1</sup>.

The data were submitted to Lilliefors tests, to verify the normality of the errors, before performing the Analysis of Variance (ANOVA) of the variables. The Cochran and Bartlett tests were used to verify the homogeneity of the variances. The data of the variables were submitted to ANOVA, and the means compared by the Scott Knott test ( $p < 5\%$ ). The principal component analysis was used to group the genotypes, with regard to the characteristics studied, by means of a visual examination of their graphic dispersions. For statistical analysis, the R program (R Core Team, 2020) was used.

### III. RESULTS AND DISCUSSION

There was no difference in the seed germination of the Arabica cultivars in the final evaluation, and total germination values ranged from 88% to 99%. All cultivars showed germination values above 70%, the minimum required by normative instruction N. 35, of November 2012, from MAPA, for commercialization of coffee seeds in Brazil (BRASIL, 2012). However, cv Catucaí-785/18 (95%), and Catucaí-2SL/CAK (95%) showed the highest germination values in the first germination count. Cultivar Catuaí IAC-81, Catucaí-24/137, Catuaí IAC-62, Acauã, Japi, and Arara, showed germination values from 86% to 90%; cv Mundo Novo IAC-379/19 (75%), and Caturra IAC-479 (80%) showed the lowest germination percentage values obtained (Table 1).

Seeds from cv Catucaí-785/15 and Catucaí-2SL/CAK showed higher GSI values than the others, even as, cv Mundo Novo IAC-379/19 showed lower GSI values, with less vigor. The difference in vigor among the cultivars was pointed out in the first germination count and in the GSI

values; although, all cultivars had good germination potential in the final evaluation. It was evident that cv Catucaí 785/15 and Catucaí-2SL/CAK showed greater vigor in relation to the others. Cultivar Catucaí IAC-81, Catucaí-24/137, Catucaí IAC-62, Acauã, Japi, and Arara, presented TG values ranging from 87% to 95%; and cv Caturra IAC-479 and Mundo Novo IAC-379/19 showed a different behavior, with a lower vigor rate (Table 1).

Table 1. First count germination (FCG), total germination (TG), and germination speed index (GSI) of seeds of different groups of Arabica coffee cultivars

Groups	Cultivars	FCG( %)*	TG( %)*	GSI*
Catucaí	Catucaí-785/15	95 a	95 a	1.70 a
	Catucaí-2SL/CAK	95 a	99 a	1.75 a
	Catucaí-24/137	90 b	95 a	1.57 b
	Japi	86 b	94 a	1.55 b
Sarchimor	Acauã	86 b	92 a	1.51 b
	Arara	88 b	88 a	1.55 b
Other	Caturra IAC-476	75 c	95 a	1.54 b
	Catuaí IAC-81	88 b	93 a	1.54 b
	Mundo Novo	80 c	90 a	1.49 b
	Catuaí IAC-62	87 b	87 a	1.50 b
<b>Mean</b>	<b>87</b>	<b>92.8</b>	<b>1.57</b>	
<b>CV (%)</b>	<b>6.17</b>	<b>5.37</b>	<b>5.31</b>	

\*Means followed by the same letter in the column do not differ statistically from each other by the Scott Knott test (p <5%).

The cultivars Catucaí-24/137 (3.68 cm), Arara (3.67 cm), Catucaí IAC-62 (3.47 cm), Catucaí-785/15 (3.42 cm), and Acauã (3.15 cm) (Table 2) presented the highest growth of the aerial part of the seedlings, even as lower growth values were observed in cv Caturra IAC-479 (1.91 cm). Cultivars Catucaí-785/15 (3.81 cm), and Catucaí-24/137 (3.72 cm) presented higher values of root length in relation to cv Caturra IAC-479 (1.52 cm), which presented less growth. The growth of the aerial part of the seedlings was directly proportional to the length of the roots. This factor could be associated with the production of cytosine, a hormone, which despite being produced in other parts of the plant, was produced in greater quantities in the roots. Limitation in root metabolism could reduce the production of hormones and limit the growth of the aerial part of the seedling (SANTOS, 2020). Cultivar Acauã (5.18 g) had

the highest fresh weight, differing from the other cultivars, followed by cv Catucaí IAC-62 (4.91 g), Catucaí-24/137 (4.87 g), and Catucaí-785/15 (4.71 g). The lowest transfer of fresh mass was observed in cv Caturra IAC-479 (4.08 g). Cultivars Catucaí IAC-81 (1.15 g), Catucaí-785/15 (1.12 g), Acauã (1.12 g), and Catucaí-24/137 (1.09 g) showed the highest dry mass accumulation values, and differed from the other cultivars.

The first two main components (dimensions) were used for the composition of equations 1 and 2.

$$CP1(DIM 1) = 0.74 LAP + 0.91RL + 0.63SFW + 0.38SFW + 0.96FCG + 0.25TG + 0.60GSI \quad (1);$$

$$CP2(DIM 2) = - 0.58 LAP + 0.01RL - 0.54SFW - 0.17FSW + 0.16FCG + 0.87TG + 0.76GSI \quad (2)$$

First germination count (FCG), and seedling root length (RL) (Equation 1, Figure 1A) are highlighted in the first main component, and total germination (TG), and germination speed index (GSV) (equation 2, Figure 1). Strong correlations are also observed between the variables fresh seedling weight (SFW) and length of seedling aerial part (LAP), according to the acute angles formed between them.

Table 2. Length of aerial part (LAP), root length (RL), seedling fresh weight (SFW), and seedling dry weight (SDW) of different groups (group) of Arabica coffee cultivars (cv)

Group	Cultivar (cv)	LAP (cm)	RL (cm)	SFW (g)	SDW (g)
Catucaí	785/15	3.42 a	3.81 a	4.71 b	1.12 a
	2SL/CAK	2.76 b	3.21 b	4.56 c	0.95 b
	24/137	3.68 a	3.72 a	4.87 b	1.09 a
	Japi	3.01 b	2.35 c	4.61 c	1.04 b
Sarchimor	Acauã	3.15 a	2.16 c	5.18 a	1.12 a
	Arara	3.67 a	2.51 c	4.45 c	1.01 b
Other	Caturra	1.91 c	1.52 d	4.08 d	0.98 b
	Catuaí 81	2.80 b	2.88 b	4.48 c	1.15 a
	Mundo	2.69 b	2.06 c	4.44 c	0.99 b
	Catuaí 62	3.47 a	3.35 b	4.91 b	0.94 b
<b>Mean</b>	<b>3.05</b>	<b>2.76</b>	<b>4.63</b>	<b>1.04</b>	
<b>CV (%)</b>	<b>9.29</b>	<b>14.19</b>	<b>4.34</b>	<b>7.48</b>	

\*Means followed by the same letter in the column do not differ statistically from each other by the Scott Knott test (p <5%).

The dispersion of the 10 cultivars, with regard to the germination characteristics, based on the coordinates related to the first two main components (CP1 and CP2 — Dimensions) showed that four distinct groups were formed. These two components absorbed 75.36% of the variation in the original characteristics, with CP1 (Dim1) responsible for 46.47%, and CP2 (Dim2) for 28.89%. The



first group (A) was comprised of cv Caturra IAC-476 (black); the second group (B) was comprised of cv Catucaí-2SL/CAK (red); the third group (C) of cv Catucaí-785/15 and Catucaí-24/137 (green); and the other groups of cultivars formed group D (blue) (Figure 1B).

Cultivars Caturra IAC-476 and Catucaí-2SL/CAK did not show similarity between themselves or with the other groups; cv Catucaí-785/15 and Catucaí-24/137 (group C) showed similarity between them, and dissimilarity with the other groups; and cv Catucaí IAC-81, Mundo Novo IAC-379/19, Catucaí IAC-62, Acauã, Japi, and Arara showed similarities with regard to the studied germination characteristics (Figure 1B). The results obtained by the main components (Figure 1) confirmed those obtained by the Scott Knott test (Tables 1 and 2), which highlighted, in general, that cv Catucaí-785/15, and Catucaí-24/137 (group C) showed superior characteristics of physiological quality than the others, followed by cultivars of group D and group B. The cv Caturra IAC-476, in general, presented germination characteristics inferior to the others.

The difference in the physiological quality of coffee seeds may be associated with the ability to adapt to environmental, biotic, and abiotic stresses, which can have a disadvantageous influence on the physiology of the plant. It may directly influence the chemical composition, accumulation of reserves, and hormonal balance of the seeds. In this context, it is worth mentioning that the methodology adopted in this study, carefully standardized factors such as, climate, crop management, and management during the harvest and post-harvest, which enabled conditions for maximum expression of the physiological quality of the seeds in the analyzed conditions (Carvalho, 2012; Taiz et al., 2017).

Cultivars Catucaí-785/15 and Catucaí-24/137 have shown high vigor and resistance to rust (*Hemileia vastatrix* Berk & Br) under field conditions, in Brazil. This contributes to the maintenance of a higher index of leaf area, generating a higher rate of liquid photosynthesis throughout the period of fruit development. These conditions enable the production of seeds with greater accumulation of reserve, density, size, hardness of the integuments, and a more balanced chemical and hormonal composition. Thus, it is possible to suggest that these factors may have contributed positively to a higher physiological quality of the seeds of these cultivars. The less vigor of the plant and the high susceptibility to coffee-rust, a characteristic of cv Caturra IAC-479, may have contributed negatively to the lower physiological quality of its seeds (Giomo et al., 2008; Krohling et al., 2018).

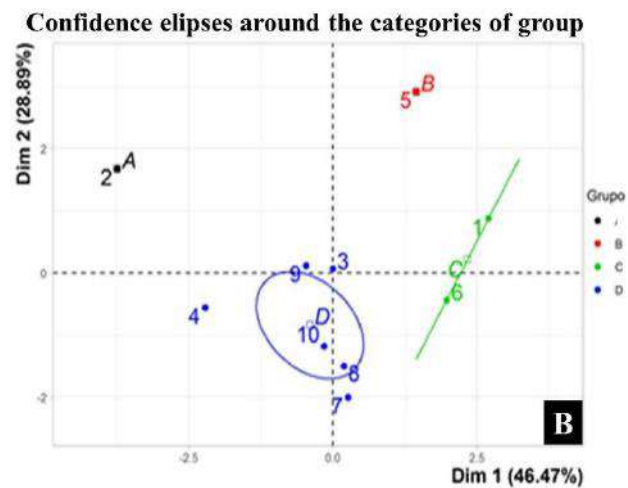
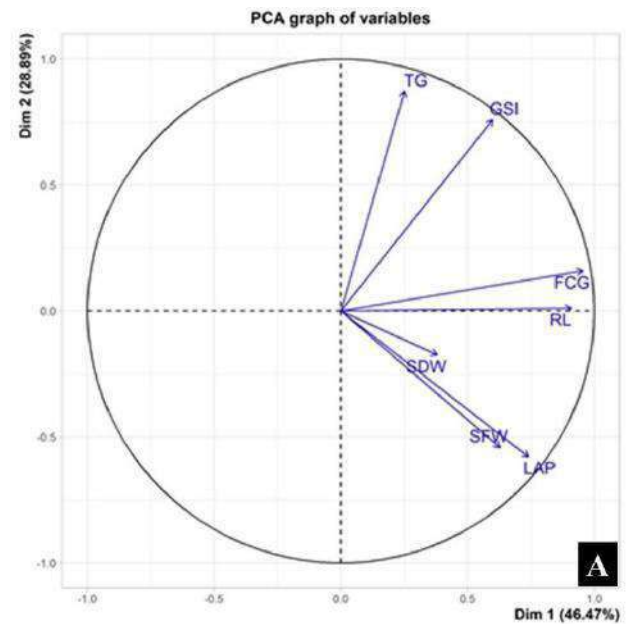


Fig.1 – Dispersion diagram in relation to the first two main components of the genotypes: 1. – Catucaí-785/15; 2. – Caturra IAC-479; 3. – Catucaí IAC-81; 4. – Mundo Novo IAC 379-16; 5. – Catucaí-2SL/CAK); 6. – Catucaí-24/137; 7. – Catucaí IAC-62; 8. – Acauã; 9. – Japi; and 10. – Arara. Variables: first count germination (FCG), total germination (TG), germination speed index (GSI), length of aerial part (LAP), seedling root length (RL), fresh seedling weight (FSW), and seedling dry weight (DSW).

Another factor that can explain the difference obtained in the physiological quality among the cultivars is related to the speed of reorganization of the cell membrane of the seeds during the imbibition process; considering that membranes reach maximum organization at the stage of physiological maturity. However, from that moment, as a result of water loss by natural or artificial means, a process of structural disorganization begins. Regardless of the degree of deterioration of the seeds, the membrane system

reorganizes itself during the imbibition process, regaining control over its permeability. Therefore, the faster the reorganization of the membrane occurs, the greater is the tendency to increase the vigor of the seeds (Araújo, 2011; Bewley et al., 2013; Marcos Filho, 2015). A difference in vigor has been observed between cultivars of the Sarchimor group (IPR-98, IPR-100, IPR-105, and IPR-106) in which cv IPR-98 has the lowest percentage of germination, radicle protrusion, germination after premature aging, and greater electrical conductivity. It suggests that a difference in vigor among seeds of cultivars within the Sarchimor group may be related to the integrity of the seeds verified by electrical conductivity. Thus, it is possible that the better vigor performance of cv Catucaí-785/15 and Catucaí-24/137 may be related to the higher speed of reorganization of seed membranes during the imbibition process, inducing greater vigor (Dalvi et al., 2013; Francisco et al., 2019).

Germination and vigor of the Arabica coffee seeds can be impaired when infected with disease. The microflora associated with coffee seeds varies depending on the area of cultivation and the climatic conditions of the production region. Fungi of the genera *Aspergillus* and *Penicillium* are usually present on the seed surface shortly after being processed; these can colonize in seeds under field conditions with abundant humidity (90–95%) and under storage. However, other fungi such as *Fusarium* spp., *Colletotrichum* spp., and *Phoma* spp., can also infect seeds (Squarezi et al., 2002). These fungi are very common in the cultivation in mountain regions, where it is humid when seeds are collected. No fungi had been observed during the entire experiment period, showing that appropriate conditions of harvest and processing of the fruits carried out in the methodology adopted in this study are limiting to the contamination process.

The physiological quality of the *Coffea canephora* ‘Apoatã’ seed varies depending on the genotype. The genetic variability between cultivars can generate seeds with different sizes, densities, tegument hardness, and concentration of substances that inhibit germination, such as, caffeine and phenolic compounds. Thus, it is possible to confirm that the study of germination and vigor is something complex, as it involves numerous metabolic processes in which several factors can act simultaneously, and the whole process is controlled by the interaction between genetic and environmental factors (Teixeira, 2012; Rubim et al., 2014; Espindula, 2018; Posse et al., 2019).

The information obtained in this study can significantly contribute to improving the efficiency of the production process of coffee seedlings. Cultivars that present seeds with higher physiological quality tend to have a higher rate

of initial development of seedlings in the nurseries, and also a lower rate of discarded seedlings. This can provide production of higher quality seedlings and also greater commercial gain for coffee seedling producers. Further studies are suggested with seed evaluation of cultivars from different regions and altitudes, in order to evaluate the effect of the interaction between the cultivars and environmental conditions on the physiological quality of coffee seeds.

#### IV. CONCLUSIONS

- All seeds of the Arabica coffee cultivars tested fall within the MAPA requirements for commercialization.
- The new rust-resistant cultivars of the coffee group Catucaí, particularly cv Catucaí-785/15 and Catucaí-24/137, present greater germination and vigor in seeds.
- Cultivar Caturra IAC-479, shows inferior performance in relation to the physiological quality of seeds.
- Arabica coffee seeds sold in the sampled region have an excellent physiological quality.
- Crops with adequate nutrition, fruit harvest in the physiological stage of the ripe cherry, correct handling in the post-harvest period, and manual removal of the endocarp, allow for maximum expression of the physiological quality potential of Arabica coffee seeds.

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## Effect of photobiomodulation with low-level laser therapy in prevention orthodontic pain: Case reports

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**Keywords**— *Low-level laser therapy, photobiomodulation, pain, orthodontics, analgesia.*

**Abstract**— *In clinical practice and research studies, there is almost a consensus that photobiomodulation therapy with low level laser causes analgesic effect. In this way, the laser can clinically contribute to postoperative pain management after the start of orthodontic treatment. Case Report: the following case reports demonstrate the application of photodynamic therapy in 2 cases immediately after the installation of the orthodontic appliance. The aim of low-level laser treatment would be to reduce possible postoperative pain. The diode laser was employed to irradiate maxillary teeth, immediately after installing an orthodontic appliance for traction. The painful sensitivity decurrent from this procedure was evaluated by a visual scale (Visual Analogue Scale – VAS) 4, 24, 72h and one week after the laser application. The diode laser with light emission at 808 nm wavelength was employed in 12 teeth, 4 points per tooth (2 buccally and 2 lingually, 20 seconds per point), resulting in the total energy was 8 J per tooth. The irradiation protocol were performed by only one operator, per points, employing light beam focused perpendicularly and in contact with the mucosa, which was kept clean and dry, through relative isolation. It appears that there are still few studies which investigated the effects of low level laser for suppressing pain in orthodontics, and the protocols for laser application are still very variable. The evaluated patients showed a low incidence of pain shortly after 24 hours after the installation of the orthodontic appliance. Based on the cases reports, it was observed that laser diode irradiation 808 nm wave-length, energy density 8 J per tooth, was enough to decrease pain, due to installation of the orthodontic appliance. Thus, additional studies are necessary in order to check the best application protocol.*

## I. INTRODUCTION

Orthodontic treatment has been increasingly adhered to by adults, mainly motivated by the aesthetic factor, but they are the same ones who most report feeling pain, which is one of the most important reasons why patients are discouraged from seeking orthodontic treatment [1].

Pain is the most cited negative effect of the application of orthodontic force and the greatest concern of patients as well as orthodontists, being reported as a relevant factor for preventing treatment initiation and/or treatment interruption [2,3]. Approximately 90% of orthodontic patients reported pain during treatment, and 39% of these still experienced pains after 7 days [4]. Soon after the installation of the appliance and the first orthodontic arch, the complaint of painful symptoms is frequent [5].

The perception of pain reported by the patient related to the installation of the orthodontic appliance is due to the process of pressure, ischemia, inflammation and edema generated in the periodontal ligament, which starts immediately after the installation of the orthodontic wire in the appliance, but which starts to present hyperalgesia in a few hours [6].

When mechanical force is applied to the teeth, an inflammatory reaction is triggered in the periodontal tissue [7] resulting in the release of inflammatory mediators such as prostaglandins, substance T, histamine and serotonin [5]. Studies have indicated that an increase in prostaglandin-E2 (PGE2) levels is related to the initial intensity of pain, while an increase in interleukin-1 is related to pain occurring 24 hours after the application of orthodontic force [8].

In order to minimize pain-related complaints, orthodontists routinely use pharmacological methods, through the prescription of analgesics [9] or non-steroidal anti-inflammatory drugs, but their effectiveness is still controversial, as there are effects side effects such as allergies and even the inhibition of dental traction [10,11].

In view of the context, an alternative for non-pharmacological pain management has been reported in the literature, which is an aspect of laser therapy, known as photobiomodulation. Some researches report this alternative as a non-invasive, safe and effective therapy [12-17]. The photobiomodulation technique consists in the application of low power laser in certain local points, presenting several benefits in different areas of medicine [18] and also in the treatment of dental diseases [19], being also used in orthodontics due to its effects of improving tissue growth, accelerating bone and nerve regeneration, in addition to reducing pain after installation and orthodontic adjustments currently considered a support measure [20].

Low Power Laser Therapy is a low-intensity, non-thermal light therapy that stimulates photoreceptors in the mitochondrial respiratory chain, leading to increased ATP and reduced oxidative stress. The subsequent cascade of intracellular effects in bone causes a reduction of inflammation and an increase in osteoblastic and osteoclastic activity [21].

Recent articles and case reports have evaluated Low Power Laser Therapy (LTLP) in orthodontic patients and the results have been promising in reducing painful symptoms [15,16,17,22-25].

Thus, this paper aims to describe two clinical case reports with the application of low-power laser aiming to prevent pain after orthodontic appliance installation.

## II. CASE REPORTS

Patients J.M., 28 years old, male and M.J.S.L., 32 years old, female attended for bonding of the orthodontic appliance in the upper arch. After the anamnesis, orthodontic documentation and planning, the Morelli Orthodontia Ltda brackets were bonded. Both patients confirmed that they were not using anti-inflammatory or analgesic mediations for various reasons before the orthodontic procedure.

In both cases, after the procedure for bonding the brackets, with the objective of preventing pain related to the installation of the orthodontic appliance, patients received in 12 teeth of the upper arch Low-level Laser Therapy, infra-red with 810 nm wave length and 100 mW power (Laser therapy XT., DMC. Equipamentos São Carlos, Brazil), and it was used 8 J/cm<sup>2</sup> as total dose per tooth, divided into four times of 2 J/cm<sup>2</sup> per 20 seconds per point. The respective points of application were: P1 - cervical root on the buccal side and P2 - in the root apex, followed by the same procedure P3 - cervical root and P4 - in the root apex on the lingual side. The total application duration was 960 seconds/16 minutes (Fig. 1-3).



Fig. 1. A) P1 - cervical point application root on the buccal side B) P2 root apex application root on the buccal side.

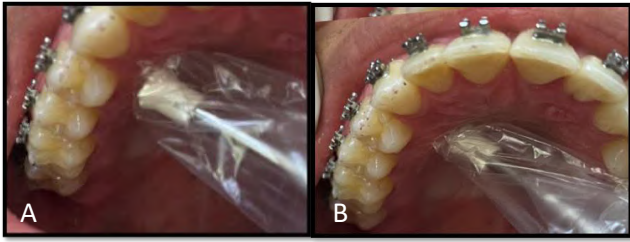


Fig. 2. A) P1 - cervical point application root on the lingual side. B) P2 root apex application root on the lingual side.

A single operator trained in laser therapy performed the laser application with the tip positioned 3mm from the mucosa without touching, at an angle varying from 90 at 70° due to the positioning of the teeth.



Fig. 3. Laser tip positioned 3mm from the mucosa without touching.

Finally, the 0.12' niTi orthodontic wire from the commercial brand Orthometric Ltda and the modular elastic from the brand Morelli LTDA were placed.

After the appliance installation procedure and the first orthodontic arch, the patients were instructed to complete a pain intensity experienced questionnaire by a Visual Analogue Scale [26]. Data (VAS) in the following follow-up times after the procedure: 4 hours, 24 hours, 3 and 7 days.

Both patients reported on the VAS scale a little sensitivity (scale index:1) after the placement of the orthodontic appliance within 4 hours and a greater intensity of pain (scale index:2-3), even if expected, within 24 hours after the procedure. However, after this second time of evaluation, on the third day of follow-up, both patients mentioned a sudden drop in the postoperative period, indicating total remission of symptoms after 36

hours (scale index:0). None of the patients report the need to use analgesics or anti-inflammatory.

### III. DISCUSSION

Orthodontic movement depends on an adaptation of the alveolar process, which is usually painful due to the inflammatory character of the tissue remodeling process [27]. Thus, the discomfort caused by tooth movement is a frequent concern of patients, even knowing that the perception of pain, in addition to being very individual, varies considerably from individual to individual. Therefore, pain is classified as a highly subjective sensation and therefore very difficult to quantify in scientific research [28].

Therefore, non-pharmacological alternatives have been studied with the aim of at least reducing the postoperative period in the first sessions of orthodontic appliance installation. Low-level laser would be one of those alternatives with a positive factor of not promoting a collateral effect to patients [12,26].

The application of low-level laser has been shown to be effective in a single clinical application for pain reduction in several studies [29-38]. Other clinical researches have already shown a real effectiveness of the laser protocol after two applications to reduce the painful condition [24,34,39]. In a study evaluating successive low-power laser applications in the orthodontic postoperative period, Almallah et al. [34] did not find differences in pain reduction when comparing a single dose with a double application dose. It is observed in the literature that there are no studies reporting the most appropriate number of low-level laser therapy applications; however, we can observe that a single dose after the application of orthodontic force was sufficient to reduce pain in the patients treated.

An important fact to mention is that the intensity of pain described by orthodontic patients varies according to the type of orthodontic force applied. The pain analysis method applied in the clinical sessions presented was the VAS, a scale mentioned in several studies in the literature [29,31,39].

According to studies by Farias et al. [31] and Bicakci et al. [24], patients who received the low-power laser had a significant reduction in pain 24 hours after the application of orthodontic force. According to the literature, discomfort in patients with orthodontic pain starts two hours after orthodontic activation [36] and usually presents a greater intensity after 6–24 hours [17, 30, 23, 31,42,38,37,33]; and likely reduction in the range of two to five days [32,33,17,34,31,37].

When using laser, it is important to choose the most appropriate wavelength for each disease [38]. Laser penetration of the tissues is directly related to wavelength [39,40]. A wavelength of 830nm presents the deepest penetration, able to reach the cortical and alveolar bone tissues; it is more effective than wavelengths between 620 and 670 nm [26, 41].

Regarding the low potency laser application protocol, the choice of dosage is extremely important, and the use of lower doses is indicated, as they make treatments more effective and safe, since doses above 20 J/cm<sup>2</sup> may have inhibitory action on tooth movement. The dose used in the clinical treatments presented was 8 J per irradiated tooth divided into 4 application points of 2 J/cm<sup>2</sup>. This protocol was proposed and applied by Bjordal et al. (2006) [42], since this dosage has the ability to promote anti-inflammatory and analgesic effects [12].

Because of its wavelength, infrared laser has been the treatment of choice for promoting immediate and temporary analgesia, acting on the cell membrane to cause hyperpolarization, that is, a photo-physical change as a result of the light-cell biological interaction [40]. Endorphin synthesis and the action potential of neural cells increase, whereas the amount of bradykinin as well as the activity of the C-fibres driving the pain stimuli decreases [43], resulting in relief of painful symptoms [26, 44].

In view of the findings in the literature that provide evidence that it would not be necessary to irradiate the entire area of the teeth involved in order to achieve the desired analgesic effect, we chose a point at the apex and another point at the middle third of the root, both on the buccal side and on the palatal side. This is because the pressure receptors are most often in the apical two-thirds of the root [12,26].

As many orthodontists are concerned, the present case reports set out to analyze the postoperative period at an initial moment of orthodontic treatment right after the installation of the orthodontic appliance and first arch. This clinical observation was also investigated by Thurhani et al. (2006) [15], where a single laser dose was applied for 30 s, as well as in the studies by Tortamano et al. (2009) [17], where it is observed application of a dose equivalent to 2.5 J/cm<sup>2</sup> distributed in five irradiated areas. Both studies conclude that LTBP is effective in controlling pain after the installation of the first arch, which corroborates the observations in this clinical follow-up article. The protocol employed by Tortamano et al. (2009) [17] indicated that a laser therapy application time between 32 and 37.5 minutes per patient is necessary, whereas In the present study, the total application time was 16 minutes

due to the number of teeth involved in the application protocol.

In agreement with the findings of Marini et al. [29] we observe how opportune the possibility of using the low-level laser therapy protocol in daily orthodontics practice.

#### IV. CONCLUSION

More studies to develop complete protocols in order to facilitate the application and execution in clinical practice of laser are really necessary to convert safe laser irradiation with effective dosage into a routine treatment for orthodontic pain.

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## ICT and the Teaching-learning process in history in high School: São Mateus-ES

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**Keywords—** History teaching, High school, Information and communication technology, Hybrid Curriculum.

**Abstract—** This research consists in understanding how the use of information and communication technologies (ICT) facilitates and stimulates the teaching-learning process of the subject of History in 3rd grade high school classes in two schools in the city of São Mateus/ ES, Colégio InPacto of the private education network and EEEFM Santo Antônio of the state public education network. This is a case study, qualitative in nature, carried out through questionnaires with open questions in order to understand the functionality of the use of technologies by students and teachers in History classes. In this context, we aim to verify the applicability of the Pedagogical Political Project of the schools surveyed regarding the use of ICT; report the teachers' understanding of the teaching and learning process and observe how students dialogue with the use of ICT during history classes. The analysis of the questionnaires showed that teachers and students use ICT frequently in the teaching-learning process, but teachers, in their pedagogical practices, use ICT only as an aid tool. We detected that students and teachers access internet networks through cell phones, and we also found that the Wi-Fi signal reception failures in schools were restrictions on the development of the proposed activities. Despite the obstacles, teachers and students are in agreement that ICT positively help the pedagogical work. The analysis of the questionnaires showed that teachers and students use ICT frequently in the teaching-learning process, but teachers, in their pedagogical practices, use ICT only as an aid tool. We detected that students and teachers access internet networks through cell phones, and we also found that the Wi-Fi signal reception failures in schools were restrictions on the development of the proposed activities. Despite the obstacles, teachers and students are in agreement that ICT help the pedagogical work in a positive way. The analysis of the questionnaires showed that teachers and students use ICT frequently in the teaching-learning process, but teachers, in their pedagogical practices, use ICT only as an aid tool. We detected that students and teachers access internet networks through cell phones, and we also found that Wi-Fi signal reception failures in schools were restrictions on the development of the proposed activities. Despite the obstacles, teachers and students are in agreement that ICT help the pedagogical work in a positive way. We detected that students and teachers access internet networks through cell phones, and we also found that the Wi-Fi signal reception failures in schools were restrictions on the development of the proposed activities. Despite the obstacles, teachers and students are in agreement that ICT positively help the

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## I. INTRODUCTION

This research work has as its line of investigation the process of teaching and learning through information and communication technologies (ICT), in History classes in the 3rd grade of high school. This study intends to contribute to the knowledge of the reality of the use of ICT in the 3rd grade of High School, in two schools, Colégio InPacto, of the private education system, and the EEEFM Santo Antônio School, of the State education system, located in municipality of São Mateus.

In the era of information systems, when analyzing Brazilian educational institutions, in terms of technology and digital media, we notice a large gap in comparison with foreign countries. However, the use of technologies by teachers and students is increasingly common in classrooms. According to a survey carried out in 2017, by TIC Educação, from the Center for Studies on Information and Communication Technologies<sup>1</sup> (CETIC), 52% of Brazilian students used cell phones in the classroom.

The research has as general objective to present how the use of digital technologies contributes to a more satisfactory and effective learning in the teaching of History in the 3rd grade of High School. In this context, we have as specific objectives: to observe how students interact with the use of ICT during the development of pedagogical activities, proposed in History classes; describe how the use of cell phones, Internet and video classes as technological tools contribute to teaching and learning in History classes in the 3rd grade of High School; to verify if the applicability of the use of ICTs, as an item of the Pedagogical Political Project (PPP), of the researched schools has materialized in practice; propose to the Regional Superintendency of Education of São Mateus/ES, and to Colégio InPacto,

For this work, it was decided to carry out a qualitative research, using the instruments of application of questionnaires, document analysis and classroom observation. The choice of these methods represents the study and collection of information about the practice of teaching History, with the use of information technologies.

<sup>1</sup> [www.cetic.br/publicacao/pesquisa-sobre-o-use-of-technology-of-information-e-communication-nas-schools-brasileiras-tic-educacao-2017](http://www.cetic.br/publicacao/pesquisa-sobre-o-use-of-technology-of-information-e-communication-nas-schools-brasileiras-tic-educacao-2017). Accessed on 21 May 19.

Data collection took into account the variants of the public served and their educational realities. Three teachers and two 3rd grade high school classes from two public and private schools in the city of São Mateus participated in this study.

The research is relevant, as it is necessary to understand that traditional academic knowledge alone does not prepare the student to carry out complex activities in different cultural environments. Teachers and students need to adapt curriculum proposals consistent with the reality in which they are inserted. With the rapid changes promoted by the information society, new ways of being, feeling and knowing about the world need to be stimulated and permeated by the technological environment. There is no way to distance education, technology and training from the world of work.

The experiences of classes organized through active methodologies dynamically and interactively enrich the carrying out of group activities, stimulating debates and discussions from different points of view, better establishing concepts and information about the content of History. We end chapter 2, discussing the Political Pedagogical Projects of the schools surveyed regarding the use of ICTs.

## II. HISTORY TEACHING IN THE HISTORY OF BRAZIL

Taking a brief walk through the historiography about the teaching of History, it is verified that its origin as a school subject was with its participation in the composition of the Classic Humanities curriculum of the 19th century. However, it was found that the historical contents were part of the classical humanities in Jesuit schools, between the 16th and 18th centuries. The teaching of history in Brazil was marked by deep contradictions, until the first half of the 18th century, teaching was based on the Jesuitic method of the Society of Jesus, a religious order founded by Ignacio de Loyola, in 1540 in Europe. This educational model, predominant in the region of the Iberian Peninsula, in the beginning of the Modern Age, reflected in the culture of Brazilian settlers.

The teaching of history as a science would only be born during the 19th century. When the Society of Jesus was founded in the 16th century, there was no university

or school that taught history as a subject. It was in the Jesuit schools that the subject of History began to be taught as a complement to the Church's history, it was an important instrument for interpreting courses in the humanities and theology.

In the first three decades of the 20th century, a series of changes were initiated in Brazilian education. In the context of the 1930 Revolution, with the implantation of the Provisional Government of Getúlio Vargas, in the following year, in 1931, the Francisco Campos Reform took place. Amidst the ideological struggles over the regime and the financial catastrophe that devastated the country, Campos officially and nationally established the modernization of secondary education, organizing school culture through the establishment of a series of measures.

In the case of a government with dictatorial characteristics, the teaching of history during the totalitarian Estado Novo dictatorship of Vargas (1937-1945) represented the colors of the national flag, exalting patriotism, national heroes and the great deeds of the past. From the 1950s onwards, there was a break with the previous pattern of teaching history, with the return of democratic normality, nationalism, populism and the advance in the industrialization process in Brazil; the labor market demanded a literate working class.

It served with greater strength to base the organization of work on the achievement of a modern capitalist project that should, by the school, not train technicians, but create historically manipulated work values in order to create the image of the worker as a building agent of the nation's wealth; not as an element explored by capital and holder of rights that needed to be conquered (BITTENCOURT, 1998, p.201).

The teaching of history conveyed political and economic knowledge to students, for a better understanding of the social changes imposed by capitalism.

From the 1980s, with the redemocratization, the promulgation of the Citizen Constitution specifying the LDB, the Law of Guidelines and Bases of Education, and in the following decade the National Curriculum Parameters (PCN's) for the discipline of History, was used the concept of citizen as a theoretical framework. The proposal of the LDB and the PCN's intended to break with

the traditional structures of the teaching of History, establishing an identity between teaching and research, a critical attitude towards constituted knowledge and the periodization taught and consolidated in the curricula.

According to the PCNs, as an integral part of the Human Sciences, the function of History would be to enable the understanding of current problems, basically those that impede the constitution of citizenship. The student, as a citizen, participant and constructor of his own history, must understand these problems and the methodological resource for this understanding must be the study of clarifying themes, established from research and critical reading of sources and bibliography (LOPES, 2002, p.392).

In the 1990s, new curriculum policies were being addressed, educational issues took on complex dimensions, as the proposal of the History PCNs was to provide teachers with a clear vision of the teaching of this subject. The document's concern is evident in the teaching of History that develop human consciousness, establishing relationships between individual, collective and social identities; building notions of similarities and differences, permanencies and continuities. Thus, the teaching of History focused on the use of specific methodologies for the student's age group, respecting the cultural and social particularities of the students.

Created under speeches of struggle and improvement for education, in December 2018, the Base Nacional Comum Curricular (BNCC) was approved, with a normative document, being approved under controversies in debates and discussions. As participants in decision-making, we highlight representatives of the school community, national and international institutions, financial organizations and the business class.

In the teachers' understanding, the regulations approved by the BNCC, present a neglect in the educational process, increasing the partnerships that lead to the privatization and outsourcing of public resources in private institutions. Therefore, the training of students occurs in a more flexible and quicker way, meeting the needs of the labor market and the capitalist and market economy.

According to Zanatta (2017, p. 324):

[...] Due to this social regulation, promoted between the public and private powers, the discussions that permeate public educational policies have become more complex. This is because the State has been losing its central role as author of regulation and entrepreneurs, through their organizations (philanthropic institutions, NGOs, foundations), are consolidating as protagonists of educational policies.

Regarding the discipline of History, in the area of Human Sciences and its technologies, related to the use of information and communication technologies, we will focus on the 5th General Competence of BNCC. This competence indicates that students need to be protagonists of their knowledge and produce it through digital resources. Youth protagonism directs to the formation of young people committed to their personal, entrepreneurial and participatory growth in the community in which they are inserted, being able to align the knowledge learned at school with their daily life.

### III. HYBRID TEACHING AND THE USE OF TECHNOLOGIES

Hybrid teaching is a methodology that combines face-to-face teaching with distance learning. According to Morán (2014), hybrid means mixed, blended, blended. This teaching model gained space in the Brazilian educational society from the first decade of the 21st century onwards, spread through information and communication technologies. Initially, hybrid education was implemented in higher education, in the distance learning (EAD) mode, as a way to expand the offer of training for those who did not complete their studies on time or were unable to continue their training because of cause of work.

Kenski (2008) reports that the distance learning modality (EAD) emerged in the United States, specifically in the city of Boston, in 1728, through the offer of shorthand courses, whose material was sent to students by mail order. Dating back to the 18th century, this was the first record of a distance course offered. Then, in 1833, we have the shorthand course offered at the University of Lund, Sweden, made available to students through correspondence. Following the advance of the distance

modality, we have England, offering from the year 1840, also the shorthand course, but focused on religious activity of biblical transcriptions. However, the focus is on Germany, pioneering the creation of the School of Languages by correspondence, in 1856.

In Brazil, the modality of teaching in distance education (EAD) emerged at the birth of the Republic, from the year 1904, with the offer of typing courses by correspondence. In the 1920s, with the popularization of radio, distance courses gained a new form of propagation by the Roquette-Pinto Foundation. In the same century, between the 1940s and 1950s, the TV sets that broadcast courses under the telecourses platform arrived, in particular, we have the Monitor Institute and the Instituto Universal Brasileiro.

The 21st century opens the era of notebooks and cell phones, with internet access, opening up a range of facilities and services, followed by tablets. As a result, we have an improvement in the technology of cell phones, classified as smartphones, that is, smart devices that, through applications, offer services of the most varied orders. From then on, we moved towards the experience of hybrid teaching that, through social and economic changes, started to gain space in Brazilian education in light of the popularization of internet access.

The internet appears as a possible space for articulation and integration between people connected with everything that exists in the digital space. Experiences with the use of digital media make it easier for young people of the new generation to learn what interests them (KENSKI, 2012, p. 44).

At the beginning of its diffusion, the objective of distance education was professional improvement, through the provision of content to complement university education. Over the centuries, EAD follows the evolution of technologies, also directing the focus to basic education, to the classroom space. This, in the organizational and physical form, has changed little in its structure, however, with regard to distance education, it follows a pace of change as technology advances and students start to interact with these means during the execution of classes.

Currently, hybrid education is gaining prominence in basic education. Still little explored in Brazilian education networks, it is a way of modernization so that schools become more attractive, surpassing the traditional model and showing new paths for education,

since; educational practices need to be rethought and fragmented content does not meet the demands of a technological world. Hybrid teaching experiences in Brazilian education move slowly.

The greatest complexity of hybrid teaching is in breaking with the traditional, archaic and rigid school model, bringing to the reality of the school community the expansion of pedagogical practices that integrate what is necessary to learn and what is worth learning, combining theory and practice. For Bacich, Neto and Trevisani (2015), there is no single way to learn, we are all apprentices and teachers, consumers and producers of information and knowledge. We all teach and learn.

Moran (2014) defines hybrid teaching as a symbiotic interconnection between the physical world and the digital world. Highlights the classroom as an environment that redesigns itself from the emergence of new ideas, based on projects, activities, games, challenges and group work; permeated by technology with the supervision and guidance of teachers. Therefore, in the view of these authors, hybrid can be a more flexible and broad curriculum, which is developed in accordance with the needs of society in constant change.

The shift from traditional to innovation brings new things to the classroom space, with pedagogical models focused on active methodologies. Thanks to technological and communication advances, increasingly integrated into society, active methodologies have their origin in Distance Learning (EAD). This teaching model opened the doors to new pedagogical learning practices, allowing students to control the content, place and time needed to learn and assimilate concepts, combining traditional teaching with innovation.

Distance education is already a reality. More than that, large universities today make some of their courses available virtually, free of charge and with certification, providing a basis for discussing whether technology is not precipitating a change of enormous proportions in the educational system as a whole (BACICH, NETO e TREVISANI, 2015, p. 127).

In active methodologies, the student is the protagonist, acts as a participant and mediator in practical situations, with individual or group productions. The student has autonomy over their learning, as the content is available in different means of acquisition such as the

virtual environment, games, video classes, e-books, smartphones; always with the supervision and guidance of specialist professors in the field of knowledge.

Therefore, with the expansion of the highly connected society, formal education was put at an impasse, it urgently needs to be redesigned to serve this generation. As for educational practice mediated by digital resources, there is no previous model of education structured through technologies, but rather the construction of methodologies, the reorganization of curricula according to digital media, students' life projects, the requirement of proactivity, personalization, collaboration and entrepreneurial vision required by this current society.

Active methodologies, as the spelling itself defines, makes the student active, placing him as the central figure in his learning, being autonomous and participative, critical and challenging, trying to solve his difficulties and problems. For this reason, active methodologies assume different teaching practices and can be applied in the form of projects, with the purpose of stimulating partnership and collaboration. Another highlight is problem-based learning, where the student builds their attitudinal, conceptual and procedural learning based on solving problems that prepare them for the world of work. On the diversity of teaching methods Gabriel (2014, p.132) states that "when teaching is done in an interesting way and involving practical everyday issues, inserted in the personal experience, students are deeply engaged".

The teacher is responsible for planning what will be taught, carrying out the activities in a way aimed at learning processes in collaboration with students. Different from the traditional teaching model, for this methodology to be successful, students need to get used to the fact of carrying out studies on the topics investigated/studied before classes. This is another factor that generates autonomy for students, anticipating the study of content carries the intellect of prior information, stimulates curiosity and promotes shared doubt when explaining the proposed topic.

the maker culture<sup>2</sup> it is one more aspect to be applied in active methodologies. With an emphasis on learning to do, it maintains that any individual can create,

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<sup>2</sup>Teaching methodology that encourages learning to do in a creative and playful way to meet your educational needs. CORDOVA, Tania; VARGAS, Ingobert. Education Maker SESI-SC: inspirations and conception. In: 1st FabLearn Brazil Conference. 2016 Available at: <[http://fablearn.org/wpcontent/uploads/2016/09/FLBrazil\\_2016\\_paper\\_108.pdf](http://fablearn.org/wpcontent/uploads/2016/09/FLBrazil_2016_paper_108.pdf)>. Accessed on: January 25, 2019.

build or repair their own objects. This culture is based on real projects, with significant problems, combining craftsmanship with technological creation. It highlights testing new ideas, life stories, cross-functional environments and trying out practical solutions. In education, its applicability returns to creating and sharing experiences carried out with technological resources, created from educational needs.

Thus, the most used learning methodologies mainly involve the construction of projects with electronic games, videos, robotics applied to problem solving and content software, learning facilitators. For students of the current generation, the projects developed by this teaching methodology are received very naturally, as these resources are part of their daily routine.

The difficulties faced by teachers and students in expanding the use of digital technologies and media in the classroom are many: the spaces need to be adapted, the material to be used must be prepared in advance, we have the displacement of students in several spaces at the same time. There is a certain initial "disorder" in the process of applicability of activities, seen as a nuisance for the traditional teaching model. And yet, the rigidity of the curricular organization itself and of the school, classrooms structured for classes with changes of teachers at each end of the discipline's class time.

For Gabriel (2014), among the advantages of active methodology in education, we have the development of digital skills, team learning, interaction between students, engagement in the search for answers, group debates and constant updating through the use of applications of mobile classes. It highlights that active learning places the student at the center of education, going from a passive being, to a transforming agent of education in their interests, curiosity and identification with the contents.

The student, by resignifying their role in the teaching-learning process, understands that the school is the fundamental basis of their cultural universe of direction in the face of the new challenges imposed by society. In this process of change, the teacher is of paramount importance, he becomes an essential and vital figure to tutor the path, not as a provider of knowledge, but as a catalyst for learning, guiding, encouraging, assisting and pondering its retention process and discovery of knowledge.

THE Innovative high school education boosts the insertion of young people into the labor market and provides them with a leading role, because at this stage of their educational life, students are eager for intellectual and financial independence. Thus, when we critically reflect on

the use of technology in pedagogical practices, we understand that the social function of the school must promote autonomy.

#### IV. THE POLITICAL PEDAGOGICAL PROJECTS OF THE SCHOOLS

The Pedagogical Political Project (PPP) is a fundamental piece in the organization of the pedagogical work of educational institutions, it is it that directs the academic life of the school, organizing the various levels and modalities of teaching offered to students. It is in its writing that we find the education model that the school intends, idealizing possible objectives and goals to be achieved.

In Brazil, the importance of the PPP is highlighted after the publication of the Law of Guidelines and Bases of Education (LDB), in 1996, in its articles 12, 13 and 14, which establish the mandatory nature of a pedagogical proposal for basic education schools. As it is a political project, it presents proposals in an unfinished form, that is, it can be modified according to the institution's interests, with changes in the laws and pedagogical interests of the school. However, all changes are subject to approval by the school community.

By analyzing the political pedagogical projects of Colégio InPacto and EEEFM Santo Antônio, we found that schools treat the use of digital media and the insertion of technology in the classroom as a proposal integrated with theoretical content, based on the writing of the LDB and of the PCN's. The InPacto school highlights the use of technologies through digital media and platforms, present in its teaching material and those directed according to the teacher's planning. It places technology as an integral part of the daily routine of subjects and interdisciplinary activities, promoted throughout the school year, and encourages students to participate in fairs and scientific events that involve technology in the training path of students

EEEFM Santo Antônio brings in the writing of its PPP excerpts taken from the Common Basic Curriculum (CBC) of the state education system, where it explains in general the need to integrate technology in the context of the classroom. The CBC encourages activities that integrate theory and practice with the use of media. The school's PPP, in its last update, in 2019, describes as a goal to improve the use of the Mobile Computer Laboratory (*notebooks*) in the routine of classrooms as a tool to support educational activities and the use of cell phones, upon authorization of teachers to carry out school activities.

## V. METHODOLOGICAL COURSE

The qualitative research, answers to very particular questions, was carried out in two schools of the municipal education network of São Mateus, Colégio InPacto of the private network and EEEFM Santo Antônio, of the public education network of São Mateus/ES. The choice of the final year of the final stage of basic education reflects my daily practice as a history teacher in high school.

The social representations, discourses and knowledge produced by professors/students were analyzed, as the researched reality differs in the social context, representing two distinct social universes in which the researched subjects act. In this perspective, the contribution/participation of students to the realization of pedagogical practices that encourage the use of information technologies in the teaching-learning process, and how they dialogue with these resources, were also evaluated.

The InPacto school is a private educational institution, located in the city of São Mateus/ES. Founded in 2014, its facilities are located on Rua Pitu, Inocoops neighborhood. The main building has 12 classrooms, seven of which are operating in Elementary School II, High School, Pre-Ifes and Pre-Enem. In the organizational structure of this building, we have a library, science laboratory, educational computer lab with wi-fied signal for pedagogical activities, an elevator for wheelchair users in compliance with Law No. 10,098, of January 19, 2000 and the school's parking lot.

The school stands out as a reference in the quality of teaching and approval of students for higher education in the northern region of the state through the preparation for the National Secondary Education Examination (ENEM). It has been using since 2016, the Bernoulli System of handout material, from Elementary School to High School. As a pedagogical proposal, it focuses on teaching based on collaboration, respect, tolerance and understanding of reality. Its main function is to form citizens capable of living in a world of constant social, political and economic changes.

The Santo Antônio State Elementary and Secondary School, located in the Santo Antônio neighborhood, is a public school system, located at Copa 70 street, number 145, was founded in 1975 through Ordinance No. 3153 of 28/ 11/1975, with the act of approval and accreditation by the State Council of Education CEE/ES under number 41/75. It serves the following types of education: Elementary School II, High School, Youth and Adult Education and Vocational

Technical Course.

Its physical structure, consisting of a two-story building, has 16 classrooms, two educational computer labs with Wi-Fi signal restricted to pedagogical use, two science labs, resource room for specialized educational services (AEE), inner courtyard covered integrated to the cafeteria, external patio, an uncovered multi-sports court, auditorium, storeroom, secretariat, library, study room, teachers' room, pedagogues' room and bathrooms with accessibility for people with special needs. As it is an old building, the school does not have an elevator for wheelchair users, in order to ensure accessibility for this public, it allocates classes that have wheelchair users and those with other physical limitations in the classrooms on the ground floor.

In the administrative staff, the school has three pedagogues, four shift coordinators, two caregivers and two educational assistance teachers (AEE) to advise students with special needs and five school secretaries. The outsourced staff includes four lunch ladies, six cleaning assistants, two guards responsible for controlling the entrance and exit of the school community and monitoring the institution's surveillance cameras. We emphasize that the number of employees in the administrative and outsourced staff covers the three work shifts.

As a pedagogical proposal, it follows the Common Rules of Schools of the State Education Network of the State of Espírito Santo, which highlights in Title II - the purposes and principles of education the following orientation:

The participants in this research are three History teachers and 61 students from the 3rd grade of High School – last year, from the last stage of basic education in two public and private schools in São Mateus. For research applicability criteria, we considered limiting the researched subjects to the 3rd grade of high school. The questions were presented from a script so that the interviewees could reflect on the fundamental questions for our analysis.

The identification of research participants was optional, and in the universe of 64 participants, including students and teachers, only eight mentioned their names in the respondent's identification field. To guarantee the professional secrecy of the professors researched in this work, it was decided to identify them by numbers.

Of the 61 students interviewed belonging to the 3rd grade of high school, 28 students belong to the private education network and 33 students belong to the public education network in the city of São Mateus/ES. We emphasize that the researched public portrays different



social realities. In the private network, students have a study schedule with a study shift, monitoring offered by the school, wi-fi networks and didactic material with handouts with a digital platform accessible in various electronic media. The library, available in two shifts, has a library assistant and computers connected to the network available for research.

In the public network, students use textbooks as chosen by teachers through the National Textbook Plan (PNLD), guided by the Ministry of Education (MEC) and the wi-fi network is only allowed, in the specific case of this public school, as request of the teachers to coordinate the shift. As for the virtual learning environment, students can access the indications of virtual pages present in the textbook or access the page of the Secretary of State for Education (SEDU) in the Interactive Curriculum icon that offers an overview of content, videos, texts and animations on the contents provided for in the Common Basic Curriculum (CBC) of the state education system.

## VI. RESULT AND DISCUSSION

For the case study, we opted for a structured observation with observation sessions and the use of data collection instruments in two 3rd grade high school classes in the selected schools. In July, 2019, we started observing History classes using information and communication technologies; completing the observations in the first week of August 2019. The observation sessions are analyses, or verifications of the behavior of adolescents and teachers regarding the use of information and communication technologies in the schools observed.

The questions were answered by teachers and students in order to verify the degree of interest in using ICTs as a pedagogical tool in History classes. Of the various questions made available in the questionnaires, only a few were selected for data analysis and description.

History teachers and all students of the respective observed classes answered the questionnaire, applied with dates previously scheduled with the school management and pedagogical supervision of the mentioned schools. The planning time was the moment chosen by the teachers to respond to the survey. In this way, everyone belonging to this research universe could express their opinions on the requested approach. To guarantee the professional secrecy of the surveyed teachers, in the description of the class observations, it was decided to represent them by numbers.

In this context, I observed the fluidity of classes and the dynamics of planning when students use smartphones in an oriented way and the indications of the digital content platform in understanding the proposed

theme. The planning that combines digital media with theoretical content encourages creativity, criticality, diversity of views and understandings about the subject covered in class.

Regarding question 1 of the questionnaire applied to teachers, regarding academic training, all of them have a degree in History. Analyzing (Graph 1), it was found that 66% of the researched professors, that is, two professors, have a *lato sensu* postgraduate degree and only 34%, one professor has a *stricto sensu* postgraduate degree in the area of Human Sciences, discipline of History. In question 2 of the questionnaire, when asked where they concluded their graduation training, two teachers answered that they graduated from a federal institution and one teacher graduated from a private institution.

Questions 3 and 4 were directed to employment relationships and the teaching modalities in which teachers work. Responding to question 3, regarding the employment relationship, two teachers work simultaneously in the state public education network and in the private education network and only one, specifically, in the private education network. In question 4, regarding the type of teaching they teach, one works exclusively in high school and two work in elementary and high school.

In questions 5 and 6, we discussed the access/offer of training courses for the use of digital media in the classroom. Professor 1 reported that "the training is short, insufficient, the offer is small and in most cases they occur superficially, not being directed to our discipline. It is difficult to adapt the content taught to the digital media offered outside our didactic context. The school behind in relation to advances in technology, what we use are palliatives to make our classes more attractive.

Teacher 2 considered that the offers by the public network are permanent in the case of SEDU, made through access to the EAD Escolas Conectadas digital platform, in which registered teachers are informed by e-mail of the training schedule, but the courses are of short duration and encompass only training for the use of digital resources in general, not specifically covering the subject of History. We do training to be aware of changes, however in daily practice, it adds little as a didactic tool; we need changes in the pedagogical structure of schools. We cannot continue teaching with this traditional model, full of amendments to new practices, but plastered by material limitations.

Teacher 3, who works only in the private education network, emphasizes in her answer that the training offered by the private network meets the basic requirement to work with ICTs in the classroom, but because they are expensive courses and paid for by the interested party, there is no way maintain a frequency of

training in this area. I hardly find specialized formations in ICTs for the field of History. The digital formations offered by the educational material platforms adopted in the school I teach are directed towards the use of the material itself, and sometimes need to be adapted to the content I am working on.

For Bacich, Neto and Trevisani (2015), in the continuing education of teachers in Brazilian schools, both public and private, little has been developed in relation to new skills, especially those necessary for the intentional use of digital technologies in classrooms.

We evidence, according to the data exposed above, that in the new conception of learning, the teacher needs to show the student that there are different ways of building knowledge that go beyond the physical barriers of the classroom, therefore, continuing education in the area information and communication technology is of paramount importance for the pedagogical practice of teachers.

Regarding question 6, regarding the access of teachers in relation to training courses in digital media, we found that 67% of teachers, two teachers do not have access to training in digital media for applicability in the classroom and 33%, specifically one teacher, has access to training courses in digital media. In this way, we understand that teachers who have access to training courses can apply the knowledge acquired in the training process of their students, expanding the planning of their classes, using information and communication technologies aimed at the skills and competences necessary for the student's learning.

In question 7, we investigated the teachers' opinion about the possibility of a thematic history classroom, organized in a flexible way, with maps, images, books and notebooks with internet access.

Teacher 1 responded to the question saying that it is impossible to idealize thematic rooms in the public school system, due to the structure of the schools "There are not enough rooms for this type of organization, of course, if it were possible, it would be a great advance towards content learning. It is no longer up to us to be stuck in the textbook and in a plastered space. The thematic room allows the facilitation of the use of several methodologies adapted to the theme of the class, which would flow in a more pleasant and profitable way, the student could choose which tool to use to start their study.

Teacher 2 reported that she did not believe that this education model, with thematic rooms per curricular component, would soon be viable in the public school system. "I know of some public schools that try to implement this system, it is common in full-time schools,

but difficult in part-time schools, financial resources are minimal and physical spaces in schools are limited. But as for having thematic classrooms in my school, in the case of History, it would be the rebirth of the discipline, as I see that students lose interest in the subject because it is too theoretical and not very practical.

For Professor 3, who teaches exclusively in the private school system, in relation to thematic classrooms, she emphasized that "I like this concept of structuring, it would be very good if we had specific space for each discipline, but this is not the reality, the that we have today are adapted and shared spaces that we use according to our planning and availability of the rooms. I believe that, for the pedagogical practice, the thematic classrooms would be fundamental allies to technology".

As for the frequency of access to the Internet in the classroom, we applied this question to question number 8, of the questionnaire directed at teachers, and also, to question number 1, of questionnaire 2, applied to students. We found that the internet is a widely used information vehicle in the classroom, proof of this is that teachers and students access the web several times during the school term. Among the group of respondents, the category teachers has the highest percentage of accesses, around 99%, followed by the group of students from Colégio InPacto with 98% and with the lowest percentage, but no less relevant, we have students from EEEFM Santo Antônio with 87%. On the use of the internet, Brito and Purificação (2008, p.

Comparing the use of the internet between teachers and students in the schools surveyed, we can see that both are using the network frequently for pedagogical activities in the classroom, this fact demonstrates that a new educational model is needed.

The data obtained through the answers to question 2, of the questionnaire number 2, applied exclusively to the groups of students in the 3rd grade of High School of Colégio InPacto and EEEFM Santo Antônio, regarding the type of media most used to access the internet in the classroom. In the classroom, data referring to the responses of the 61 students interviewed were tabulated, with 85% representing 51 students using smartphones for research, 9% highlighting 6 students using tablets and 6% which is equivalent to 4 students using the Notebook for research.

The data tabulated from the answers to question 9, of the teachers' questionnaire and of question 5, of the questionnaire number 2, applied to students, show the form of media most used by students and teachers to access the research sites of the subject's contents Of history. We emphasize that this pedagogical practice refers to media access in the classroom.

According to Moran, we understand that digital media fit perfectly into the didactic practice of the classroom and that they walk together with students and teachers towards an educational process based on autonomy and objectivity.

Analyzing the group of 28 students surveyed at Colégio InPacto, we observed the preference for content offered in video classes with 38% of accesses, followed by educational websites with 29%, electronic book of Bernoulli teaching material with 27% and only 6% opting for the printed book. The group of 33 students surveyed from EEEFM Santo Antônio highlights their preference in 55% for access to video classes media, surpassing the first group of students from InPacto school in this option.

The second media option for students at EEEFM Santo Antônio are also educational sites with 23% access and 12% access to electronic books; it is noteworthy that the book is not offered in electronic form to students of the state education system, only electronic addresses contained in the textbook adopted by the PNLD of the current triennium so that they can have access to the content of the discipline, and finally, the printed book with 10% access surpassing InPacto college students in this option.

The 3 teachers surveyed are in divergence of option in relation to the two groups of students mentioned, the teachers prefer the electronic sites with 34% access, as it is from the consultation and evaluation of the content of the sites that they define in their planning the indications for the research/study of students, followed by 30% access to video classes media, previously defined for display/indication when consulting the material on electronic sites during the class.

In relation to the electronic book, teachers are in the middle between the two groups of students surveyed, with 22% of access, as they justify the fact that they need to frequently consult this material to develop assessment instruments and define exercises in the ENEM model. They surpass both groups in the printed book option, with 14% access, as this is necessary during classes. The printed book is used as a guiding object for planning/reviewing content, recording journals and other requests by the administrative part of the teaching units. According to Kenski (2008), teachers are the new architects of learning processes and need to show students that there are different ways to build knowledge.

Questionnaire 3, aimed at students, investigated the importance of teaching history in the last stage of basic education, the 3rd grade of high school. The production and transmission of historical knowledge involve power relations. Silva and Fonseca (2010) emphasize that power is consolidated in its historical forms of reproduction, that

is, legitimizing itself in schooled and socially accepted knowledge, materialized through the curriculum.

We can see that digital media gain space in relation to printed teaching material, this becomes a guide for pedagogical activities offering the basis for the study of the discipline and as a result of digitalization, we have a more attractive and enjoyable class.

Question 1 of Questionnaire 3 demonstrates the students' view of the importance of studying History. The teaching of History is responsible for the formative, educational, political and cultural role of students in line with the demands of today's society. For Silva and Fonseca (2010) "Borders, between-places, and mediations between the study and teaching of History in everyday school life must always be thought of in movement, linked to the social, political, economic and cultural context of the evolution of societies."

For 52% (17) students from EEEFM Santo Antônio and 44% (15) students from Colégio InPacto, the study of History is very important as it informs about the past, present and consequences for future generations, demonstrating the development of critical thinking in the face of changes historical events. For 37% (11) students from Colégio InPacto, followed by 28% (9) students from EEEFM Santo Antônio, the study of History is important and exposes themes from the past that are linked to our reality in politics, economics and culture. According to 20% (7) students from EEEFM Santo Antônio and 19% (2) students from Colégio InPacto, the study of History is of little importance since they do not consider the studies of historical facts close to the reality in which they live.

We understand that the discipline of History aims at the social formation of the individual in the context of the plurality of experiences. Studying History is to understand the process of change and permanence of societies. It is from the understanding of historical facts that the subject builds his social identity and becomes aware of his role as a transforming agent of reality and modifier of his environment.

Regarding the strength and power of curriculum direction, the curriculum proposal in the area of History in High School shows two discourses: economic and productive development focused on training the worker/consumer for the labor market and political training with the purpose for the exercise of citizenship. We observed from the data collected in question 1 that the subject of History is considered very important/important in some themes for 81% of the students at Colégio InPacto and for students at EEEFM Santo Antônio, it represents 80% as very important/important in some themes.

Therefore, we deduce that the teaching of History

in high school is a direct channel for transmitting ideas, knowledge and resistance, assuming the beacon of past issues intertwined with social facts of the present, and speculating future events.

Question 2 of questionnaire 3 refers to the didactics and practice of teaching History. Didactics has a decisive role in the teaching and learning process, it is considered a science that aims to know and expand the cognitive abilities of students. The didactic practice of History teachers throughout the structuring of the discipline, until the end of the 20th century, was marked by theoretical and repetitive content exposure. Didactics combined with technology and more flexible planning becomes a promise of revitalizing the classroom, however, two decades later, the changes are not very significant, the qualification offers in this area are limited and access to materials compatible with reality technology in this society is almost non-existent.

We realized, in the pedagogical practice of History teachers, that one way of motivating students to study the discipline is bringing the studied content closer to the reality experienced, in interdisciplinary activities, field research, use of digital content platforms and videos, debates, seminars, I encourage the creation of videos and podcasts on the subject studied. In this way, students associate theory with practice, making the study of the discipline and class dynamics more enjoyable.

Understanding the importance of identifying the reason for the students' lack of interest in the study of History, we asked in question 2 of questionnaire 3 what makes the History classes uninteresting according to the options in that question. Born from the 2000s onwards, in the era of the technological revolution, young people highlighted as the main reason for lack of interest in History classes is the little use of digital media with 39% (13) students from Colégio InPacto and 38% (10) students from EEEFM Santo Antônio the little use of technologies. The second reason for greater lack of interest is the content expository classes showing the dissatisfaction of 37% (12) students from Colégio InPacto and 31% (10) students from EEEFM Santo Antônio.

The lack of practical classes and the indication of reading many texts in the discipline of History appear with a low percentage and close to rejection in both groups of students surveyed. Freire (2011) highlights the importance of the teacher adapting the planning of his class to reality of the environment in which it is inserted, construction occurs through actions in an interactive process with social facts permeated with everything that can be extracted through exchanges of experiences, knowledge and knowledge.

Therefore, I understand that the students' lack of interest in the discipline of History is in the didactic practice used by teachers in their classes, reinforced through Freire's speech about teaching methods that must be in line with the reality of the world experienced by students. Students want to use technology in their training process as they use it for other daily tasks.

Questions 5 and 6 of questionnaire 3 applied to students investigated the optional choice of studying the subject of History in the high school curriculum. History is a science that studies the formation and advancement of societies over time, it is present in everyday life as a warning mechanism for human beings in their condition of transforming agent in the world.

In the answer to question 5, we detected that 68% (42) students surveyed would take the subject of History against 32% (19) students who would choose not to take the subject. The BNCC for the modality of high school, in the area of Human and Applied Social Sciences has the prerogative of expanding and deepening the learning developed up to the 9th grade of elementary school. Oriented towards ethical education, the area of human sciences, which includes the discipline of History, aims to train a full citizen, with ideals of justice, human rights, solidarity, understanding, respect for differences, encouraging interculturality and combating ethnic, religious, cultural and gender bias.

In question 6, the respondent was asked to justify his choice of choice in question 5. As a justification for 42 students taking the subject of History, answers were highlighted about the need to understand the economic, social and political context of society and 19 students justified who would not like to take the course due to the following factors: they prefer subjects with practical content, do not see such relevance in the study of history for everyday life, and are more skilled in the exact sciences.

Given the above, the research reveals that the use of technologies by students and teachers in History classes present a significant improvement in the teaching and learning process, giving new meaning to the study of the discipline and opening new perspectives for the applicability of the content in practical life. Through the variety of resources used in class planning, we notice the dynamism in which the themes take shape, the interest of students, the fluidity of the class, the critical sense in the face of converging/divergent points of view bringing the real world into the context of learning.

During the observation of classes we realized that the use of technology facilitates the development of historical content, however; the various forms of access to

content through technology do not replace the teacher's need. For students, the teacher represents the figure that safely guides the content, is the reference, the facilitator and mediator of the teaching and learning process. Technology is an ally, adapting itself according to the need for the development of activities proposed in the classroom.

Technology can keep any individual focused, when it exhausts the subject in one source, it searches for new sources until it reaches its training objective. For Gabriel (2014), there is no way to dissociate the technological evolution of society from teaching methodologies, technology combined with learning plays the role of adaptability to new social structures and preparation for the labor market.

Therefore, the practice of studying and teaching the subject History, as a curricular component, must adapt to the new times, it needs to seek methods that align the theoretical content with information and communication technologies. makes it clear that most students are interested in taking a course in History, but they want their practice to be aligned with technological resources so that they can experience the historical fact as close to the reality as experienced.

## VII. FINAL PRODUCT: CONTINUING TRAINING

Understood as a permanent process, continuing education ensures the improvement of knowledge necessary for the activity of educators for the curriculum component of History in the schools surveyed through their respective sponsoring networks: The Regional Superintendence of Education of São Mateus, responsible for EEEFM Santo Antônio; and the Bernoulli Group, a supplier of teaching material adopted by the InPacto school.

Within the scope of the São Mateus Regional Education Superintendence, we suggest that this moment of continuing education can take place during the school year, specifically in the pedagogical planning journeys (JPP) and during the area planning that take place at the beginning of each quarter. This moment, led by the SRE's pedagogical supervision team responsible for EEEFM Santo Antônio, has the function of guiding teachers on teaching methodologies using ICTs used by the State Department of Education (SEDU); and also direct History teachers to the continuing education available at the Education Professionals Training Center of Espírito Santo (CEFOPE). All History teachers from the State Education Network of SRE São Mateus will be able to participate in the continuing education, who work in the high school

modality. As for the content developed, it should be what is described in the Common Basic Curriculum (CBC) of History for the 3rd grade of high school in state schools, since this content encompasses all topics studied in the 1st and 2nd grade of high school, the 3rd grade being a content review moment.

At the InPacto school, we suggest that Continuing Training take place in line with the training offered by the Bernoulli teaching material adopted by the school, which takes place in person at two times of the school year: in the last week of January and at the return of the month's recess July. Bernoulli offers online training, in general, for the use of teaching material on the Bernoulli Teaching System platform and on the YouTube channel Bernoulli 360°. Our suggestion is that the school, as a partner company, may request the Bernoulli group to customize this training, offering training by teaching area and curriculum component through its pedagogical instructors, responsible for updating its teaching material.

## VIII. FINAL CONSIDERATIONS

The use of information and communication technologies in the 3rd grade of high school in the pedagogical practice of researched students and teachers has ensured a more significant and effective learning in the discipline of History. It is believed that teachers will only be able to exercise their educational role in the technological world if they know how to align theory with practice.

The use of cell phones, datashow, educational platforms with the variety of media resources available brings real life events into the classroom, and the school needs to evolve to keep up with these changes in a society in constant motion, permeated by technology. Access to the virtual field of content breaks the physical barriers of the school by opening new spaces for the production of knowledge, these spaces have been shared collaboratively by students and teachers who redesign the function of the classroom, making it more dynamic, critical and open to the variety of worldviews.

The approval of the Common National Curriculum Base (BNCC) for High School brings in its wording the use of teaching materials with technological support, providing the relationship between theory and the present time, teaching starts to rely on experiences outside the classroom, aiming at an approximation of the school-society relationship with the current moment. The direction of the Human Sciences curriculum, a discipline of History, proposed by the BNCC, leads to the formation of citizens able to face the diversities of the world of work and who know how to seek their learning autonomously in

a technological society.

Students and teachers face difficulties in accessing technological resources at times, and for this reason, the planning needs to be adapted for the conclusion of the class. The entire educational process must be thought of in the student's education, however; even with the setbacks of technology, there is a collaborative factor between students and teachers to execute the class proposal. Sharing and collaborating become watchwords in the educational process anchored by technology.

Another relevant factor throughout this research was the highlight, on the part of the professors, of the lack of offer of qualification courses in technologies for the area of History. They showed their dissatisfaction with the generalization of training and the lack of more complete and specific content platforms for the discipline of history. For the teacher, digital media are allied in conducting and executing their planning and the school needs to adapt to the new methodologies.

It is seen that the reproduction and repetition of content is losing space to the search for answers from different sources, which can be confronted, discussed, evaluated, rewritten, experienced through field class experiences and displayed in videos, podcasts, electronic books, museums and digital historical archives.

A change of attitude on the part of teachers in relation to the didactics of History is necessary. The redefinition of the study of History in the curriculum in view of the demands of this new society is not a simple task, it requires a look that transcends theoretical teachings, interacting the contents with the real needs of everyday life.

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# Analysis of the Mental Health of Professionals who Work on the Front Line of Combat by Covid-19 in an Early Care Unit in the City of Marataizes-ES

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**Keywords—** *Pandemic, UPA, Mental Health Promotion, Quality of life.*

**Abstract—** *The present work is the result of a research referring to “Mental Health Analysis of Professionals working in the Front Line to Combat COVID-19 in an Emergency Care Unit of Marataízes - ES”, because we experiencing a great pandemic With the new Coronavirus (SARS-CoV-2), whose disease is called COVID-19, which is highly contagious, being considered one of the great health challenges on the global scale. ItIt was carried out in an emergency care unit in the city of Marataízes-ES” with the objective of measuring the impact of COVID-19 on the mental health of Emergency Health Care Professionals (UPA) in the municipality of Marataízes - ES. The subjects of the research were 45 (forty-five) employees. It was a qualitative research, through bibliographic studies with field research. The results revealed that it is necessary that the health of these professionals needs attention, and should be associated with their physical, mental, emotional and social well-being. The Final Product elaborated was a booklet aimed at promoting the quality of life and mental health of health professionals in order to contribute to awareness and awareness to face the challenges, in view of the scenario of the pandemic of COVID -19.*

## I. INTRODUCTION

in the year 2020a new disease started in China and spread to other parts of the world, causing worry and fear. Brazil was also affected and as of March the first cases of the disease emerged, as well as measures to contain the pandemic with isolation decrees, and cases of collapse in health systems with large numbers of patients and deaths.

Despite providing various services in the services of the Emergency care unit (UPA), we know that health is experiencing a major pandemic with new Coronavirus (SARS-CoV-2), whose disease is called COVID-19, which is highly contagious, being considered one of the biggest challenges in health on a global scale, with implications on issues of a biomedical, epidemiological, provoking and

social fields such as: political, economic, historical and cultural. According to Teixeira et al (2020, p.6):“The Covid-19 pandemic has produced significant numbers of infected people and deaths worldwide. [...] by the new coronavirus, mainly affecting the American and European continents.”

Therefore, in the municipality of Marataízes – ES, it was no different, despite preventive measures having been adopted even before the first case occurred. The actions initiated aimed to reduce the impacts of the pandemic. But, unfortunately, the municipality has even reached the highest level. As a result, concerns and fear spread throughout the population and with the health professionals who are at the forefront of this pandemic. “Marataízes became the municipality most affected by the

Coronavirus pandemic in southern Espírito Santo. [...] The situation could have been worse, but measures that anticipated the problems were put into execution.” (The Fact, 05/20/2020)<sup>1</sup>

Given the above, we have a whole look at all these aspects, we sought to analyze in this study the mental health of professionals who work in the front line of the COVID-19 fight in an emergency care unit in the city of Marataízes-ES.

This study was justified by the fact that we are experiencing with great intensity in the world the Coronavirus pandemic that has caused cases of breakdowns in health systems and demanding measures to contain them. In Brazil, in the states and municipalities, laws, decrees and norms were emerging to protect the population and health professionals.

We know that humanity has historically gone through numerous pandemics such as: smallpox, measles, cholera, influenza caused by H1N1, H2N2, H3N3 in 1968-69 and by H5N1, in cycles repeated for centuries. the mental health of professionals who work on the front line to combat COVID -19 in different contexts of action and levels of exposure to the disease. Souza (2020, p.20) states that: “COVID-19 brought an impact on the lives of individuals at a global level, calling attention to the reach it had and the speed with which it spread”.

Thus, this research was carried out in the Emergency Health Care (UPA) of the Municipality of Marataízes - ES, having as Research Subjects, the professionals from the Emergency Health Care (UPA) of the Municipality of Marataízes - ES, whose Search Problem was: What is the potential impact on the mental health of professionals who work on the frontlines of the COVID-19 fight in an Emergency Room in the city of Marataízes-ES? In him 38 (thirty-eight) nurses work, 63 (sixty-three) nursing technicians, 05 (five) general practitioners, 02 (two) pediatricians.

It has 01 (one) orthopedic doctor who works every day as an immobilization technician. The dental service is offered every day of the week, from 09 (nine) to 21 (twenty-one) hours, focusing on emergency oral health and prioritizing workers who do not have access to administrative hours.

It also has the services of Laboratory, X-ray with fingerprint, electrocardiogram, urgent and emergency room, adult and pediatric medication station, as well as 25 beds (twenty-five) adult and 04 beds (four) pediatric rest,

in addition to 02 (two) isolation sectors, and also has removal services with 06 ambulances, with 24 (twenty four) hours service. Thus, a public health space for urgent and/or emergency cases, contributing for the population to have a healthy, full and quality life.

In this perspective, we believe in the fundamental role of UPA Health Professionals in this pandemic for health promotion. Therefore, under these circumstances, this research gave a dimension of their reality in the work environment and in their personal life, thus, an opportunity to seek to understand the different experiences in relation to this pandemic. That it made it possible to know the countless possibilities of actions that excel in the care provided to this specific segment of professionals, and also enable the performance of previous interventions in complicating physical, social and emotional situations.

In view of the above, this study is justified by trying to measure the proportion of the impact of COVID-19 on the mental health of professionals who work on the front line to combat COVID-19 in a UPA city of Marataízes-ES, permanently and with contact direct with the population allowing them to potentially detect diseases and trigger treatment and prevention measures in a timely manner in the numerous challenges.

## II. TWO-COVID-19: THE GREAT PANDEMIC

We are experiencing a major pandemic with COVID19, that means it is happening on a large scale the abnormal increase in people infected with Coronavirus known as SARS-CoV-2. This disease was officially declared by the World Health Organization (WHO) on March 11, 2020. Corroborating, Medeiros (2020, p.3) emphasizes that:

A person with a new coronavirus infection transmits it to two or three other people, depending on environmental conditions. Closed places with poor ventilation and low light facilitate the transmission of the virus. This transmission rate is called the reproductive number, which in COVID-19 varies between 2.0 and 3.5.

It is a disease that is transmitted through droplets and contact, especially in closed places and hospital environments, in addition to touch contaminated objects and then touch eyes, mouth and/or nose.

[...] the pandemic is experienced on a global scale, it does not mean that it is experienced in an equal, homogeneous, universal way. Despite Covid-19 being a disease with standardized biological

<sup>1</sup><https://www.jornalfato.com.br/cidades/marataizes-intensifica-combate-ao-coronavirus,357467.jhtml>. Accessed on August 11, 2020.



mechanics, the way the disease reveals itself socially is different and depends on a number of issues. (FIOCRUZ MINAS, 2020).

COVID 19 has the following symptoms: fever, nasal congestion, dry cough, muscle fatigue, sore throat, difficulty breathing, diarrhea and loss of smell. It is a disease that causes major complications in adults over 60 years of age and people with the following comorbidities: chronic respiratory diseases, diabetes, cancer and cardiovascular diseases, which can then appear more severe symptoms.

An important factor in the transmissibility of COVID-19 is the high viral load in the upper respiratory tract, even among pre-symptomatic patients, which distinguishes it from other respiratory diseases. In many individuals, particularly the elderly, the diagnosis of infection based on symptoms is more difficult: many do not have fever, have chronic cough due to other pathologies, or present dyspnea on exertion due to previous heart failure. In a nursing home outbreak in the United States of America, screening alone based on clinical symptoms failed to diagnose many elderly people with infection and was not sufficient to control the transmission of COVID-19. (MEDEIROS, 2020, p.3).

Coronavirus has an incubation period, that is, the time it takes between infection by the virus and the onset of disease symptoms, which range is from 1 to 14 days, however, it is around 5 days. This being the justification for the campaign of social isolation, in order to prevent the spread of COVID 19 due to pathogens from one place to another, which can go unnoticed in crowds at home, in clubs, on the streets, bus stations, airports, bus stations and others places. It is noteworthy that in addition, asymptomatic people infect others.

### III. THE IMPORTANCE OF EARLY SERVICE UNITS (UPA)

The Family Health Strategy (ESF) emerged to tune into the principles of universality and equity of care, with integrated actions aimed at defending the lives of citizens. It is fully structured for health care, carrying out new sectorial practices, aiming at the inseparability between health promotion and clinical work.

The World Health Organization (WHO), in its International Conference on Primary

Health Care (PHC), held in 1978 in Alma Ata, reaffirmed health as a fundamental human right. Furthermore, it advocated, as the most important global social goal to be achieved, the attainment of the highest possible level of health, which requires the action of many other social and economic sectors, in addition to the health sector. (CaSAPS, 2019, p.3).

This new strategy came to establish a new relationship between health professionals and the community in general, seeking to develop humanized actions, intersectorially articulated and with technical skills. That is, develop health actions based on knowledge of the local reality and the needs of a given population. It configures a new concept of work without the team members having a new form of bond that is different from the traditional biomedical model. (TEODOSIO; LEANDRO, 2020).

Health care allows for greater diversity of actions and seeks permanent consensus, as it is a relationship based on interdisciplinarity that values the permanent encouragement of communication between the team members in a horizontal manner. This required significant professional changes in the individual, family and community approaches for its effective implementation.

Therefore, there is the exercise of a new practice, built in a democratic and participatory way that starts from a solidary premise, which is capable of transforming people into true social actors, being subjects of the development process itself.

In this perspective, it seeks to favor as much as possible the approximation of the family health unit, so that they have access to services, establishing bonds between the team and its users. With this, the continuity of care increases through the co-responsibility of care, the ability to solve the most common health problems, and, consequently, producing a greater impact on the local health situation. According to Velloso et al (2016, p.5):

Collective health demarcates a broader conception than public health. The latter should be based on a collective health perspective, which is translated as a movement, an institutionalization process, which allows seeing the human being in its multidimensionality, only capable of being understood interdisciplinary, and whose action on it should be interprofessional.

For this, the Ministry of Health expanded its partnership with State and Municipal Health Secretariats for the development of Family Health. In its

implementation, it provided training opportunities to intensify the in-service qualification of the professionals who make up the teams. According to Oliveira et al (2015, p.239):

The Health System in Brazil is structured into three complementary hierarchical levels of health care – primary care, of medium and high complexity. Each of these components of the care network must participate in Emergency Care, respecting the limits of its complexity and resolution capacity. It is expected that the population in need of care can be welcomed at any level of care and referred to other levels when the complexity of the care required exceeds the service's capacity for assistance.

It is important to highlight that the organization of the teams' work is centered on the users' needs and continually seeks to improve the quality of services provided to the population. All of this has been consolidated as a strategy for the reorganization of Basic Health Units (UBS), in line with the Guidelines of the National Primary Care Policy (DPNAB).

The UPA is a service that is part of the National Urgency and Emergency Policy of the Ministry of Health, which was implemented in 2003, comprising the organized network of emergency care 24 (twenty four) hours with the objective of integrating attention to emergencies. Silva et al (2020, p. 30) state that:

Public health in recent years has been showing an increasing demand in the emergency service, due to users not starting their preventive care in Primary Health Care, the main gateway to the system. [...] indicates a significant number of users [...].

UPAs can be of 3 (three) sizes:

- Size I: is that unit that has a minimum of 7 observation beds, has an average service capacity of 150 (one hundred and fifty) daily patients; with a population in the coverage area of 50 (fifty) to 100 (one hundred) thousand inhabitants.
- Size II: is that unit that has a minimum of 11 (eleven) observation beds, has an average service capacity of 250 (two hundred and fifty) daily patients; with a population in the coverage area of 100 (one hundred) thousand to 200 (two hundred) thousand inhabitants.
- Size III: it is one that has a minimum of 15 (fifteen) observation beds, has an average service capacity of 350

(three hundred and fifty) daily patients with a population in the coverage area of 200 (two hundred) thousand to 300 (three hundred) thousand inhabitants.

In this scenario, the Emergency Care Units (UPAs) emerge as one of the strategies of the National Emergency Care Policy for better organization of care, articulation of services; and definition of resolving flows and references.<sup>3</sup> This strategy appears as one of the resolving initiatives for the problem of overcrowding in hospital emergencies. (OLIVEIRA ET AL, 2015, p.239).

They work 07 (seven) days a week, striving to resolve most of the emergencies that arise, such as fractures, pressure, cuts, high fever, stroke and heart attack. With this, they contribute to the reduction of queues in hospital emergency rooms.

It is noteworthy that they innovate by offering a simplified structure, with pediatrics, X-ray, electrocardiography, examination laboratory, in addition to observation beds, because when the user arrives at the units, they must be properly attended to, so that doctors provide assistance, aiming to control the problem and detail the diagnosis. After analysis, if necessary, they are referred to a hospital or kept under observation for 24 (twenty-four) hours.

#### IV. HEALTH PROFESSIONALS: CHALLENGES AND CONTRIBUTIONS

The Coronavirus Pandemic has spread to all continents, contaminated millions of people, and in Brazil, at the moment, we have more than 100,000 (one hundred thousand) deaths, in the State of Espírito Santo, we have:

The Holy Spirit registered until Sunday (9), 2,735 deaths by Covid-19. The number of confirmed cases reached 91,791. The disease lethality rate in the state is 3%. The data were released on the Covid-19 Panel Platform, of the State Government, has affected the entire society and increased the discussion in the health area. (08/09/2020).<sup>2</sup>

As a result, we are living in the midst of the most recent pandemic that has contributed to the growth of the crisis in the health of the population and health

<sup>2</sup><https://g1.globo.com/es/espírito-santo/noticia/2020/08/09/es-chega-a-2735-mortes-e-91791-casos-confirmados-de-coronavirus.ghtml>. Accessed on August 12, 2020.

professionals who are at the forefront of this battle. ANDexposed to the risks of the new Coronavirus, who need good working conditions, care, protection and safety, as they are the first to suffer the impacts of this pandemic. It is worth highlighting the activity of researchers who seek to develop a vaccine against this virus as quickly as possible.

The State Health Department (SESA) issued Ordinance No. 129-R, published in the Official Gazette of the State of Espírito Santo last Saturday, July 4th, with the new classification map of the risk of contamination by the new Coronavirus in the municipalities of Espírito Santo . According to the new mapping, which came into effect this Monday, July 6th, the Municipality of Marataizes remains classified as High Risk of contamination. This means that the Municipality must continue to adopt all preventive and combat measures against Covid-19 provided for by the legislation relating to the pandemic.<sup>3</sup>

Given the above, it is clear that the city of Marataizes-ES, has a big increase in the number of people seeking the services of the Basic Health Unit (UBS) and Emergency Health Care (UPA), has worried everyone, and with that, there are discussions about when and what services to seek according to the problem and the degree of health presented by the patient.

The Mayor of Marataizes, [...] inaugurates [...] the new Family Health Strategy (ESF) Cidade Nova “Francisco Benício Leite”, which will serve around 6,430 people. This will be the second ESF unit inaugurated this year by the current administration, the first was in June, in Barra de Itapemirim. [...] objective is to increase and improve the coverage of the ESF to the population. “We identify where there is a greater demand for service and where it is also necessary to improve service even further, bringing quality of life and comfort to our residents. Some families need to move to units far from their homes and with the re-

mapping, we bring the service closer to citizens.”, explains the secretary.<sup>4</sup>

It cannot be denied that it is professionals and health workers who are directly and indirectly involved in dealing with the pandemic. Thus, they are very exposed to the risk of Coronavirus contamination, as they are the different workforces needed in this pandemic, involving the various categories of these professionals. Authors claim that some problems in these professionals have increased, such as:

Problems such as increased physical fatigue and psychological stress, insufficiency, and/or negligence with regard to the protection and health care measures of these professionals, moreover, do not affect the various categories in the same way, and it is necessary to pay attention to the specifics of each category, in order to avoid reducing their work capacity and the quality of care provided to patients. (REDECOVIDA, 2020, p.4).

Therefore, it is extremely important to be concerned with protecting the health of these health professionals, because it is necessary to avoid complications caused by COVID-19. Hence the importance of adopting clinical care, such as control protocols and adequate availability of Personal Protective Equipment (PPE), which are: masks, coats, eye protection, gloves, boots, aprons, gloves, sunscreen and other protective items at your workplace.

Therefore, we must consider that health professionals not only deal with the issues that already afflict the rest of the population, but also suffer a greater risk of exposure to the disease, more intense work shifts, transfer or changes in their work environment and dilemmas morals.<sup>5</sup>

We know that the new Coronavirus, made people distance themselves to prevent the spread of the disease. However, not all of them were able to isolate themselves, including health professionals, who, due to their work in combating the pandemic, are on the front lines. In this context, health professionals face numerous problems, including:

<sup>4</sup><https://www.marataizes.es.gov.br/noticia/ler/2718/prefeitura-de-marataizes-inaugura-esf-cidade-nova-nesta-quarta-feira-24>. Accessed on August 13, 2020.

<sup>5</sup><https://pebmed.com.br/a-ansiedade-nos-profissionais-de-saude-durante-a-pandemia-pela-covid-19/>. Accessed on August 11, 2020.

<sup>3</sup><https://www.marataizes.es.gov.br/noticia/ler/3309/covid-19-marataizes-permanece-na-classificacao-de-alto-risco-de-contaminacao>. Accessed on August 12, 2020.

The main problem is the risk of contamination of professionals, which has generated absence from work, illness and death, as well as producing intense psychological distress, which is expressed in generalized anxiety disorder, sleep disorders, fear of falling ill and contaminating colleagues and relatives. (REDECOVIDA, 2020, p.2).

Given all this, health professionals have to work, experiencing rapid spread of the disease, patients with severe symptoms, in addition to great concerns with the health systems themselves in dealing with the demands that involve the number of beds and availability of respirators. Hence the need to assess and reflect the conditions that these health professionals must have to exercise their functions. The author Medeiros (2020, p. 3) discusses that:

Data from the teams of health professionals on the front line of care for COVID-19 cases show physical and mental exhaustion, difficulties in decision making and anxiety due to the pain of losing patients and colleagues, in addition to the risk of infection and the possibility of transmit to family members.<sup>(3)</sup> Thus, ensuring medical care for health professionals and psychological support are essential. Likewise, perform diagnostic tests on the symptomatic quickly.

It is extremely important to map the related characteristics of the work of these professionals in the midst of this pandemic, as well as the initiatives that are being carried out and the challenges faced by them, to do so, identify the coping strategies used by them.

## V. METHODOLOGY

This research included based bibliographic studies in articles, dissertations and theorists that address the theme, which contributed to a reflection, from which it was possible to obtain information about the mental health of Health Professionals working in the Covid-19 pandemic scenario that in the current historical context in which we are inserted. , it becomes necessary to study the problems and the weaknesses they face.

This was a survey This qualitative study aimed to analyze the mental health of professionals who work on the frontlines against COVID-19 in an emergency care unit in the city of Marataízes-ES. According to Santos et al (2018, p.14):

The search qualitative is demarcated by a strong humanistic, interactional and empathic factor. [...] Due to the characteristics that constitute qualitative research, it is constantly questioned regarding its scientific rigor. [...] of qualitative studies involving different perspectives, used not only to increase their credibility, by implying the use of two or more methods, theories, data sources and researchers, but also to enable the apprehension of the phenomenon at different levels, considering, in this way, the complexity of the objects of study.

For its development, the questionnaire instrument was applied to the participating subjects. According to Bernd; Anzilago (2019, p.18): “[...] questionnaire is a data collection instrument represented by a series of ordered questions presented in different ways (open, closed, multiple choice)”. This gave analyze and understand the perceptions of mental health of Health Professionals and faced against the scenario of the Covid-19 pandemic.

## VI. RESULTS AND DATA ANALYSIS

The data collected from the 45 (forty-five) employees were tabulated and analyzed using descriptive statistics of the variables, aiming to identify the profile of the sample and all the data, where it was possible to see that the team has a significant number of young professionals, that is, from 18 to 30 years of age, the team has a good level of education, and

almost half have very little time of experience, but they work together with a group with great experience in the area of Health.

We realized that almost half have very little time of experience, but they work together with a group with great experience in the area of Health and that there was an increase in the number of professionals to meet the demand, and more knowledge about the Coronavirus was acquired at work, but communication was also a significant target about it.

It was clear in the survey that the work was cited by the participants as the largest provider of knowledge of Coronavirus, followed by the awakening of reading, the interest of each health professional to the new, followed by the media (TV) which also represents a significant target on the same. It became clear that it is a work team that has healthy health, but almost half of the UPA employees had symptoms of Covid 19, as almost half of the UPA

employees during this period of the research had already contracted Covid 19. The Nursing Council states that in relation to nurses:-material information about Coronavirus and what the precautionary measures that are adopted in your work environment are those of l.avaagem of hands, oronly 70% alcohol gel, and Personal Protective Equipment (PPE).

Protecting the health of health professionals, therefore, is essential to avoid complications from COVID-19, as well as the adoption of clinical care, with clear infection control protocols (standard, contact, airway) and adequate availability of PPE in your workplace, including N95 masks, aprons, eye protection, shields and gloves. In addition, the concern with the mental health of health professionals and workers emerges, due to the stress they are subjected to in this context. (REDECOVIDA, 2020, p.4-5).

We realized that the biggest concerns of Health professionals in relation to the COVID Pandemic 19 is to be exposed to the disease and transmit it to their families.

Professionals and health workers directly and indirectly involved in fighting the pandemic are daily exposed to the risk of becoming ill with the coronavirus, and the heterogeneity that characterizes this contingent of the workforce determines different forms of exposure, both to the risk of contamination and the factors associated with the working conditions of the different professional categories. (REDECOVIDA, 2020, p.4).

There were numerous comments from participants in relation to the challenges faced in working against the COVID-19 Pandemic scenario. For example: "At the beginning of the pandemic, we faced many professionals who were unprepared and panicked and with little work material; respirators, we only had two, and the people do not protect themselves, even with so many deaths." (Employees 44). "[...] there are several: emotional, overload, lack of vacancies for patients, little knowledge about this disease that is new to us so far, among others..." (Staff 12). Thus, according to REDECOVIDA (2020, p.2):

The main problem is the risk of contamination of professionals, which has generated absence from work, illness and death, as well as producing intense psychological distress, which is expressed in generalized anxiety disorder, sleep

disorders, fear of falling ill and contaminating colleagues and relatives.

It was very clear that there is a need for urgent measures both in the work environment and in the emotional aspects of employees, as well as improvement in the work for the prevention of COVID-19, as the approaches were numerous, it is worth noting: "It should only offer a closed hospital for Covid, treatment and hospitalization, I see it's mixing a lot. Surveillance is not contacting patients. " (Employees 21). "Continuous training and better information for working professionals." (Employees 5). As well as: "More guidance on the subject to continue using PPE and not relax, because this disease is terrible and takes us by surprise." (Employees 44). Among others, the need to receive more guidance is noticeable.

Therefore, [...] infection control measures among teams of health professionals, proposals for change in the organization of the work process, in the training of personnel and in the protection and assistance to the mental health of health professionals, concluding with a set of recommendations to managers of health institutions and services in order to support the adoption of measures to promote, protect and assist the health of professionals and workers who are at the forefront of the fight against the pandemic. (REDECOVIDA, 2020, p.2)

In relation to challenges to maintain its balance against the COVID-19 Pandemic scenario, there were numerous approaches, which we highlight: "We are courageous and ethical[...] I have never seen so much suffering, finally, and continue to help and suffer together with the population who suffers. This for me was the biggest challenge." (Employees 36). "A look like all health professionals in Brazil, where they are so devalued by the government of our country [...]." (Employees 12). According to CONASEMENS (2020, p.7):

We are going through an unprecedented crisis in the history of the Unified Health System. As if not enough so many challenges faced in daily life, now with the Covid-19 pandemic, we have to deal with this acute and serious situation, causing an even greater burden and abruptly for our healthcare system. The moment requires tranquility, planning and a lot of solidarity and collaboration.

All of this made it possible to realize the urgent need for improvement measures for the health of the

Brazilian people in general and also for the professionals who work in it.

## VII. FINAL CONSIDERATIONS

We know that in 2019, the disease started in the world caused by a new coronavirus, Sars-CoV-2 that was discovered in China and this was called COVID-19, which ended up spreading very quickly around the world and with a very high rate of contagion and mortality. Being the target of this study.

During the course, it was possible to analyze the mental health of professionals who work on the front line to combat covid-19 in an emergency care unit in the city of Maratáizes-ES, which made it possible to realize the importance of health, as it is a fundamental human right, which was advocated by the United Nations (UN) and the World Health Organization (WHO)

This pandemic invites everyone, especially health professionals to question, discuss and reflect on the role of health, the patient's rights and their own right. Not least because, since the promulgation of the 1988 Constitution, it has been recognized as a good for every citizen.

It was noticeable in this study the need to understand the functioning of the UPA, which was the locus of this research, considering the context of the health system, its employees and attention to the emergencies in which it is inserted. Therefore, it should strive for a work of humanization of practices and attention to it, especially those linked to public health.

Therefore, the results of this study revealed the importance of integrated planning and the reformulation of some components of the care network and especially the lives of employees in the Health area. Thus, this research, in addition to providing space for these professionals, provided an opportunity for analysis and discussion and presentation of propositions by all involved actors.

It is expected, therefore, to contribute to decision-making, management and implementation of actions in health services that will meet the demands, concerns and perceptions of everyone involved in the process. Therefore, we believe it is possible to mature the reflections proposed here in order to seek ways to rethink and develop the quality of life and mental health of the UPA health professionals in all its dimensions.

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# Aggregates and organic matter stability in soils submitted to different temperatures in West Bahia, Brazil

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**Keywords**— Soil structure, Soil quality, Forest fire, soil management.

**Abstract**— Estimates indicate that about 30% of the planet's surface suffers from seasonal fires. In Brazil, in the first half of 2020 these numbers already reached 62.402 km<sup>2</sup> equivalent to 0.7% of the national territory. Due to the high temperatures that fire can reach on agricultural land, this practice can have negative consequences for the physical, chemical and biological properties of the soil. In this study four soil classes were obtained (Red Yellow Argisol, Haplic Vertisol, Red Yellow Latosol and Haplic Cambissol) predominant in the Western region of Bahia. Four samples were removed by point and then were taken to carry out analyzes at the Soil Physics Laboratory of the University of the State of Bahia. After preparing the sample, the aggregates were placed in a petri dish and then were subjected to firing in a muffle oven at temperatures of 100, 200, 300, 400, and 500°C. After cooling for 24 hours inside the muffle, they were placed in the appliance Yoder to carry out analyzes related to soil aggregation. The results showed that soils with a higher percentage of organic matter obtained the best aggregation results, as already presented by several authors. Regarding the temperature variation, when subjected to combustion at 200°C, the soil presented a decrease in aggregation compared to the ambient temperature. However, lower averages were observed in those submitted to 300°C with the exception of the MiAg variable. The increase in soil temperature changed the distribution of aggregates mainly in classes with a diameter smaller than the class of 1 <Ag <2 mm).

## I. INTRODUCTION

Forest fires are natural phenomena common to tropical, temperate and boreal regions. These phenomena have undergone modifications in their behavior due to global changes, which directly affect fertility and structure of soils as well as their management and sustainability (Bento-Gonçalves et al., 2012; Lopes and Machado, 2017). It is also known that the conservation of soil vegetation cover promotes the diversification of microorganisms (suppressiveness), inhibiting the development of soil diseases and prolonging their sustainability (BETTIOL E GHINI, 2005; LOBMANN et al., 2016).

Chuvieco and Giglio (2008) state that more than 30% of the earth's surface suffers from the presence of seasonal fires. In Brazil, in 2020, fires had already reached an area of 312.140 km<sup>2</sup> (3.67% of the Brazilian territory). Among the Brazilian biomes, the cerrado was the most affected by forest fire this year. In this period, 139.644 km<sup>2</sup> were burned, which corresponded to 44.74% of the burned area in the country (INPE, 2020).

Chen et al. (2016), state that clay soils, when subjected to temperatures above 100 °C are influenced by their morphological characteristics, highlighting those of a physical nature. Campo et al. (2014) when studying macro- and micro-aggregates of soils subjected to different

temperatures, identified that these physical attributes are interfered with the temperature rise at the maximum threshold of 750 °C where macro-aggregates are able to regenerate but with erosive tendencies due to their low stability.

Chen et al. (2012), when conducting studies on fire behavior in boreal forests, concluded that fires generate direct consequences on the stability of aggregates and on soil organic carbon. Nunes et al. (2019) found a decrease in the aggregation of Red Yellow Latosol subjected to high temperatures in a similar work on Brazilian cerrado soils. For Badía Villas et al. (2014) soils submitted to open air combustion reduced water repellency and aggregate stability up to 2 cm in depth with different intensities depending on the properties of each soil.

Soil aggregation can be hierarchical by organic binding agents, such as: (a) transient, mainly polysaccharides, (b), temporary, fungal roots and hyphae (c) persistent, resistant components associated with polyvalent metallic cations and polymers strongly adsorbed to soil particles (TISDALL AND OADES,

1982). Therefore, the stability of aggregates in soils subjected to fire is more susceptible to changes in soil organic carbon than in organic molecules contained in macro aggregates (CHEN AND SHRESTHA, 2012).

After a high-intensity fire, the organic matter content is in general, negatively affected to the surface horizons. However, in low intensity fires the soil organic matter content can increase due to the contribution of plant material (MINAYA, 2013).

Based on exposed above, this work aimed to evaluate the effects of different temperatures in four classes of soils in Western Bahia on the stability and diameters of aggregates and organic matter.

## II. MATERIAL AND METHODS

### Location and characterization of the area

The samples were collected in four municipalities in the west of Bahia in places chosen according to the soil class. Table 1 shows the location of the areas, municipality, current land use and geographic coordinates.

Table.1: Municipality, current land use and geographic location of the studied areas.

Município	Current Use	Latitude	Longitude
Barreiras (PVA)	Fallow	12°08'34,69" S	44°57'41,87" O
Riachão das Neves (VX)	Pasture	11°58'54,57" S	44°57'38,99" O
Luís Eduardo Magalhães (LVA)	Permanent preservation area (APP)	12°06'16,00" S	45°20'20,20" O
Barreiras (CX)	Jatropha	12°08'37,29" S	44°57'48,94" O

The climate of the region, according to Koppen's classification, is of the Aw type (rainy tropical) with rain from October to April and dry period from May to September with an average annual temperature of xxx °C and rainfall ranging from 800 to 1800 mm in the far west of the state (AIBA, 2012).

The evaluated soils were classified as Red Yellow Ultisol (Ultisols), Haplic Vertisol (Vertisols), Red Yellow Latosol (Oxisols) and Haplic Cambisol (Inceptisols), whose particle size and organic matter (OM) are shown in Table 2.

Table.2: Composition of the particle size of the study areas

Soil	Sand	Silt	Clay	OM
	.....g kg <sup>-1</sup> .....			g.kg <sup>-1</sup>
RedYellowArgisol(PVA)	590,02	187,44	222,50	26,84
HaplicVertisol (VX)	418,14	394,64	187,22	17,01
RedYellowLatosol (LVA)	831,58	45,41	122,01	19,12
HaplicCambisol (CX)	765,55	170,03	64,31	17,85

### Sampling and experimentation

For the physical characterization and determination of organic matter (OM) of the soil, samples were collected randomly in the previously chosen areas (Table 1) at a depth of 0.00 to 0.20 m with the aid of a cylinder with a capacity of 0.001 m<sup>3</sup>. Analyzes were

performed at the Soil Physics and Chemistry Laboratory of the State University of Bahia (UNEB).

The determination of granulometry was performed using the pipette method (Embrapa, 2017). Aggregate stability (Ag) was obtained by wet way. In the separation of aggregates by wet way, the procedure of



Kemper and Rosenau (1986) was adopted. In water sieving in the Yoder apparatus were used a set of mesh sieves of 2.00; 1.00; 0.50; 0.25 and 0.106 mm Samples of 50g of aggregates were pre-wetted by capillary action and transferred to a set with the five sieves mentioned above. They were subjected to vertical agitation for 15 min and immersed in a container with water. The soils retained in each sieve were taken to an oven at 105 °C for 24 hours. Then, the mass of water-stable aggregates in each diameter class was weighed and calculated. Weighted mean diameter (MWD) and geometric mean diameter (GMD) values were obtained according to expressions 1 and 2, respectively.

$$MWD = \sum_{i=1}^n (xi \cdot wi) \dots\dots\dots eq. 1$$

Where: xi = average diameter of the aggregate classes;

wi = proportion of each class in relation to the total.

$$GMD = (\exp \sum_{i=1}^n (wp \cdot \log xi)) / (\sum_{i=1}^n wi) \dots\dots eq. 2$$

Where: wp = weight of the aggregates of each class in grams;

xi = mean diameter of aggregate classes in grams;

wi = proportion of each class of aggregates in relation to the total.

An aliquot of each sample was transferred to petri dishes that withstand high temperatures and prevent overlapping between aggregates. These samples were subjected to the following treatments: control (room temperature at 25°C), 100, 200, 300, 400 and 500 °C, heated in a muffle oven for 10 min. After this procedure, the samples were left to rest for 24 hours to assess the stability of the aggregates in water.

Aliquots of macros (MaAg) and micro aggregates (MiAg), removed after being subjected to treatments, were placed in a crucible and macerated in order to obtain smaller particles that were passed through an 80 mm mesh sieve. The organic matter (OM) content was estimated based on the total organic carbon (TOC) according to the method described by Embrapa (2017).

Qualitative data were subjected to analysis of variance and means were tested by Tukey's test ( $p < 0.05$ ) and quantitative data by regression. The computer program AgroEstat (2019) was used to perform the analysis of variance and to the regression, the software SigmaPlot 12 (2011) was applied.

### III. RESULTS AND DISCUSSION

#### Distribution of aggregates at each temperature

Initially, for all temperatures considered, there was a greater distribution in the class of aggregates greater than 2 mm ( $Ag > 2$  mm) in all soils, regardless of

temperature. It is noteworthy in this class of aggregates that VX presented the lowest values at temperatures of 200 and 300 °C, while CX decreased at temperatures of 400 and 500 °C. In the other classes of aggregates, these soils showed a tendency to increase at these same temperatures (Figure 1).

In general, the increasing variation in temperature did not change the stability of aggregates larger than 2 mm except for Vertisol and Cambisol. In the other classes of aggregates, there are significant differences ( $p < 0.05$ ) in the temperatures such as: 100 °C between the PVA and the soil VX, LVA and CX, 200 and 300 °C between VX and PVA, LVA and CX, 400 °C and 500 °C between CX and the other soils in classes of  $1 < Ag < 2$  mm,  $0.5 < Ag < 1$  mm,  $0.125 < Ag < 0.5$  mm. In the class of  $0.106 < Ag < 0.125$  mm, there is a difference in LVA at 100 °C, in PVA and LVA at 300 °C, PVA, VX and LVA at 400 and 500 °C, all presenting the lowest values. For  $Ag < 0.106$  mm, at temperatures of 25, 100, 200 and 300 °C, VX was different from other soils, showing the highest values.

In classes of  $1 < Ag < 2$ ,  $0.5 < Ag < 1$ ,  $0.125 < Ag < 0.5$ ,  $0.106 < Ag < 0.125$  and  $Ag < 0.106$  mm, there is a tendency to increase the percentage of aggregation when compared with the results of ambient temperature, mainly in PVA (100 and 200 °C), VX (100, 200 and 300 °C) and CX (400 and 500 °C) soils. This could have happened due to the Ca<sup>2+</sup> content of these soils, which makes them more resistant to hydration (Nunes et al., 2019). The LVA, on the other hand, presented a drop in these percentages with the increase in temperature, results that are similar to those of previous authors who also worked with the Red Yellow Latosol and found that for the native cerrado soil the temperature caused a reduction in the percentage of aggregates greater than 2 mm.

#### Weighted average diameter, geometric average diameter, macro aggregates and micro aggregates as a function of temperature

In all studied soils, there is a tendency for the MWD, GMD and macro aggregates (MaAg) variables to decrease as the temperature increases to a certain value, except for the LVA soil in which these attributes behave inversely proportional the rise in temperature (Figure 1). For micro aggregated variable (MiAg), the curves behave inversely to the previous variables. Another fact that stands out is that, as equations that describe these relationships, they were important as a function of temperature for MWD in PVA ( $p < 0.11$ ) and LVA ( $p < 0.01$ ) soils, in the GMD and MaAg variables only in the soil LVA ( $p < 0.01$ ) and no MiAg in PVA (0.10) and LVA ( $p < 0.05$ ) soils.

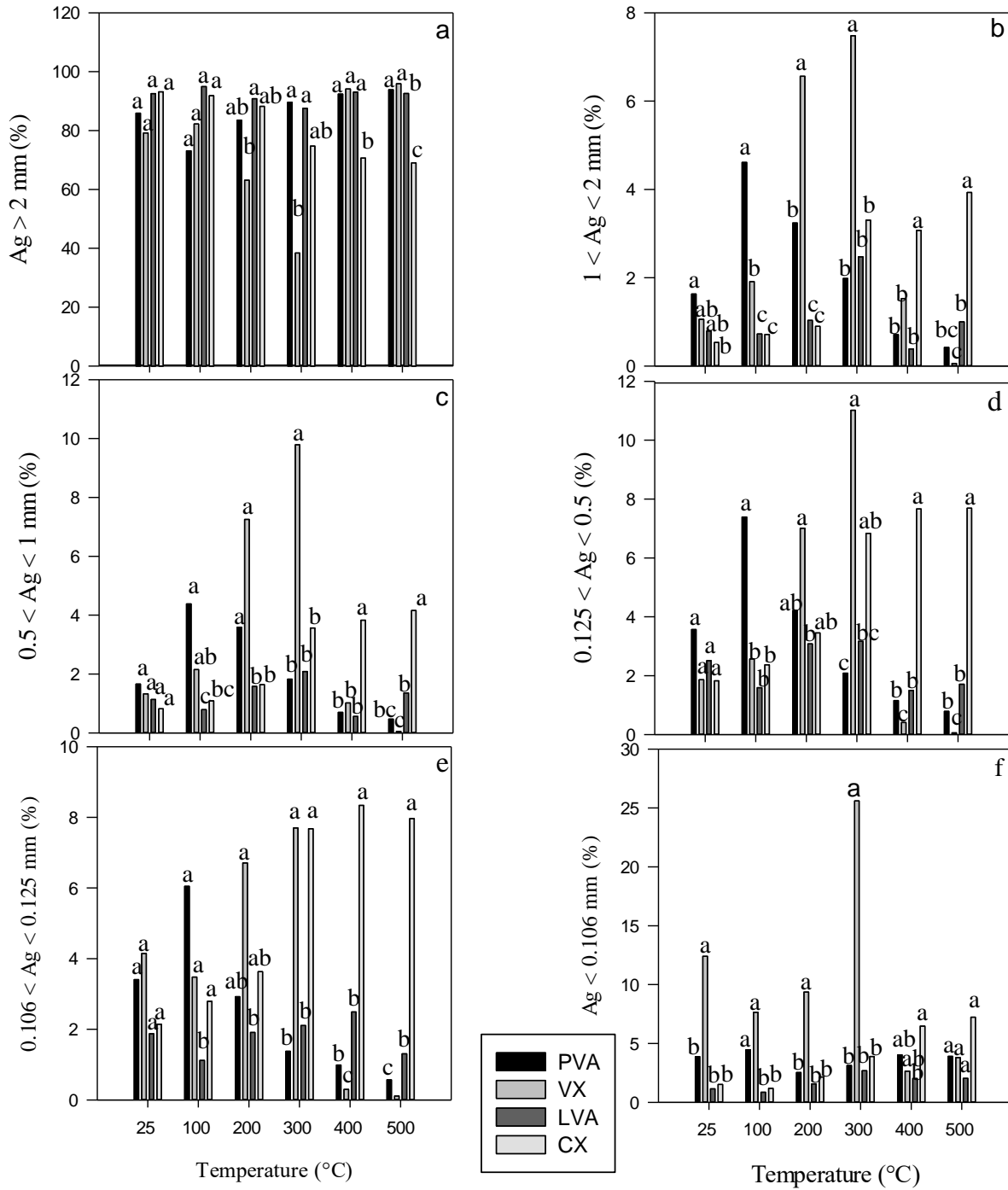


Fig.1: Distribution of stable aggregates in water at different temperatures.

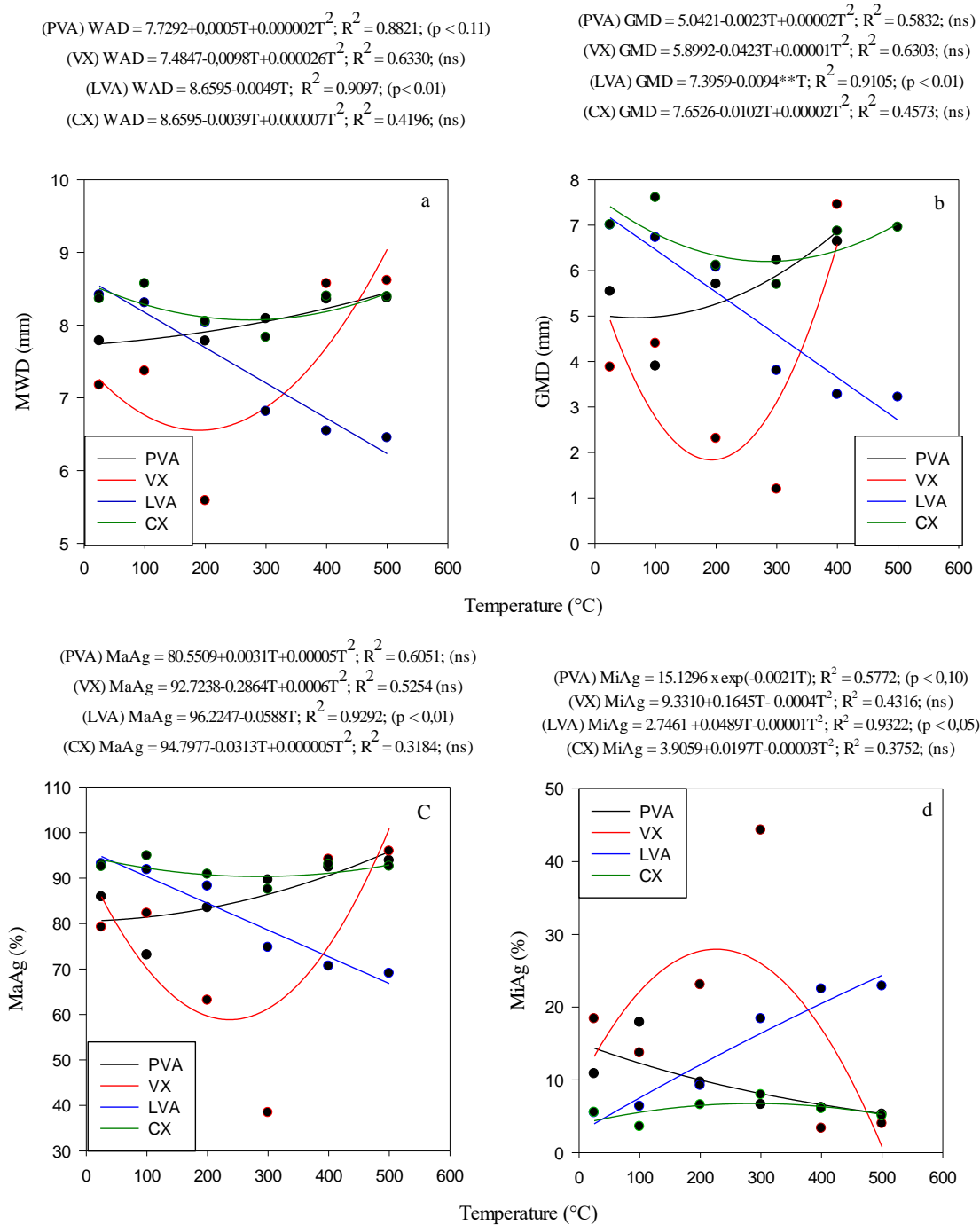


Fig.2: Weighted mean diameter (a), geometric mean diameter (b), macro-aggregates (c) and micro-aggregates (d) as a function of temperature.

The results of MWD, GMD and MaAg for PVA, VX and GX soils were similar to those found by Thomaz (2011), especially from the temperature of 200 °C for Canada Chernosol with wet sieving. When soils are subjected to a temperature of 200°C, the destruction of cementing agents occurs, affecting the larger aggregates. This effect influences the values of MWD, GMD and MaAg.(Mataix-Solera et al., 2011; Thomaz et al., 2017).

The increase in the stability of aggregates from certain temperatures was already observed by Thomaz and Fachin (2014), when they raised the temperature from 550 to 650 °C despite the decrease in organic matter. For LVA in this temperature range, MWD, GMD and MaAg described a decreasing curve as a function of soil temperature. As this soil is located in a permanent preservation area, where there is a predominance of bioenic aggregates, it may have favored an inverse

relationship between temperature and these attributes. This occurred with the work by Nunes et al. (2019) in which they found a similar relationship for forest soils. In addition to altering soil aggregates, Thomaz (2017) warns that fire in agricultural areas can harm soil chemistry, biology and fertility.

**Organic matter (OM) in macro aggregates (MaAg) and micro aggregates (MiAg) as a function of soil temperature**

The relationship between organic matter and temperature variation in all studied soils describes a

(PVA)  $OM = 32,4876 \exp(-0,0038 T); R^2 = 0,7655; (p < 0,05)$   
 (VX)  $OM = 13,21 \exp(-0,0029 T); R^2 = 0,8219; (p < 0,05)$   
 (LVA)  $OM = 34,36 \exp(-0,0047 T); R^2 = 0,9240; (p < 0,01)$   
 (CX)  $OM = 30,43 \exp(-0,0045 T); R^2 = 0,8542; (p < 0,01)$

decreasing and significant exponential function for both macro aggregation and micro aggregation with probability ranging from 0.01 to 0.10 (Figure 3). It is also observed in Figure 3a, for MaAg that the PVA, LVA and CX soils formed a group with curves in which they presented higher organic matter content compared to VX. However, in all soils there is loss of organic matter with increasing temperature, converging to values similar to 500 °C. In a similar work, Thomaz (2017) found that a temperature of 250 °C with 15 min duration was sufficient to reduce OM. In the ether hand, Thomaz et al. (2014) did not observe the effect of fire on soil organic depletion in the surface layer.

(PVA)  $OM = 28,30 \exp(-0,0038 T); R^2 = 0,7896; (p < 0,05)$   
 (VX)  $OM = 14,93 \exp(-0,0017T); R^2 = 0,5139; (p < 0,10)$   
 (LVA)  $OM = 12,34 \exp(-0,0033 T); R^2 = 0,8200; (p < 0,05)$   
 (CX)  $OM = 12,43 \exp(-0,0035T); R^2 = 0,7471; (p < 0,05)$

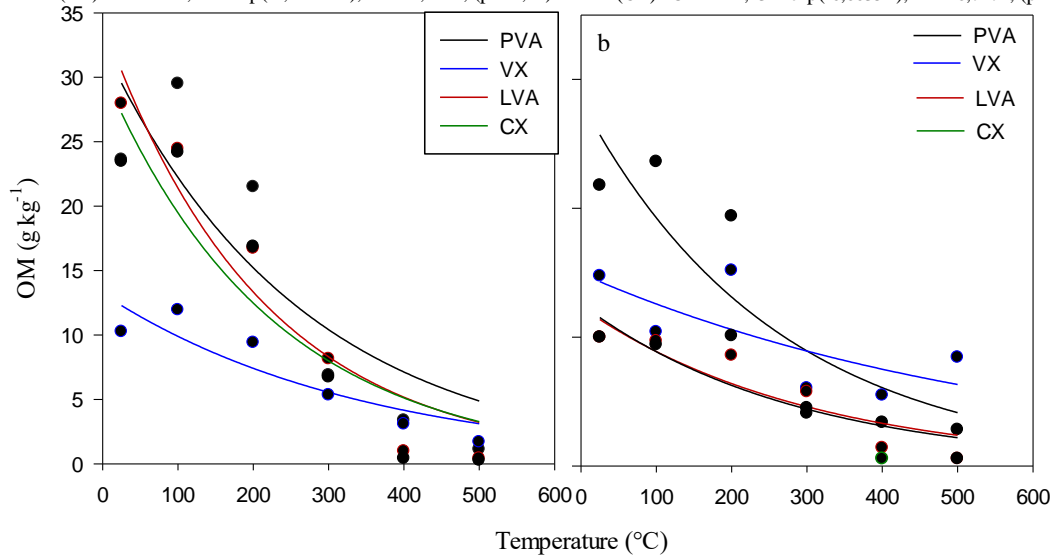


Fig.3: Effect of increasing temperature variation on soil organic matter in macro (a) and micro-aggregates (b).

Figure 3b shows the soil OM as a function of temperature for the MiAg in the four evaluated soils. It is verified that the highest organic matter contents in micro aggregates are in PVA and VX soils, while LVA and CX presented similar contents. These results are different for typical orthic chromic luvisols and typical orthic hypochromic luvisols in which temperatures above 400°C, even with longer exposure to heat, there were higher values of total organic carbon, especially in aggregate class of smaller diameter. This occurs because organic matter is retained within the aggregates, especially in soil micro aggregates (Silva et al. 2010). On the other hand, Chen et al. (2016) state that temperatures above 100°C, depending on the duration, can already cause a reduction in organic matter and changes in clays.

In general, the effects of fire on soil organic carbon depend on the type of fire, fire duration and

intensity, soil moisture, soil type and vegetation (GONZÁLEZ-PERES et al., 2004; COAN et al., 2014).

**IV. CONCLUSIONS**

The increase in soil temperature changed the distribution of aggregates, especially in classes with diameter smaller than the class of 1 < Ag < 2 mm);

The PVA, VX and CX soils for the attributes MWD < GMD and MaAg presented a minimum aggregation point for a certain temperature;

The soils, PVA, VX and CX, both in macro-aggregates and in micro-aggregates showed losses of organic matter with increasing temperature.

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# Analysis of the Impact on Axial Compression and Diametric tensile strength of concrete using recycled fine aggregate

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**Keywords**—Recycled fine Aggregate (RFA),  
Workability, Strength.

**Abstract**—Due to the current environmental crisis and the improper disposal of construction and demolition waste (CDW), the incorporation of these as aggregates in the manufacture of concrete is presented as one of the main alternatives for the proper disposal and consequent recycling of it. Such use requires technical knowledge regarding possible changes in the properties of the final product. Thus, this study aims to compare some of the main properties of conventional concrete with the executed one through the incorporation of recycled fine aggregates (RFA). The aggregate was collected in the recycling factory at FUTURE, a company located in Cascavel, Paraná – Brazil. Four mix ratios were elaborated, distinct by the replacement percentages of the conventional fine aggregate to the recycled one (0, 20, 40 e 60%), where the workability, the water absorption of the concrete, the axial compressive and tensile strength were evaluated. Thus, the increase of the workability and the absorption were verified with the highest degree of replacement as well as the reduction of the axial compressive and tensile strengths.

## I. INTRODUCTION

With the growing environmental and sustainable debate, the emergency is evident of the alarming problem related to the disposal of waste, whether domestics, industrials or mainly from civil construction. In the case of Paraná, in more than 90% of the state territory the disposal of construction and demolition waste (CDW) ends up being done in the wrong way [1]. Destined primarily together with other urban waste for landfills, which is commonly improper. Among the main reasons that trigger such attitudes, one can cite the lack of education for the community of workers in the sector, as well as the lack of supervision by regulatory and competent bodies [2]. In this way, solutions capable of making the reuse of such waste possible are tested to the point of encompassing the production process, consumption and disposal in an ecologically correct cycle and economically

advantageous. A possible alternative to preserve the environment is the reuse of these residues as aggregates in the manufacture of cementitious materials.

In Brazil, the National Council for the Environment (CONAMA), in its resolution number 307/02 [3], together with n° 448/12 [4], deals with the issue of the disposal of waste from civil construction. On the 10th article of the resolution no. 307/02 [3], it is verified the obligation of recycling or correct reuse as aggregate of the residues belonging to class A. In this class include ceramic components, mortars and concrete from construction, demolition, repair and renovation of buildings, as well as waste from the handling of precast concrete parts. Thus, it is observed that one of the destinations for the reincorporation of such aggregates is in the production of recycled concrete. At the municipal level, law No. 6663 of

December 6, 2016 defines in its Article 1, the possibility of using in public works these aggregates from waste belonging to class A, originating from civil construction. Therefore, a minimum percentage is stipulated for this use, being 10% of the total materials used in each work [5]. Thus, the incorporation of these aggregates into the concrete consists of one of the main alternatives for such percentage to be accomplished.

Thus, the objective of this study is to verify the feasibility of using RFA (recycled fine aggregate) as a substitute for the conventional fine aggregate in the manufacture of concrete. Since, the axial compressive and diametral tensile strengths, as well as the workability and absorption of the cementitious material consist in the parameters used to check whether the recycled aggregate meets expectations.

## II. LITERATURE REVIEW

There are several problems involving the subject term, especially when dealing with the influences of these residues on the properties of the concrete. Considering or taking into account that a large part of the concrete volume consists of aggregates in general, it is concluded that both their chemical and physical properties will directly interfere in the performance of the matrix material [6]. With regard to this executed concrete using recycled aggregates from the CDW, the main obstacle is the heterogeneity of the analyzed component. Since in most cases the CDW are provided from ceramic materials such as bricks, tiles, porcelains, glass, to grains from cement, through the remains of mortar and the original concrete of the work. In this way it is difficult to analyze such an aggregate in relation to the specific strength, because each parcel of material constituting the whole may present distinct characteristics.

Based on the literature of the subject, recycled aggregates have higher porosity when compared to natural ones, due to the heterogeneity of their constituents, which also gives them a higher hygroscopic [7]. Due to this fact, the same author also reports on the need for a pre-moistened of these aggregates, in order to reduce the unbalance of the water-cement (w/c) fraction of the final mixture.

Many studies discuss the changes caused by recycled aggregates in the general properties of concrete. Regarding workability, the literature shows a reduction in this property when recycled coarse aggregates are incorporated into the cement matrix [8]. Because of the subjective character, we consider the workability of the samples as a sum of two parameters, namely: "Slump Test" and the quantity of fine aggregate particles present in the cement mass. However, with regard to the fine aggregates, an increase of the slump-test can be seen as the highest amount of RFA (*recycled fine aggregate*) in the mixture. A possible explanation would be

that this effect may occur due to the different particle-size curve presented by the heterogeneous recycled material, since the increase in the number of fines of the mixture promotes the lubrication effect of the largest particles [8]. The same author observed an increase of about 17% in the workability of the paste by replacing 50% of the conventional fine aggregate by RFA (*recycled fine aggregate*).

Datas indicate that by incorporating recycled aggregates, the concrete in its hardened state presents a higher water absorption compared to that produced with natural aggregates. By using a coarse-grained crusher run, it is possible to observe a gain of 42 and 65% in this property for concretes with 25 and 50% of substitution, respectively [9].

In relation to the compressive strength, Lovato [10] used in his study a recycled fine aggregate passing in the 4.8 mm mesh sieve, constituted of concrete waste, mortar, red and white ceramics, and natural rocks. The author found a reduction of 4.8, 9.6 and 14.4% for concretes with 25, 50 and 75% substitution, respectively. The following values were found by the author: 25 MPa for the reference concrete, 23.8 MPa for 25% replacement of conventional fine aggregate by RFA (*recycled fine aggregate*), 22.6 for 50%, and 21.4 MPa for 75%.

Evaluating the tensile strength by diametral compression, Leite [8] verified a direct proportionality between the RFA (*recycled fine aggregate*) content and the tensile strength of concrete. However, the author points out the possibility of this effect being altered by the adopted w/c ratio, and there may even be a decrease of the strength as higher percentages of RFA (*recycled fine aggregate*) in the mixture. It is also worth mentioning that in general terms, the tensile strength of concrete usually corresponds to 10% of its compressive strength [11].

Considering the importance of the knowledge about the effects of aggregates in concrete, this study justifies itself through the experimental analysis of some of the most important influences of the recycled fine aggregate (RFA) in the concrete obtained by its incorporation. The analyses performed are primarily intended to investigate both compressive and tensile strengths, as well as the absorption and workability of the proposed mixes for different concentrations of the recycled fine aggregate (RFA) in the concretes.

## III. METHODOLOGY

### 3.1 Materials used

In order to make concrete specimens for the present study, several materials were used, namely: drinking water, Portland Cement CP II F-40 (type II, Moderate Sulfate Resistance), gravel ( $9.5 < d < 19$  mm) from basaltic, washed river sand with medium grain (natural aggregate) and recycled sand from crushing of CDW.

### 3.2 Laboratory equipment and utensils

The procedures, on the other hand, are summarized by the elaboration of the mixing ratio for concrete dosing and the molding of cylindrical specimens for the execution of tests on the material's properties. The laboratory tools used for making the specimens can be listed as: Various laboratory glassware, precision balance SOLOTEST ( $\pm 1$ g), MOTOMIL Mb 150l portable concrete mixer, 20x10cm metal molds to mold the specimens, buckets, plastic trays, mold release agent from the fractional distillation of petroleum. As for the equipment with the purpose of storing the specimens and subsequent analysis, they can be listed as follows: chamber for moist curing, drinking water, hydrated lime (applied in the curing chamber), QUANTEQ hydraulic press CH 019 S 004, slump cone test, neoprene plates and discs. Besides these, it is worth emphasizing the proper use of safety equipment, such as gloves, masks, goggles, and lab coats, among other necessary items.

### 3.3 Control of the manufacturing processes of the specimens

Seeking for a standardization of the remaining variables, a rigorous laboratory control system was established, and several preventive measures were followed for the preparation of the specimens. The main factors to be highlighted during this step are: the entire experiment was performed within a single laboratory and at the same ambient temperature ( $23^{\circ}\text{C}$ ). The relative humidity of the air can be considered constant, since the room temperature controllers were always turned on two hours before the confection of the specimens.

The order of insertion of the constituents in order to obtain the proper homogenization in the concrete mixer was the same for all the elaborated mixes, namely: aggregates and 1/3 of the total water of the mixture in stirring for 5 minutes, then the total cement and the rest of the water are added concluding with another stirring of 5 minutes; to continue maintaining the standard, all specimens were molded by the same researcher. The molding followed the regulation of the Brazilian Association of Technical Standards [12], in which the dimensions of the specimens are described, as well as the concrete compaction method required for each type of mold. Thus, according to Table 3 (Number of layers for molding the specimens) present in this standard, for each specimen, 2 layers were executed

with a total of 12 strokes each, since the mold used consists of a cylinder 100mm in diameter by 200mm in height and the method of compaction was manual.

### 3.4 Collecting the recycled aggregate

The recycled fine aggregate was donated by FUTURE Reciclagem Inteligente and collected at the company's headquarters, located in Cascavel city - Paraná state. Future is a company that, besides performing demolitions, receives civil construction waste, separates and classifies them into different classes according to the Conama Resolution 307/02 [3]. For those class A, it performs the grinding, resulting in several by-products that can be reinserted in the construction sector. These include crusher run, crushed stone, clearst one, gravel and sand, which was used in this study.

The recycled sand obtained has a uniform granulometry, and is made up of different materials, such as brick, flooring, porcelain tiles, concrete, and mortar for plastering and laying. Thus, about 1000 liters of the material were collected for further use. The raw material (Fig. 1) was obtained from productions carried out on different days, as a way to ensure product standardization, provided by the strict control performed by the company's professionals.



Fig. 1: Aggregates recycled at FUTURE (Author)

### 3.5 Preparation of the recycled aggregates

After collection, the recycled aggregates were transported to the laboratory to be stored in hermetically sealed plastic containers. Prior to its use, the recycled aggregate was dried in a laboratory oven for 24 hours at  $105^{\circ}\text{C} (\pm 5^{\circ}\text{C})$  and then stored again in an airtight container. This moisture removal was done to ensure the same condition of the recycled material compared to the natural ones (being 0% moisture beforehand).

### 3.6 Preparation of the concrete mix ratio



In order to elaborate the baseline mix ratio, an axial compressive strength ( $F_{ck}$ ) of 40 MPa was initially stipulated, since it is above the minimum limit for use as structural concrete. However, because of the possible variations in the manufacture and handling of concrete, a standard deviation of dosage ( $S_d$ ) of 4 MPa was adopted in order to increase the desired strength ( $F_{cj}$ ) to ensure that no variations occur smaller than the initial stipulated value. For this purpose, the Equation 1 was used, according to the Brazilian standard [13]. It is worth mentioning that this value of 4 MPa was selected because of the extreme caution evidenced during the research activities, since it was performed in a controlled laboratory environment.

$$f_{cj} = f_{ck} + 1,65 * S_d \quad (1)$$

Therefore, using the Brazilian Portland Cement Association [14] method of dosage and with a delimiting strength of mixing of 46.6 MPa, the final result was the following mixes: 1:2.2:3.6, with a w-c ratio of 0.61 and a slump cone test set between 9 and 10 cm. In light of this, four mix ratios were executed, with a baseline mix ratio with 0% substitution and three more using the gradual substitution of the natural fine aggregate by the recycled one in the following proportions: 20, 40, and 60%.

Because of the difference in specific mass observed between conventional and recycled aggregate, a correction of the mass of the second one was necessary. For this purpose, the equation 2 was used with the following variables: the mass of natural aggregate ( $M_{na}$ ), the mass of recycled aggregate ( $M_{ra}$ ), specific mass of natural aggregate ( $\gamma_{na}$ ) and specific mass of recycled aggregate ( $\gamma_{ra}$ ).

$$M_{ra} = \frac{M_{na}}{\gamma_{na}} \gamma_{ra} \quad (2)$$

To avoid the change in the amount of water due to greater absorption by the recycled aggregate, a pre-wetting was performed on it with an amount of water equivalent to 90% of its total absorption, as recommended by Angulo [15].

### 3.7 Particle size composition

Regulated by the Brazilian Technical Standard [16], the particle size composition test of the aggregates aims at classifying the material based on the dimensions of its particles, as well as the percentage that each granulometric range represents in its composition.

To do so, samples of 5 kg will be used for the test referring to the aggregates (both coarse and fine). Thus, for

the realization of such characterization, the sieves of the normal series were used in combination with those of the intermediate series.

### 3.8 Workability test

This was performed for the four mixes in order to observe the achieved slump for each one. For this purpose, the slump test was performed from the slump cone, which follows the regulations of the Brazilian National standard [17].

### 3.9 Concrete water absorption

Following the regulations of the Brazilian Standards [18], to determine the water absorption of concrete, three specimens were used per mix ratio, and these were kept in a moist curing process for 28 days. Thus, each specimen was dried in a laboratory oven at a constant temperature of 105°C ( $\pm$  5°C) for 24 hours and then their masses were measured.

After that, they were submerged in water for another 24h and after superficial drying, their masses were measured again. Thus, with the difference in mass observed, the absorption of the concrete in its hardened state was obtained.

### 3.10 Axial compressive strength test

For each of the mix ratios, tests were performed at ages of 7, 28 and 160 days after demolding, and for each age 5 specimens were used. In this test the recommendations described in the Brazilian standard [19] were followed.

The equipment used consisted of a QUANTEQ hydraulic press model CH 019 S 004 with a capacity of 100 tf. A speed of 0.45 (+/- 0.15) MPa/s was applied. In contrast to the capping, metallic plates and neoprene discs with 70 shore hardness and 13mm thickness were used. The use of neoprene is justified by the fact that the specimens had not been previously rectified, which could cause them to crack due to some irregularity resulting from molding.

### 3.11 Tensile strength test by diametral compression

Regulated by the Brazilian standard [20], it consists in obtaining the tensile strength of concrete through the result of the diametral compression test of the specimens. However, in order for the data obtained to refer to the tensile strength itself, the use of Equation 3 is necessary, which contains the following variables: tensile strength by diametral compression ( $f_{tD}$ ), reached load in the test (F), diameter in mm of the specimen (d) and width in mm of the specimen (L).

$$f_{tD} = \frac{2F}{\pi dL} \quad (3)$$

In total 16 specimens were tested, 4 for each mix ratio at the age of 28 days of curing. The equipment used was the same used for the compressive strength test (QUANTEQ hydraulic press model CH 019 S 004 with a capacity of 100 tf) and a speed of 0.45 (+/- 0.15) MPa/s was also applied.

### 3.12 Statistical analysis of the collected data

The statistical test results in the possibility of the error of accepting or rejecting the null hypothesis, defined as type I and II errors, respectively. Therefore, the significance of 5%, adopted in Tukey's statistical test, consists in statistically safeguarding the probability of correctness in 95% of the evaluations of the null hypothesis [21]. Therefore, in order to ensure reliability to the data obtained, they were submitted to Tukey's test, where they followed the checks for their similarities and categorized into groups according to the proximity of the values. Through this analysis, the goal is to establish correlations to determine the variations caused by the replacements of the natural fine aggregate by the recycled one. It is important to point out that Student's t-test was used for the statistical treatment of the data referring to concrete water absorption, since, due to the large variance observed among the values, the use of Tukey's test is not recommended.

Student's T-test consists of a test that through statistical means focuses on whether or not to reject the null hypothesis when the test statistic (t) holds in a Student's t-distribution [22].

## IV. RESULTS

In total, 88 cylindrical specimens of 10 x 20 cm were made, 22 for each mix ratio. After 24 hours of pre-curing, all were demolded, and then stored in a moist curing chamber, kept submerged in drinking water with hydrated lime at saturation. The subsequent tests performed with the deferred concretes by their respective mixes were responsible for determining the axial compressive strength and tensile strength by diametral compression, as well as the absorption. The subsequent tests performed with the deferred concretes by their respective mixes were responsible for determining the axial compressive strength and tensile strength by diametral compression, as well as the absorption. The workability was also verified, and its test being performed at the time of concrete mixing.

### 4.1 Particle size influence

The Fig. 2 compares the particle size distribution curves for the natural and recycled fine aggregates.

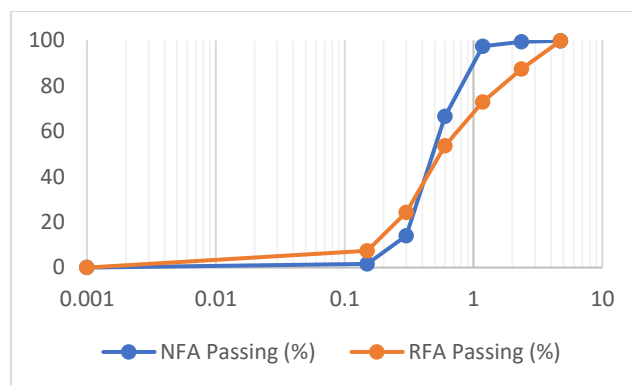


Fig. 2: Particle size distribution curves (Author)

Therefore, when analyzing the size distribution curve of the recycled aggregate in comparison to the natural one, one can note a higher number of fines, that is, a greater size distribution along the sieves. This greater number of fines, according to Cabral [23] would be a possible explanation for the increased strength of the concretes made with such alternative aggregates. Since these particles, especially the red ceramic ones, can exert a pozzolanic effect inside the mixture, which leads to an improvement in the transition zone and increases the strength of the composite [23]. Similarly, Vandhiyan[24] cites that the volume of the fine aggregate plays a key role in reducing voids in the cementitious mixture, so a sand with less volume is preferred in the realization of the same, to achieve higher strength. Furthermore, Medeiros-Junior [25] reports in his work that concretes with fine recycled aggregate had higher compressive strength than concretes with coarse recycled aggregate for the same waste sample.

Despite the possible beneficial effect portrayed above, in the present study the result was the opposite, i.e., there was only a reduction in the concrete strength as higher rates of recycled aggregate were added to the mix. Therefore, it can be concluded that the negative effect caused by the low strength of the particles of the alternative aggregate outweighs the benefits from the improvement by the effect of a greater particle size dispersion.

### 4.2 Workability of concrete in its fresh state

The tests performed through the slump cone indicate the slump of the different concretes right after the homogenization of the components in the mixer. The results obtained were: 9.5 cm for concrete with 0 and 20% substitution and 16 cm for those with 40 and 60% of incorporation. These data indicate that the more the natural aggregate is replaced by the recycled, the greater the slump of the concrete will be.

As explained by Leite[8], a possible explanation for this consists in the different particle-size curve of the recycled aggregate. Another factor would be the pre-wetting

performed, which may be responsible for the addition of water. The constant pre-wetting percentage of the samples was justified due to the higher water absorption of the aggregates, where when the mixes were made, the recycled aggregate consumed a lot of water in the mixture, considerably altering the w/c ratio. The most significant difference of workability lies between the concretes with 40 and 60% with respect to the others, a fact that can be interpreted by the greater mass of recycled material in these mixes with more than 40% substitution. Thus, consequently

in those concretes with a higher percentage of incorporation, a larger amount of water was used for pre-wetting.

#### 4.3 Concrete water absorption

The tests performed for each of the mix ratios at 28 days of curing generated the results that, together with the standard deviations, can be seen in Table 1.

Table 1: Concrete Water Absorption.

Mix Ratio	Mass in saturated state	Mass in dry state	Mass difference	
% of RFA	(g)	(g)	(g)	(%)
0	3960,67±9,29	3752,67±9,98	208,00±4,32	5,25
20	3870,00±43,8	3641,33±53,3	228,67±95,6	5,91
40	3841,33±31,7	3573,00±33,4	268,33±59,5	6,99
60	3786,00±34,8	3501,33±40,1	284,67±66,4	7,52

Therefore, it is noticeable that the absorption of concrete is directly proportional to the content of replacement of natural fine aggregate (NFA) by recycled fine aggregate (RFA). There was a gain of 9.94, 29.01 and 36.86% of this property for the concretes with 20, 40 and 60% of incorporation, respectively, in relation to the mass of water absorbed by the specimens (taking the mass of water absorbed by the sample without replacement of recycled aggregate as the reference).

It is worth mentioning that, as explained in the previous paragraph, the data were presented in their absolute form, without statistical treatment and analysis using standard deviation. This choice of procedure can be understood because of the irrelevance presented by the standard deviation in this case, since it obtained too high values, a fact that can be justified by the use of only 5 samples for the study, as well as the analysis of a single property. Nevertheless, the demonstrated values reflect an information already expected, which consists in the direct proportionality between concrete absorption and replacement content, as seen by Frotté[9].

Nevertheless, the values of the mass difference were submitted to the statistical Student's t-test, in order to check how close, the data are. As a result, it was found that the relative values for the mass differences of each mix ratio are

not statistically different from each other. This conclusion reaffirms the stance described in the previous paragraph, that the best way to analyze these data is to work with their values in an absolute way.

Thus, this effect can be justified by issues previously discussed. These results corroborate, thus, the already expected fact that the recycled aggregates present higher porosity and consequently higher hygroscopy, conferring to the concrete an increase in this analyzed characteristic as well [7].

#### 4.4 Axial compressive strength

The results found for the axial compressive strength of the different mix ratios at ages of 7, 28 and 160 days can be observed in Table 2. The data presented are the averages of the strengths among the 5 specimens tested for each mix at different ages. Table 2 also shows the standard deviations next to each average.

The data were submitted to an entirely randomized statistical design, and the differences were evaluated by Tukey's test at a 5% significance level. It is worth mentioning in the table that the measurements followed by the same capital letter in the column and lower case in the row do not differ by the Tukey test at 5% significance level.

Table 2: Axial compressive strength for the different mix ratios at the three tested ages.

Mix Ratio	7 days		28 days		160 days	
.% of RFA	MPa	Corr.	MPa	Corr.	MPa	Corr.
0	22,75±2,57	Aa	44,61±2,78	Ab	47,32±2,96	Ab
20	19,25±3,52	ABa	33,07±3,35	ABb	37,87±0,84	Bb
40	18,12±2,14	Ba	30,37±1,46	BCb	32,89±3,23	Cb
60	15,95±1,46	Ba	27,69±0,72	Cb	31,0±1,04	Cc

Thus, we can see that at 7 days of curing, there was a slight decrease in strength according to the higher percentage of recycled fine aggregate (RFA), however, the data of the 4 mix ratios are somewhat similar. Analyzing at 28 days, a reduction of that property is again observed, together with a greater distance between the results. However, a greater differentiation at the last age was evidenced, segregating the results into 3 groups, both the mix with 0% and the mix with 20% being individualized, and a greater proximity between those with 40 and 60%. One can see from this that the influence of replacement becomes effective when analyzing the material at an advanced age of curing. This factor can possibly be explained by the higher amount of water incorporated into the mixture due to the presence of recycled aggregates, which depreciates the final strength. Therefore, analyzing Table 2 in rows, in the four categories of concrete was noted the differentiation between the 7 days of curing for the other ages, while at 28 and 160 days, the results remained mostly close. This factor can be understood by the efficiency of the moist curing to ensure the development of concrete strength during the first month. However, it is noteworthy the reduction of the speed of such achievement at ages greater than 28 days. Then, it is possible to observe in Fig. 2 the interpolation of the data obtained by the averages of the strengths, through a logarithmic adjustment, justified by maintaining a better quality of the data correctness. These data were distributed throughout the curing ages and classified according to each concrete mix ratio. Regarding the curves presented in the graph of Fig.3, Table 3 shows the equations for each fitted curve, as well as the coefficient of determination (R<sup>2</sup>) of the same.

Table 3: Equations of the fitted curves and R<sup>2</sup> for each mix ratio.

Concentration % de RFA	Regression	R <sup>2</sup>
0	$y = 7,5883 * \ln(x) + 12,036$	0,7798
20	$y = 5,8163 * \ln(x) + 9,9936$	0,8898
40	$y = 4,5802 * \ln(x) + 11,318$	0,8267

$$60 \quad \left| \quad y = 4,4069 * \ln(x) + 8,6562 \quad \right. \quad 0,8659$$

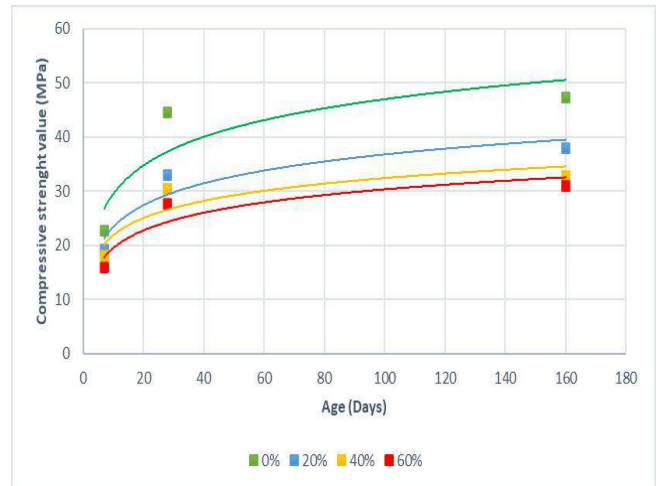


Fig 3: Evolution of the compressive strengths of the mix ratios according to the age. (Author)

Therefore, the variation of the axial compressive strength along the curing age is observed and highlighting the distinction between the curves of each mix, thus evidencing that the compressive strength of concrete is gradually reduced as the recycled fine aggregate (RFA) is incorporated to replace the natural fine aggregate.

In comparison with the baseline concrete at a 28-day curing, a strength loss of 25.85, 31.92, and 37.92% was observed for the mixes with 20, 40, and 60% substitution, respectively. Therefore, a greater reduction of compressive strength is highlighted in the first 20% substitution, and a milder reduction is notified in the following incorporation ranges.

#### 4.5 Tensile strength by diametral compression

Being analyzed at 28 days of curing, the results together with the standard deviations of the four specimens per mix tested for tensile strength by diametral compression can be seen in Table 4.

Table 4: Tensile strength by diametral compression for the different mix ratios.

Concentration	Tensile Strength	
% of RFA	MPa	Correlation
0	3,22±0,355	A
20	2,30±0,703	AB
40	1,86±0,173	B
60	1,80±0,192	B

Therefore, it was noted that the tensile strength decreases as the replacement content of the natural fine aggregate (NFA) by the recycled fine aggregate (RFA) increases, since a reduction of 28.57, 42.24, and 44.10% was observed for mix ratios with 20, 40, and 60% replacement, respectively. It is possible to understand what happened because of the larger amount of water inside the concrete as a consequence of the introduction of recycled aggregate and its pre-wetting. Similarly, such a change in the w/c ratio can be noted in the variations that occurred in the slump test.

When comparing the tensile and compressive strengths, it was verified that the first one corresponds on average to only 6.7% of the total value of the compressive strength.

## V. CONCLUSION

The obtaining of the recycled fine aggregate and its incorporation into concrete at different replacement rates precipitated the execution of the tests and analyses explained in this study. With the interpretation and discussion of the results, it was possible to draw conclusions about the effects of the recycled fine aggregates on the characteristics of concrete when incorporated.

The slump and consequently the workability of concrete in its fresh state had an increase from 9.5 to 16 cm, the first measure corresponding to the mixes with 0 and 20% substitution and the second for mixes made with 40 and 60%. This fact promotes the understanding of the effect by distinguishing the particle-size curves of the compared aggregates, as well as the incorporation of water in the pre-wetting.

The absorption of concrete showed growth as higher percentages of the RFA were introduced in the mixture, a factor possibly justified by the higher porosity and absorption by the recycled aggregate when compared to the natural one.

As for the axial compressive strength, a reduction of the property was observed as the percentage of replacement of the natural aggregate by the recycled one increased. There was a more abrupt reduction in strength in the first replacement ranges, and after 20%, the reduction of this property occurred in a milder way. An inverse

proportionality was also observed in the tensile strength obtained by diametral compression, since an equivalence of 6.7% of this property was notified to the value found for the axial compression strength.

Thus, it is possible to state that despite the changes observed in the properties of concrete, the fine aggregate collected has characteristics that allow its incorporation in the material. However, it is emphasized that this use must be made with appropriate caution in order to ensure the control of the influences of the recycled aggregate in the concrete. To do so, pre-use analyses are required so that the present variables in each situation are accounted for and controlled.

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# Citizens' quality of life and the conceptual relationship with smart cities: A literature review

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**Keywords—** *Quality of life, smart cities,  
literature review, citizens, conceptual.*

**Abstract—** *By 2050 about 80% of the world's population will live in cities. This is a scenario that worries planners and managers in the search for solutions capable of improving cities and citizens' quality of life. Smart cities have the potential to achieve ideal conditions for housing, health, education, environment, economy, service infrastructure and information with quality of life. This study aims to identify the conceptual relationship between smart cities and citizens' quality of life. The study analyzed 16 scientific journals relevant to the research objective. Twelve key concepts were found that demonstrate the way to relate a smart city and citizens' quality of life. This research is a literature review where three stages were adopted to describe the direction that the research directed.*

## I. INTRODUCTION

The large concentration of people living in urbanized areas has required cities to seek to meet the minimum quality of life for people. About 55% of people lived in 2018 in urbanized areas, with a trend towards a gradual and continuous increase in population in the coming decades [47], [27]. Society increasingly demands effective, creative actions, planned for urbanized centers so that they can improve the dynamics of social life [42], [44].

Nowadays, cities are considered complex urban centers, inhabited by people with the most varied interests and can collaborate with each other in order to allow a sustainable environment with quality of life [12], [11], [27]. In this scenario, the quality of life in smart cities can represent a situation of subjective, affective and cognitive well-being of people [15], [21]. And these situations, behaviors and emotions allow for increased socialization [5], [17], [22], [40].

This factor can be achieved with the use of information technology (IT), which allows cities to point out solutions and conditions for improvements that involve jobs, housing, reduction of social inequality, health, reduction of violence, mobility, making these centers more inclusive. Guimaraes *et al*, [27] points out that cities can take

advantage of IT in governance processes as a way to create intelligent ways to meet various demands of the private and public sectors. In this context, the question is: there a conceptual relationship between smart cities and people's quality of life?

The objective of the research is to identify the conceptual relationship between smart cities and citizens' quality of life. This work is a literature review that adopted three stages to describe the direction that the research directed. The first stage describes the research planning, then addresses the literature review through a descriptive analysis and ends with a synthesis analysis of the results according to the research objective. Sixteen manuscripts relating the link between the smart city and citizens' quality of life were analyzed. It is noticed that the quality of life in smart cities is related to twelve key concepts that together show the path that smart cities should follow to obtain quality of life for citizens.

According to the result, meeting these criteria tends to improve cities and people's well-being by building a stronger community within the city. In addition to this introduction, the research is structured with a brief description of the relationship with governance and the challenge to quality of life. Next, the research method,

followed by the results found, ends with the study's final considerations.

## II. THE GOVERNANCE AND THE CHALLENGE FOR QUALITY OF LIFE IN SMART CITIES

In recent years, there has been an extensive migration from rural areas to urban centers and from smaller to larger urban centers, a fact that has given rise to several problems that affect the quality of life. Among them are the lack of clean water, sanitation, work, unhealthy conditions, economic growth, increasing inequality and irresponsible consumption of goods. This factor is related to population growth, increased resource consumption combined with vigorous industrialization, urbanization, globalization and agricultural intensification, in addition to the lifestyle driven by excessive consumption [20], [54], [55].

Cities can be characterized as a driving force of the economy and provide better opportunities for work, education, health and several centers struggle to organize and manage population growth, accessibility of economic inclusion and air quality [51]. Air quality is a key factor for quality of life and the greater the number of people living in urban areas can lead to an increase in greenhouse gases harmful to health [45]. In this scenario of urban chaos, actions aimed at sustainable development linked to the UN's SDGs Sustainable Development Goals seek to reduce poverty and create healthy planning to ensure a proposed future [46], [25].

Quality of life is related to the decisions that managers take when planning cities [25], and affects the relationship between health, safety and well-being of populations in urbanized areas [24]. At this point, the link between health, quality of life and sustainable development becomes more integrated [31], [49]. This relationship can be achieved through smart cities. In theory, this city model can contribute to the formation of high-quality, healthy urban spaces with regenerative environments modeled on the premise of circulating economy reducing negative impacts on the natural environment [30], [3], [7], [8].

From this perspective, issues related to health, quality of life, safety, well-being, environmental pollution, loss of biodiversity, resources, scarcity, traffic congestion, inequalities are highly problematic for urban administrations [18], [36], [53]. One of the most effective ways to manage these problems is through data with real and continuous indicators, which enable the manager to make decisions safely. In this aspect, the city comes to represent efficiency, based on management supported by an urban system using information and communication technology (ICT) [6].

Technologies can influence and be useful in the way administrations manage the quality of life [26]. This is because the reality of cities changes daily, in a short space of time it undergoes transformations that can be found in the technology of information a valuable [27]. The smart city can improve people's quality of life as several projects pertaining to smart cities such as: a) urban mobility and travel behavior; b) urban modeling and land use; c) integrated database; d) work and the impact of social networks; e) participatory governance; f) transport and economic interactions, and; f) and decision support as urban Intelligence [4].

In this perspective, a city will only become intelligent when aspects related to human and social capital, communication infrastructure (ICT) support economic growth and quality of life [35]. Bibri and Krogstie [6] go further, describe that there are two approaches to the city: a) oriented towards technology and ICT and b) oriented towards people. There are currently strategies that focus on the efficiency and advancement of infrastructure and technology systems improving transport, energy, communication, waste and water that are managed through ICT and enable the development of strategies that focus on light infrastructure and people, or that is, social, human capital in terms of knowledge, participation, security, quality of life and equity [3].

These aspects are directly related to the governance of cities, which currently, in the traditional model, tends to devalue society's participation and the use of technologies [27]. Blanco [9] emphasizes that this bureaucratic governance model can be replaced by new, more collaborative mechanisms.

Social participation and the use of technology are in line with improving the quality of life, as society's demands can be debated and resolved, while the use of ICT facilitates its development. In this aspect, governance can become intelligent, when it uses this information, seeking forms of social and political change, improving decision-making in the management of cities [43]. Currently, cities face barriers that, according to Bolívar [10], go beyond the usual conservatism and demand new ways to govern, that is, intelligent governance is nothing more than social participation and its actors using ICTs to improve decision-making by cities [50].

In fact, governance becomes one of the instruments that can improve the quality of life, but how to measure the quality of life and how the intelligence of cities can favor this process. It is currently relevant when we think about policy planning and municipal territory management [39].



### III. REVIEW METHODOLOGY

This article seeks, through a literature review, to identify the relationship between smart cities and citizens' quality of life. Thus, three stages were adopted to describe the direction in which the research was directed. The first stage consists of planning, which defines research sources and procedures. The next stage addresses the literature review through a descriptive analysis. The review ends with the synthesis analysis of the results according to the research objective.

The analysis was based on selected articles from 2015 to 2021. For the search, the keywords were used: "quality of life in cities" or "smart city and quality of life" or "quality of the city" or "quality and intelligence". The criteria for selecting the research articles are based on: (i) focus: the text addresses the issue of quality of life and smart cities; (ii) characteristics: the text deals directly with the chain of quality of life and the smart city and their specificities; (iii) access: the document in its entirety online, written in English. (iv) quality: peer-reviewed scientific articles; and (v) Unit of analysis: Chaining: quality of life, ICT, citizen, society, environment, sustainability, governance, economy and mobility, smart city. The database used to develop the research was: Scopus, Science Direct and Web of Science.

The second stage was the literature review, in this aspect we identified 245 articles, where duplications were removed and the relationship with the theme was evaluated. Sixteen scientific articles were selected and the information collected is analyzed and tabulated in the order: author, year, study objective, main variables, concept of smart and sustainable cities used as a guideline and/or reference in the study, smart city practices, benefits the adoption of smart cities, theoretical contribution of the study, research findings, research limitations and recommendations for future studies. The third stage points to a synthesis of the results according to the research objective.

### IV. QUALITY OF LIFE AND THE RELATIONSHIP WITH THE SMART CITY

Urban centers are complex, sophisticated, complicated systems involving various sociocultural, economic, environmental, management and technical aspects [1]. No study was noted that there is little discussion of quality of life related to smart cities. There is a greater approach to urban planning and quality of life. But few studies bring contributions to meaning as interconnected faces of quality of life domains in Smart Cities. There were about 245 manuscripts with references to quality of life, but

only 16 works provide pertinent information about the research objectives.

We found the key concepts that demonstrate the way to relate a smart city and citizens' quality of life. These factors are: (i) efficient governance; (ii) well-being and environment; (iii) social inequality; (iv) urban services; (v) sustainable development; (vi) economic growth; (vii) human, social capital and ICTs; (viii) sustainable economic growth; (ix) private and public collaboration; (x) innovations and technologies; (xi) education and citizen participation; and, (xii) public policies. All these concepts integrate the smart city with quality of life.

When referring to people's quality of life, we are talking about a combination of several factors that involve human capital, economic capital and infrastructure capital. These elements support the concept of smart cities. Technology makes it possible to provide infrastructure and services immediately in various situations [33], while city governance becomes a key organism, capable of solving various urban problems such as sustainability and quality of life in the environment urban [14], [31], [34], [36].

Quality of life can be understood as a perception of one's position in life, that is, in the sociocultural context and values in which they live and in relation to their goals and expectations, parameter and their social relationship [52]. In the view of Skevington et al. (2004), physical and psychological health, level of independence and social relationships can affect the individual's quality of life. In this context, we find several definitions and relationships that involve the quality of life in cities. Let's look at some definitions in Table 1.

Table 1: Synthesis of the relationship between smart cities and quality of life

Relationship	Author
Managerial responsibility through efficient governance enables economic development, improves well-being and is responsible for reducing social inequality in access to urban services, that is, improving the quality of life.	Healey [29].
In the smart city, efforts are focused on economic growth and sustainable development, providing better quality of life for its citizens, becoming a key element for the smart city.	Giffinger et al., [23]; Nam & Pardo, [41]; Thuzar [44],
Investments in human capital, social and communication infrastructure drive sustainable economic growth and quality of life, as well as natural	Caragliu, Del Bo & Nijkamp

resource management and participatory governance make the city smart. [13].

In the context of smart cities, quality of life aims to promote sustainable development and is related to actions to encourage collaboration between the private and the public. The city uses resources to efficiently provide adequate health, education and safety conditions, through joint work between the state and people. Governance uses technological innovation resources to offer products and services that influence the quality of life. Chourabi et al. [16], Harrison et al. [28].

The design of a smart city impacts the quality of life of citizens, promoting information, education and citizen participation. Albino, Berardi & Dangelico [2].

The development of public policies generated by smart cities contributes to a better city and to the evolution of citizens' quality of life. Meijer & Bolívar [37]; Meijer, Gil-Garcia & Bolívar [38], Van Winden et al., [48].

The combination of human, social and information capital combined with the use of ICTs generates economic development, improves well-being and quality of life, becoming the basis of smart cities. Capdevila & Zarlenga [12]; Dumay [19].

The concept of smart cities goes beyond technology, including concern for the well-being of citizens, infrastructure for education and innovation, partnerships between companies, government and quality of services. Bibri & Krogstie [6]

A smart city with the domain of smart life can be achieved by providing the four factors a) socio-structural relationships; (b) environmental well-being; (c) material well; and (d) integration with the community, the result of these criteria improves the citizen's quality of life and allows for a stronger community within the city. Macke et al. [35]

Quality of life is related to participation and partnership in the context of smart cities. Quality of life is related to the Guimaraes et al. [27]

collaboration of people in the context of the smart city.

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*Source: Research data.*

All aspects that characterize smart cities seek to improve people's quality of life and well-being. Efficient governance allows for the economic development of actions and greater quality for people. Another key point is education, the higher the educational level, the more qualified people will be, in other words, we have smart people. Collaboration between private and public actions tends to encourage sustainable development and efficient public policies. Investments in human and social capital and ICTs promote economic, sustainable growth and improve the quality of life in cities.

In a smart city, good indicators such as education, longevity, mortality, income, employability, housing, economic dynamism, basic sanitation coverage, environmental management, environmental preservation, revenue capacity, financial incentives, planning capacity, quality of staff, transparency, electoral participation and gender representation may indicate better quality of life and intelligence of people in cities. In a way, the entire context of the smart city causes significant changes in the context of people, [2] points out that one of the impacts caused by smart cities is the quality of life, because it promotes more information, education and participation in issues related to the city.

To make a city smart it will be necessary to have smart people and this is only achieved through initiatives between private and public partnership where governance will lead the city towards smart sustainable development. However, positive aspects such as greater competition between urban centers in the search for investment and qualified personnel tend to improve the quality of life of citizens.

## V. CONCLUSION

The survey points to a relationship between the smart city and the quality of life of citizens. Twelve important factors were noticed that demonstrate the path to a smart city with quality of life. The study reveals that intelligence starts with efficient governance, environmental well-being, reduction of inequality, efficient urban services, sustainable development and growth, technological innovation, education and citizen participation in the elaboration of public policies.

Considering these findings, it is recommended that cities seek to develop through public policies with the participation of citizens and private initiative. From this perspective, the need to include governance with

collaborative involvement in decision-making processes. Another aspect perceived is that this relationship between quality of life and intelligence involves the need for human and social capital and ICTs. It is noteworthy that the study corroborates the view of Bibri and Krogstie [6], Macke et al [35] and Guimaraes et al [27], and that to achieve people's quality of life, smart cities must go beyond technology, they must be concerned with well-being, with quality education combined with the infrastructure of services and partnerships between institutions.

This is a theoretical study that can contribute to the advancement of research on smart cities and their relationship with quality of life. The research has several limitations, the structure of the aspects that identify quality of life is based on empirical paths, although associated with the aforementioned strategies, it can improve the quality of life of people in cities. It is not possible to guarantee that these relationships alone make cities smarter and improve the quality of life, but they can help to achieve paths for development.

Based on these results, it can be suggested that future studies investigate what are the interferences between well-being in smart cities, in the same sense, what factors can be measured and what strategies municipalities can follow to achieve better standards of quality of life. Based on these results, it can be suggested that future studies investigate what are the interferences between well-being in smart cities, in the same sense, what factors can be measured and what strategies municipalities can follow to achieve better standards of quality of life.

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## Teaching Practice Through the Integrated Curriculum: Permanent Education in the Amazon, Para, Brazil

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**Keywords** — *Health education, Permanent Education, High Education, Curriculum, College education.*

**Abstract** — *This article reveals the teaching practice in health education in a Nursing Undergraduate course guided by the guidelines of the integrated curriculum in a Higher Education Institution (HEI) in the Amazon region, Pará, Brazil. This institution has specific singularities in the region, and teachers need to change their didactic and pedagogical practices. . The objective was to analyze whether the continuing education of teachers at the researched HEI meets the operational guidelines for the practice of the proposed curriculum. We opted for a qualitative, descriptive, exploratory methodology with triangulation of collection methods and a case study approach. Data collection took place in two stages: via documentary Curriculum Lattes of participants and oral semi-structured interview. For analysis, the techniques of simple descriptive statistics and categorical content were used, supported by the theoretical references of Freire, Perrenoud and Berbel. Among the results, it was pointed out that the institution does not have a permanent education program to support the implementation of the integrated curriculum, among the main factors, the low proximity between the initial training of the teaching staff and the redefinition of the practice stand out didactic and pedagogical for institutional curricular demands. It is*

*concluded that there were advances in relation to practical changes, for strategies that mobilize the student to elaborate a reflection. However, they point to the institutionalization of permanent education for teacher training with an emphasis on interdisciplinary practice, active methodologies and Integrated Health Activities.*

## I. INTRODUCTION

In the scenario in which teaching in health is inserted, it is considered essential that teacher education encompasses a theoretical and practical arrangement, based on pedagogical and didactic knowledge, which must interact according to the teaching demands of Higher Education Institutions (HEI). Pedagogy constitutes the theoretical field of educational practice, being present in several actions of society, which go beyond the didactic aspects of the classroom. Didactics, on the other hand, is understood as the theoretical organization of the teaching activity, in which the objectives, contents, methods and forms of class planning are related to each other to create a favorable condition for knowledge and learning for the student (Libâneo, 2015; Anastasiou & Pimenta, 2008).

In this sense, it is considered essential that teaching practice in higher nursing courses achieves a balance for the mastery of pedagogical and didactic knowledge, with the objective of promoting success in the construction of professional training. In this way, permanent education assumes the role of deepening knowledge between theory and practice in the work context, in addition to guiding the necessary transformation of the curricular training processes of interdisciplinary pedagogical practices and the articulation between health service managers and training institutions (Abreu et al, 2003; Fontenele & Cunha, 2014; Brazil, 2014).

Thus, the concept of curriculum refers to a proposal for the cultural organization of educational centers that articulate fragments that guide teaching and learning in tune with a logical condition for the construction of learning, however, they surround problems of reality related to theory and practice and the relationship between education and society. Thus, among the demands of teacher education, the constructivist concept brought great repercussions to the educational sphere, with changes in educational curricula and didactic and pedagogical practices based on active learning methods, which value the action of the subject, the rescue of knowledge prior to meaningful learning and openness to a critical and reflective posture (Freire, 1996; Gómez, 2011; Sacristán, 2013; Lima, 2017).

Faced with the repercussions of higher education, the discourse on curricular integration was resumed in Brazil and in many countries in the 1990s, within the scope of

official proposals and of international bodies such as the United Nations Organization for Education, Science and Culture (UNESCO) and as part of the literature published by foreign and Brazilian authors. In this sense, the curricular guidelines, developed in the educational reform movement of the time, provide for various forms of integration for education and objections to teacher training (Freire, 1996; Veiga, 1998).

Among the challenges, we highlight the task based on professional training that integrates work and teaching, linking to the actual practice of a profession, bringing theory and practice closer to professional practice, highlighting innovation in the field of education, called integrated curriculum. Such proposal, in contrast to the fragmentation of knowledge, represents the concept of integration, learning based on the exchange of knowledge and balance in the pedagogical relationship, placing interdisciplinarity as one of the axes within the scope of a proposal that represents education as a social, scientific practice, cultural, humanistic, technical and ethical-political (Bernstein, 1996; Santomé, 1998; Lopes, 2008; Silva et al, 2016).

However, in the trajectory of academic training of undergraduate courses in the health area, among them the Undergraduate Nursing Course, it is pointed out that didactic and pedagogical knowledge is not prioritized. This scenario is in conflict with the expansion of the nurse's professional practice area in the field of secondary and higher education, given the challenges of articulating two professional practices: teaching and health care. Thus, the discussion on the training of nursing teachers gains strength by reflecting on the quality of education they offer (Furlanetto, 2011; Fontenele & Cunha, 2014; Brazil, 2015; Corrêa et al, 2018).

Thus, bringing to the reality of a public, state HEI, located outside the headquarters, in the interior of the state of Para, Amazon region, Brazil, it faces specific singularities, related to the reduced number of teachers in the region, who need to aggregate transformations. In its didactic and pedagogical practices, develop interdisciplinary activities, scientific initiation programs, extension programs, together with the expressive demand for an institutional training program aimed at meeting the guidelines of the institutional curriculum.

In the search to adapt to the National Curriculum Guidelines (DCN), this institution guides in the Pedagogical Course Project (PPC) new methodological strategies such as the active problematization methodology and other critical-reflective and transformative pedagogical strategies in accordance with the curriculum guidelines integrated. Although sometimes, the processes of change in HEIs focus mainly on changes to the curriculum, with changes in the adjustments of subjects, workload and not on the peculiarities of training and changes in practice in the academic community (Barbosa & Viana, 2008).

From this perspective, in order to confront the reality of a HEI to the process of adaptation of the professors to the curricular guidelines, this study aimed to answer the following question: What are the demands in continuing education actions for the professors of the Nursing Course of a HEI located in the countryside from the Amazon region, Pará, Brazil, to meet the guidelines of the Pedagogical Course Project (PPC) based on the Integrated Curriculum?

Based on the foregoing, this research aimed to analyze the demands in continuing education actions to the faculty of the undergraduate Nursing course at the HEI researched to meet the guidelines of the integrated curriculum. In support of meeting the proposed objective, the characterization of the academic and professional profile of the professors of the course was carried out, as well as the description of the pedagogical and didactic practices.

## II. MATERIALS AND METHOD

To achieve the analysis proposed in a research developed in a Master's program in Education and Health in the Amazon from 2017 to 2019, this study was based on a qualitative methodological design, of the descriptive and exploratory type, with triangulation of collection strategies in an approach of case study.

In summary, triangulation is used as a resource in qualitative research, it proposes multiple views through various collection and analysis instruments that complement quantitative, qualitative perspectives, ensuring a deeper understanding of the phenomenon investigated, but which is based only on the qualitative axis. The case study technique, on the other hand, allows the choice of a unit that belongs to a larger context that can be analyzed with greater particularity (Denzin & Lincoln, 2003; Minayo, 2004; André, 2005; Canzonieri, 2011).

The field determined for the study was a state HEI, located in the interior of the state of Para, Amazon, Brazil. It is characterized as a Polo University Campus for

municipalities in the southeast of the state. The target audience was the professors of the Undergraduate Nursing Course, a representative of the pedagogical advisor, a representative of the assistant coordination of the course, and the general coordinator of the institution. The faculty of the Nursing Course is made up of several professional categories, but the majority is composed of professional nurses.

With reference to data collection, it was carried out in two phases: documental via the information source of Curriculos Lattes and oral via semi-structured interview. Both stages were developed by a professor and researcher in the area of teaching and health at the researched HEI. The first phase took place through a survey of the number of professors allocated in the first semester of 2018 in the Undergraduate Nursing Course. It was established as an inclusion criterion for this stage only professors who develop theoretical or practical academic activities in the Nursing Course, since the other courses on the researched campus do not yet work under the guidelines of the integrated curriculum.

Through the list of 25 professors, the database of the National Council for Scientific and Technological Development (CNPq) Lattes Platform was used as a secondary source of information to compose the academic and professional profile of the course professors. However, it is noteworthy that to characterize this profile, information collected in the two phases of data collection was used in order to avoid a possible bias in outdated curricula.

In the first phase, a Lattes Curriculum Assessment Registration Form (FRACL) was used as a collection instrument, used in selection processes for professors at the institution. The choice of this one enabled the organization of data with statistical resources through the scoring and systematization of information related to the area of health teaching, such as: academic titles, length of professional experience, scientific production, teaching, research and extension activities.

The second collection phase reiterating the qualitative methodological predominance of the research, a previously structured interview script was used as a collection instrument, containing 18 standardized guiding questions for the pre-defined thematic categories: Teacher training for the integrated curriculum, Continuing teacher education for the integrated curriculum; and didactic and pedagogical strategies of the teacher in the practice of the integrated curriculum.

Of the 25 professors in the first collection phase, in this second stage, 20 professors were approached for the interview, according to the inclusion criteria: bond in the



institution for at least 6 months, this period was established with the purpose of selecting professors who had already had some proximity to the practice of the integrated curriculum. As well as the criterion for the order of approach with participants, we prioritized professors with more time in the institution, considering the purpose of collecting valuable information from the period of implementation of the integrated curriculum in the institution.

Regarding the exclusion criteria, it was applied to: teachers on health and maternity leave; vacation; I terminate the contract with the institution during the research collection period, as well as the use of the sampling technique by information saturation - operational aspects for redundancy and repetition of data. (Denzin & Lincoln, 1994).

It is noteworthy that among the 20 professors interviewed, three are professors who exercised positions of coordination or pedagogical accessory at the institution, with more than half of these participants having been working for 10 years or more at the institution. The interviews took place with the invitation and prior scheduling of the time and place most suitable for the participant, the recording of data, took place at the same time as the collection with annotations by the researcher and the aid of an mp3 voice recorder for further detailed analysis.

In summary, the information collected in the first and second stages of data collection enabled the triangulation of data and evidence between the statements presented in the interviews and the information mentioned in the curricula. Likewise, ethical aspects were respected, based on Resolution 466/12 and 510/2016 of the National Health Council, which regulates research involving Human and Social Sciences, with regard to the right to spontaneous participation after explanation of the research objectives and signing the Informed Consent Term (FICF), confidentiality of information and risk reduction for participants. As well as approval by the Research Ethics Committee under the opinion number CAAE-83174217.3.0000.5174 (Brazil, 2016).

Based on the requirements of analysis strategies with data triangulation, it was based on simple descriptive statistics, expressed in numerical data, percentages, tabulation of pertinent information in graphs and tables to characterize the academic and professional profile of the participants. This strategy allowed us to explore more widely the data from the second collection phase for the content analysis of a qualitative nature of the social research proposed by Bardin, (2012), with theoretical

support in authors such as Berbel, (1992), Perrenoud, (2000) and Freire, (1996).

The coding scheme for data analysis was performed by the three authors and researchers who participated in the data processing in the three stages of the chronological poles of Bardin, (2011). In pole 1 - pre-analysis: there was the alphanumeric codification of the participants, systematic organization of the answers, with transcriptions and exhaustive reading of the answers to understand their meanings. These were compiled according to thematic categories pre-defined by the guiding axes in the semi-structured interview script. A model called "inverse process" was developed: once the system of categories is provided, the elements are divided, in the best way, as they are found" (Turato, 2008, p.447).

In pole-2: exploration or coding of the material: the process of subcategorization was started, which consisted of designing prominence, according to the frequency, repetition and relevance of the data, which allowed the description of the relevant characteristics expressed in the reports. At this pole, it was decided to organize the categories and subcategories into tables, thus facilitating the visualization of data for analysis. In pole 3: Treatment of results, inference and interpretation, the data were presented in the form of words, phrases and ideas, then went through interpretations and inferences, in order to relate the categories and their respective dimensions, which was represented by means of a diagram synthesis of the categories, providing a panoramic view of the research findings (Fig. 1).

In compliance with the scientific rigor in qualitative research, the reliability and validity criteria were used during the coding stages of the analysis. Among them, the use of different collection instruments to analyze the same research problem stands out, data triangulation to overcome limitations in the use of a single instrument with cross-referenced results, as well as conference of members between the authors, providing elements of coherence internal evaluation of the results in the analysis and review of the research stages with external evaluators (Flick, 2009; Creswell, 2007).

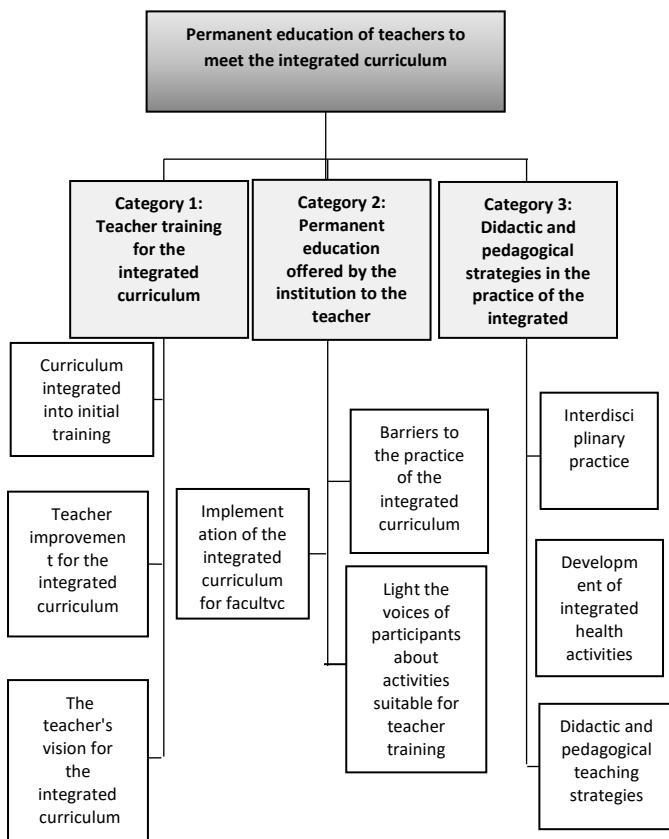


Fig. 1: Overview diagram categories and subcategories of analysis Overview diagram categories and subcategories of analysis

### III. RESULTS AND DISCUSSION

#### 3.1. Academic and professional training of teachers and the nuances of the integrated curriculum

In order to recover the subsidies from the initial training of the participants, the characterization of the academic and professional profile, allowed an analysis of the potentials and limitations to the new adaptations of the integrated curriculum in the institution, as well as triangulated information from the participants' discourse to the conceptual understanding of the integrated curriculum.

Among the potentialities, we point out: the initial training of teachers from the year 2000 (80%), training in public HEIs (76%), graduates of academic training at the institution (36%) and time of experience in teaching for ten years or more (60%). On the other hand, there were findings that represent weaknesses, these are represented by the limited participation in research and extension activities (40%), low investment in scientific production (30%), associated with little training in the stricto sensu type of teachers (32%), in addition to the low rate of academic training with a degree (28%).

Certainly, initial academic training from the 21st century onwards is seen as an advantage in the academic body, as it represented the growth in the offer of HEIs, postgraduate courses, with an increase in the demands for the teaching profession in the labor market, in addition to covering a period of new training and curriculum changes in Brazil (Schwartzman, 2014; Sampaio & Sanchez, 2017).

Furthermore, professors with initial graduation from public university institutions provide opportunities for the relationship between teaching, research and extension practices. Since, public institutions lead the ranking of scientific productions and point to the greatest incentive in the teaching-research-extension triad (Carmo & Santos, 2015).

Though, despite the predominance of training from the 21st century onwards, in the speeches of the participants, a limited contact with the integrated curriculum is revealed. Mainly due to the few trainings for licensure and contacts with the integrated curriculum only as students, which does not represent a formal training for this curriculum, since, for the deepening of this training, training for licensure or concomitant with bachelor's training, a scarce feature in the training of most health courses (Nóvoa, 2017).

In this context, the dimensions that made up the subcategory "the curriculum integrated in initial academic training", the statements of most participants express that they had no experience for the integrated curriculum in initial training:

*[...] I did not receive any graduation training for this curriculum. I had a very traditional education [...].*  
(Teacher-01).

*[...] This curriculum was not mentioned. It was the traditional teaching, but what helped me to understand a little were the two years I did my degree [...].* (Teacher-17).

As a result, it is considered that the low rate of teachers with a degree is unfavorable for the practice of this curriculum, since it requires more than just knowledge related to the subjects taught, but also the requirements of professional skills for the act of teaching post that initial bachelor's training does not cover these demands (Tardif, 2002).

However, professionals who join as professors in the same HEI of initial academic training are considered a potential because they enable the entrenchment of the teaching profile fostered by the institution due to familiarity with the routine and guidelines of institutional practices. As well as the length of professional experience, it is classified into periods, which mark characteristics

ranging from instability to professional maturity, since the longer the period of professional experience, a trajectory of solidification and consolidation in the teaching career is expressed (Humberman, 1992; Star, 2010).

Also in the characterization of the training of the participants, we sought to describe "the improvement of the teacher for the integrated curriculum", the results show that the majority did not participate in any external training activity in the last 24 months, as shown in the following statements:

*[...] I haven't taken any courses outside the institution.*

*I still haven't had the opportunity to participate [...]*  
(Teacher-07).

*I didn't even do a training abroad. What happens a lot is the socialization of materials among teachers (Teacher-12).*

This situation reflects a scarce routine of participation in refresher courses, which is confirmed by the weaknesses found in the training profile of the participants. Few professors report the search for professional improvement for the presuppositions of the institutional curriculum, a reduced framework for academic education of the stricto sensu type, which contributes to the low scientific production. Given that this type of training requires greater rigor in production through a system of courses that strengthens advanced training for scientific research (Brazil, 2017).

With reference to the types of participation in research, relevance is expressed only for the quantitative in Course Conclusion Work (TCC) guidelines, showing an incipient picture in intellectual production in research of a deep scientific nature, which is not possible to achieve in research at graduation. This scenario causes a distance from the dissemination of technical, pedagogical, scientific and cultural knowledge, as well as the low participation in extension projects, which generate barriers for the propagation of knowledge from the academic field, to return and promote transformations in society (Vieira, 2013).

Therefore, it is noteworthy that valuing access in stricto sensu postgraduate courses in education and health, contributes to the achievement of methodological demands of pedagogy and didactics, provides subsidies to instruct knowledge about active learning processes that foster autonomy, creativity, criticality of students, consolidation of training spaces that favor the confrontation of problems and challenges within the scope of professional practice, combining the perspective of qualifying higher-level professional training (Freitas & Seiffert, 2007).

During the interviews, "the teacher's vision for the integrated curriculum" was also asked, making it possible to explore the theoretical knowledge formed by the participants:

*[...] I understand that this curriculum can support, in general, all subjects. Train the student to work in a generalized manner in accordance with the demand of various health sectors. [...] prepares the student to work according to the experience of the service. Prepares a professional to experience various areas of knowledge (Teacher-13) [...].*

*[...] The integrated curriculum is a practice, a way of doing things. In this way he only adds, because everything that is fragmented he loses. So, when I propose to work through content integration through contextualization, I manage to make that speech bring meaning to his reality.*

*Because I'm not working on an isolated subject, but, bringing knowledge from various areas through a simple correlation, this will add to the student's learning [...]*  
(Teacher-12).

Regarding the teacher's vision for the integrated curriculum, despite the gaps in initial training among the majority, a theoretical deepening close to the real potential that encompasses the conceptual context of the integrated curriculum was noticeable. However, there were no references in the statements about critical and reflective competence. This characteristic is considered essential for the development of an integrated curriculum and should be part of the attitude between professors and students.

The structuring of a concept that meets the core of the requirements of the integrated curriculum must be supported by knowledge organized in content that relate to various subjects, having the following guiding principles: the conception of critical-reflective teaching-learning, interdisciplinarity and the relationship theory and practice, conceiving forms of integration from the intercalation of problems resulting from the contextualization of practical needs in the real context of a profession and inserted in a dynamic process open to criticism and changes, providing integration between academia, service and community (Barba et al, 2012; Kikuchi & Guariente, 2014)

From this angle, it is essential to know the experiences present in the faculty and incorporate the requirements to improve this training in the trajectory of implementing changes in the education system. The success in adapting the new curriculum recommendations is contiguous with academic activities and in the role of the teacher in teaching practices. Without adherence, awareness and encouragement to the training of these professionals, such changes tend to fail (Kopruszynski & Vechia, 2011).

### 3.2. Continuing teacher education for the assumptions of the institution's integrated curriculum

The first group of themes was called "implementation of the integrated curriculum for the teaching staff". In this finding, the participants were professors in stating that they have not received permanent education since the implementation of the curriculum at the institution. The reasons that made up this analysis were expressed in the following speech:

*[...] When he switched to the integrated curriculum, which was in 2007 [...] there was a meeting with the coordination here on campus, they did a 2-day work explaining how the curriculum was, they gave us some material to read, the problematization was discussed, but there was no practical monitoring or evaluation work and that is how it has been happening until today [...].*  
(Teacher-04).

This context reflects an unfavorable scenario to align with the demands of curriculum implementation. Since, the teaching profession is constituted in the midst of a process of constant transformations, added to the various knowledges that are mainly constructed in accordance with the institution's needs. It is necessary to establish an open dialogue about the difficulties of the faculty and use the space of the HEI to empower them, valuing the exchange of experiences (Vogt & Morosini, 2012).

Given the complexity portrayed in the lack of institutionalization of a teacher training program, barriers related to the process of adapting to changes are revealed. During the speeches, limitations to the adequacy of the curriculum were raised. Among them, the following were cited: the lack of integration among the faculty, local and regional limitations, together with staff turnover in the institution and the attitude of the student. These findings comprised the theme "the barriers of the path to the practice of the integrated curriculum", as shown in the following statement:

*[...] In fact, in our professional rush we are unable to integrate and for those who do not live exclusively from teaching, this prevents us from participating and only the same teachers always end up in the activities we carry out. [...] All of us professors have other jobs, so we can't get together to plan an activity that shows this reality of integrating disciplines for the student. I think this is the first point, the problem is with us [...].* (Teacher-02).

Such statements express that the professor recognizes himself as one of the main barriers to the implementation of the curriculum, which is justified by the multiple employment bonds in other institutions. Since, according

to information from the professional profile of the participants, 85% have more than one employment relationship. In addition, the Exclusive Dedication regime in the framework is occupied by only three professors (15%) and the rotating links are represented by half of the group (48%). These factors contribute to the lack of integration and influence various limitations in labor relations, such as the negative performance of work activities, instructional effort, academic productivity and commitment to a professional career (Rowe, Bastos & Pinho, 2013; Alves & Pinto, 2011).

As well as, in the speeches of the participants, the specific limitations of the region of a university campus located in the interior of the state of Pará, Amazonia, Brazil are referred to.

*[...] The university demands a lot from us, I don't know if it's the reality of being on a campus in the interior of the state. Here at this institution, we do not receive continuing education [...] The level of demand is a lot and there are few subsidies to teachers [...] When it happens, it is not disclosed in advance and few people participate [...].*  
(Teacher-03).

In this sense, it is reiterated that interiorization is a feature present in state university campuses. As of 2001 there was an expansion of state universities, with 17 located in capitals and 22 in the interior of Brazil, totaling 39 university campuses by 2016. This process was accompanied by some implementation problems, such as factors related to infrastructure and deficits in the composition of the human resources framework. On the other hand, they were responsible for the expansion of enrollments in public higher education, representing 27.5% across the country (Andrade, 2012; Fialho, 2012; Carvalho, 2018)

Regarding the barrier raised on the students' posture for the development of the integrated curriculum, there is a real weakness that permeates since high school, as the adaptations of the integrated curriculum in basic education are not yet established in Brazil. In general, these young people entering higher education carry trajectories of a school culture of low valuation of education and content fragmentation, which, if not properly conducted, can represent difficulties in monitoring the demands of higher education (Sampaio, 2011).

During the interviews, many participants also make suggestions for continuing education activities, represented by the theme: "Light the voice of participants on the appropriate activities for teacher training":

*[...] What we need is monitoring. Designate a team to come here, make an intervention and again come back and*

*assess the changes that have occurred or not (Teacher-18).*

*[...] Listening to the teachers to find out about the needs, the main difficulties, the themes, but that the teacher could also participate contributing ideas [...] (Teacher-05).*

In fact, the reluctance of the speeches show that there is no teacher training program in the institution that directs towards the precepts of the integrated curriculum. The statements give rise to effective strategies aimed at continuing education actions such as: the development of internal working groups for the schedule of educational interventions, action planning, setting goals to achieve theoretical and practical professional improvement in didactic and pedagogical performance, establishing a flow of monitoring and follow-up by the external coordination (matrix campus) of the goals and transformations achieved in the group's practice.

In this sense, it is noteworthy that the successes in continuing education activities developed in the educational institution, intend for the need for systematic meetings that must take place under supervision, valuing information exchange environments in order to expand interpretations and meanings of teaching practice through collective reflections raised on the particular needs of each institution (García & Vaillant 2001; Bolfer, 2008).

### **3.3. A critical look at reality: the curriculum produced in the didactic and pedagogical field**

In order to promote the analysis of the development of the guidelines of the integrated curriculum in the researched institution, we sought to make an interpretation of the practice of teachers in order to explore the context of the actual practice of the curriculum.

In this sense, for the first group of results in this category, score on "the interdisciplinary practice" as described in the following speech:

*[...] The interdisciplinary practice still doesn't occur as it should, some teachers still show resistance. They are still carried out in a very tenuous way with some subjects in some semesters, but not with others [...] This is a consequence, I would say, within this very lack that the university has to work and accompany teachers from the interior [...]. (Teacher-14).*

The term interdisciplinarity is used to express an interlocution between the understanding of a science in its most varied areas, covering themes and contents, allowing the articulation of innovative and dynamic resources for the expansion of learning. The collaboration of different professional areas for health care allows for a broader

understanding of the health-disease process, reinforcing the goals of prevention and health promotion with a focus on comprehensive care (Costa & Guariente, 2016).

Only a small part of the participants described the concept close to the one mentioned above. The majority pointed out the difficulties in the practice of interdisciplinarity, referring to the same points mentioned above as: teacher turnover, difficulties in participation and integration, limitation as it is a rural campus and the need to reorganize disciplines in the axes of the curricular components.

In this sense, in relation to interdisciplinary practice, the teaching staff is encouraged to build a methodological dialogue, adding similar structures from different disciplines. To achieve this process, the rescue of stages that are much more relational than structural within an HEI is required, involving dedication and interaction with the academic community, adaptation to innovative practices, proactive reactions and flexible and changeable planning (Freire, 1996; Veiga & Quixadá, 2012; Pereira & Nascimento, 2016).

For the findings of questions about practical experiences in teaching actions in the internship field, the description for the "development of Integrated Health Activities (AIS)" was sought. The lines give the following description:

*[...] Little happens in some axes and in others it doesn't happen. [...] To develop these activities, you have to have an integrated team that keeps up to date. There cannot be professors who own the subjects [...] (Teacher -14).*

*[...] My experience with integrated activities is that we work on continuing education for professionals according to the needs of the service [...] (Teacher -17).*

In the different scenarios of health training, it is necessary to use didactic strategies in the practical internship field, among the participants' statements refer to a shallow picture in the development of AIS. Since, they showed little proximity to the requirements of the concept that make up these activities. This framework reflects the predominance of biomedical and content teaching, with training by disciplines, approaching fragmented and specialized knowledge, with little proximity between the different areas and the tendency towards isolated work among professionals (Carabetta, 2016).

AIS are identified as educational actions that are integrated into the actual practice of a profession. They can provide a rapprochement between the academic community in different areas of health and SUS professionals. They promote the understanding of different health scenarios through interdisciplinarity. Therefore,

overcoming such barriers is crucial to sustaining integrated education, since they are considered strategies centered on the production of knowledge, based on the socio-sanitary reality and on assistance consistent with the needs of SUS services (Freire, 1996; Franco, Soares & Bethony, 2016; Toassi & Lewgoy, 2016).

To complete this analysis, we sought to describe the approach of the didactic and pedagogical practice developed by the participants. These findings comprised the theme "didactic and pedagogical teaching strategies", as expressed in the following lines:

*[...] I use well blended methodologies. I use lectures I try to reduce as much as possible in 50 minutes, because it is saturating and the concentration level drops. I do targeted studies, case studies of systems involving diseases to understand the normal and the pathology even if they are not seeing the pathology yet, but they need to understand that there are already structural changes. [...] They do seminars, field research, technical visits, I try to bring other professionals from other areas and basically that's what I try to do [...]* (Teacher-20).

*[...] I provide moments of brainstorming in the internship field, work with situational diagnosis and portfolios. In these portfolios, I guide them to write daily reports, making their own reflection, putting the advantages and disadvantages of internships [...]* (Teacher-06).

Regarding the description of didactic and pedagogical practices among teachers, most intersperse the use of strategies that mobilize the student to elaborate a reflection and situations with isolated approaches such as: use of portfolios, case studies and brainstorming, with a prevailing movement innovative interventions. This framework reflects advantages in the attitude of the teacher, given that the use of constructivist-based methods prevails, however, such statements do not support the development of active teaching-learning methodologies.

In summary, active methodologies are operationalized from teaching-learning strategies based on the constructivist approach, with valuing of prior knowledge to significantly reframe the construction of new knowledge, with a collaborative approach, social interaction, interdisciplinary integrated with other disciplines and contextualized through problematization, mediated by the purpose of stimulating the student to question, examine, critically reflect on their reality, with the need to solve impasses through autonomous choices and decision-making integrating a social context (Freire, 1996; Perrenoud, 2000; Farias, 2015).

Among the didactic and pedagogical strategies to better serve the integrated curriculum, the problematization

methodology stands out. Such method constitutes a permanent circle of inquiry and search for adequate solutions to the problems observed in the concrete reality of the learning scenario. With each new hypothesis applied to reality, a new reality to be observed is generated, from which the participants are again encouraged to reflect, analyze and propose new hypotheses for solutions (Alves & Berbel, 2018).

However, in relation to the problematization methodology that is recommended in the Pedagogical Course Project (PPC) of the institution, few professors reveal its use in the didactic routine. In addition, a perfunctory view of the stages of the strategy is exposed, as shown in the following speech:

*[...] I use problematization as a strategy. I encourage students to go to the field to reflect, culminating in a context of transforming reality [...]* (Teacher-04).

With regard to the problematization methodology, the first reference in conducting these steps is related to Charles Maguerez's arch method, guided by a sequence of 5 systematized and linked steps due to a problem detected in the learning reality, such steps mobilize a path that must be followed by the student and involve reflections, questions and theoretical deepening, to then prepare the latter for an awareness of the world with the search for solutions to intentionally transform it (Freire, 1996; Bordenave & Pereira, 2007; Berbel, 1998)

In addition to the active problematization methodology, other teaching and learning strategies for the development of the integrated curriculum are mentioned, such as: discussions in curricular internships linked to clinical case studies, dramatization, theorization, systematization, synthesis, training of technical skills, home visits and the encouragement of research (Alves & Berbel, 2018).

In this context, it is noteworthy that, in order to meet the assumptions of the integrated curriculum, it is essential to invest in permanent training aimed at teaching skills such as: learning situations, encouraging the progression of learning, designing devices that provide for the evolution of the learner, involving them in learning, teamwork, participating in the administration of the institution, using new technologies, facing the duties and ethical dilemmas of the profession and administering their own training continuously (Perrenoud, 2000).

#### IV. CONCLUSION

In view of the concerns raised in the course of the research, the proposed analysis allowed us to detect that there is no institutionalization of a continuing education program for teachers to support the implementation of the

integrated curriculum. Such a strategy is necessary since, in the last two decades, there have been curricular changes in the institution and the initial training of the teaching staff has little proximity to institutional demands.

The lack of an institutional training program creates difficulties for the development of teaching practice, and are out of step with the guidelines of the proposed curriculum, such factors are expressed by the absence of an interdisciplinary approach and discreet use of active teaching-learning methods. What happens in practice are individual initiatives among teachers for innovative didactic and pedagogical strategies that, although they can mobilize the student to elaborate a reflection, cannot be classified as the use of active methodology, especially with regard to the method suggested by the institution.

However, there are interferences related to local and regional singularities such as the turnover of professors in the institution, the mitigated institutional culture for teaching, research and extension activities, and a reduced framework of *stricto sensu* training. Analyzing teaching practice in the light of the integrated curriculum requires looking at it from different angles, including one of the pillars of educational institutions represented by the teacher.

Thus, it is concluded that among the demands for permanent education actions, effective institutionalization and the rescue of the institution's commitment to the continuous construction of knowledge for the competences of teaching practice, followed by theoretical and practical professional improvement are raised. , establish an internal and external program of follow-up, planning, monitoring and evaluation of actions, start interdisciplinary work, adjustments in the development of AIS and encouragement of active methods of teaching and learning with an emphasis on problematization.

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# A rare presentation of tibial eminence avulsion fracture in adult

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**Keywords** — *tibial eminence, pediatric  
population, ACL.*

**Abstract** — *Tibial spine fracture are uncommon injuries in the pediatric population however they are rare in the adults. The treatment of the tibial spine fracture can be open or arthroscopic fixation for displaced fragments or casting. Treatment depends on the displacement degree. The paper presents the clinical history, surgical technique, pre-and postoperative images of a 37 years old female with tibial eminence avulsion fracture. The CT and MRI results show that the patient has a separation of the tibial attachment, which an arthroscopic surgical fixation performed on the patient using Hewson suture passer technique*

## I. INTRODUCTION

Knee injuries are caused by sprains described to the impact caused by the stress applied from a specific direction with the ligaments holding the knee in position undergoes tears due to the force. An anterior cruciate ligament (ACL) injury is one of the most common knee injuries (Webster & Hewett, 2018). The injury occurs when force is applied to planted foot either from the back or front of the knee, resulting in damaging the cruciate ligaments. Within few minutes, the knee swells, with the attempts of walking becoming challenging. Medical professionals usually confirm the diagnosis of knee injuries by MRI. Long-term treatment of ACL injuries usually involves surgical procedures with significant physical therapy designed to return the intended knee joint function. Tibial avulsion fracture are rare in adults yet their diagnosis and treatment is crucial to restore the function of the ACL and to prevent the patient from undergoing a more complex procedure with prolonged rehabilitation (ACL reconstruction surgery) The paper provides the atypical presentation 37-year-old female with a tibial eminence avulsion fracture with an intact ACL and avulsion of the anterior horn of lateral meniscus

## II. CASE REPORT

37 years old female staff at Fakeeh with a medical history of fall on the right knee reported while on a wheelchair complaining about pain and swelling in the right knee. A few hours after the injury, the patient said a swelling on the knee made her report to the hospital's emergency room. Several physical assessments were undertaken on the patient, including x-rays. The physician later discharged the patient from the ER but on pain-relieving medications. she denied a history of undergoing knee surgeries in the past. The patient also denied having a past medical history that might impact the current condition. The patient also denied the possibility of having any allergies.

The patient underwent physical examination illustrating a restrained effusion of the right knee joint. The extension of the right leg of the patient demonstrated a lag of 10 degrees with flexion of 40 degrees. According to the physical assessment, there were no open wounds on the right knee. The examination conducted on the patient was limited due to severe pain experienced by the patient. The patient could not bear the weight of the lower limb. Based on the allergic condition, which the patient denied being

allergic to, there were no known drug allergies prescribed

by the physician to the patient.



Fig. 1: The images above provide the computerized tomography (CT) scan of the right knee of a 37-year-old patient with severe right knee pain. Precursory (a) representing the lateral view of the right knee showing swelling on the knee joint, and image (b) representing the anteroposterior (AP) view of the right knee.



Fig. 2. preoperative CT images of the right knee. (a) anteroposterior (AP) view and (b) lateral view of the right knee showing an avulsion of the knee joint.

CT scan done for the patient and showed tibial eminence avulsion fracture (ACL attachment) (fig.2). The patient

was required to undergo a surgical procedure that was performed three days after visiting the hospital's

emergency room. The pre-operation planned procedure performed was arthroscopic vs open tibial spine avulsion fracture fixation

### III. TECHNICAL DETAILS OF THE PERFORMED PROCEDURE

Conducting procedures on patients requires following some routine that is not necessary for all the procedures. Below are the procedure details conducted on the right knee of the 37 years old female with tibial eminence avulsion fracture

Under spinal anaesthesia, supine position with the knee hanging and with the use of tourniquet, routine prepping and draping 2 portals inserted medial and lateral as standard knee scope finding were :intact ACL fibers but avulsed from its attachment intibialeminence with a displaced Fragmented

And an anterior horn lateral meniscus avulsion, after washing the hematoma in the knee and cleaning of the under bed of tibialeminence with a curate , then reduction done with preliminary fixation with k wire , Utilizing a suture pass technique with a Hewson suture passer, the medial tibial eminence fracture was reduced , then 2 drill Hole using the ACL c guide, after that Passing the suture through tibial tunnel and through the anterior horn of lateral meniscus, we pass a suture through the anterior horn lateral meniscus ,then drilling a 4.5 mmtibialtunnel, Passing the suture through the bone tunnel By pulling the suture the ACL and meniscus reduced with the knee in full extension .The 2 suture was tied over the tibial shaft and fixed with a 4.5 mm screw with washer.

After completing the procedure successfully, xays taken showing reduced fragments.After three days of surgery, physical examination illustrated that the patient started gaining stability with a significant reduction in pain.



Fig. 3. postoperative CT scan images. (a) AP view and (b) Lateral view of the right knee with a reduced tibial eminence

### IV. DISCUSSION

The tibial spine fracture is also known as the anterior cruciate ligament (ACL) avulsion fracture, which is considered a type of avulsion fracture occurring in the knee. Tibial spine fracture entails the separation of the tibial ACL attachment by variable degrees. Femoral attachment separation is a rare case of fracture reported in healthcare organizations. Tibial spine fracture is commonly reported in children than in adults, but there are specific cases that involve this type of fracture in adults. There is an assumption about the commonness of the fracture in children than in adults. It is hypothesized that it occurs in children because of the relative weakness of the partly fossilized bone concerning the ligamentous fibres (Nakashima et al., 2020). It is also caused by the relative increase in the elasticity of the ligaments for the children.

The tibial spine is caused by the powerful hyperextension of the knee or even the straight impact of a knee flexed at the distal end of the femur. The diagnosis of the tibial spine fracture is usually confirmed with the use of knee radiographs (CT or MRI). MRI findings of a fractured knee can be helpful in the determination of associated meniscus tear. The treatment of the tibial spine fracture can be open fixation and reduction and closed casting and contraction, which depends significantly on the displacement degrees and closed reduction success.

**Meyers and Mckeever's classification**

Meyers and McKeever proposed a classification of injuries in 1959 (Green et al., 2019). In 1977, Zaricznyj modified the classification, considered the most common, and applied the ACL avulsion fracture description system. Under Meyers and McKeever classification system, injuries are categorized into four different types:

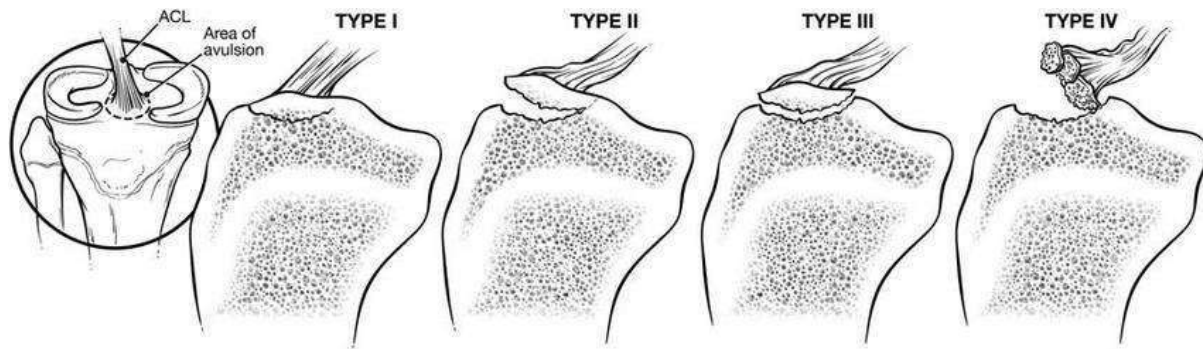
**Type one:** nondisplaced or minimally displaced fragment

**Type two:** anterior elevation of the fragment

**Type three:** complete fragment separation

- a. Entails the small eminence portion
- b. Entails the majority of the eminence

**Type four:** fracture fragment rotation or the comminuted avulsion



A tibial avulsion is categorized under the fracture fragment of the variable orientation entailing tibial eminence based on the fracture type. However, the anterior femur's translation is checked on the lateral view of the tibia.

Any fracture involving displacement of the entire tibial spine should undergo surgical fixation and anatomic reduction. Surgical management is almost always required in adults, due to the high prevalence of associated injuries and entrapment of soft tissues. Typically, because of the ACL is still attached to fragment the surgery is less complex and has better outcomes in comparison to a ACL reconstruction surgery, arthroscopic reduction with suture fixation has become the preferred treatment in compared to fixation with k wires and cannulated screws due to the potential of impingement or the need of another surgery for hardware removal.

In conclusion, early diagnosis and treatment of tibial spine eminence fracture is crucial to restore the function of the ACL and to prevent subsequent instability, post traumatic arthritis and the need for ACL reconstruction surgery latter.

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## Quality of life and health profile in individuals with Parkinson's

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**Keywords**— *Physiotherapy. Parkinson's.  
Quality of life.*

**Abstract** — *Parkinson's disease is a pathology that affects the central nervous system (CNS) progressively causing its degeneration. This results in a decrease in the dopamine hormone, which is the neurotransmitter responsible for normal brain activity, its decrease directly linked to the appearance of the pathology. Therefore, it affects the quality of life, which is represented by the degree of satisfaction found in family, loving, social and environmental life. As a treatment, physiotherapy plays a fundamental role in improving the quality of life in order to relieve symptoms and disease progression. The aim of the study was to analyze the quality of life and the health profile of the individual with Parkinson's disease. The research is descriptive, with a cross-sectional design and a quantitative and qualitative approach. The sample consisted of 11 individuals with Parkinson's. Data collection was carried out through a mixed online questionnaire, developed through Google Docs®, containing information and general characteristics of the participants, a questionnaire on the health profile of Nottingham (PSN) and finally a questionnaire that evaluated the quality of individuals with Parkinson's (PDQ-39). The PSN questionnaire brought an average of 13.7 points indicating a worse perception of health and the PDQ-39 presented 45.8% in the average of the final score. With this study, it was possible to note that the quality of life of the participants is greatly affected due to the symptoms, degree and progression of the disease.*

## I. INTRODUCTION

Parkinson's disease is a pathology that affects the central nervous system (CNS) causing its degeneration progressively leading to the decrease of the hormone dopamine, which is the neurotransmitter responsible for the normal activity of the brain. Its decrease is directly linked to the emergence of the pathology (GOULART et al., 2004).

Among the alterations present in Parkinson's disease are: tremor, described as at rest and usually involves mainly the hands; stiffness that leads to a limitation in range of motion and resistance to movement; bradykinesia due to slowing of movements; postural instability and musculoskeletal changes altering balance and causing postural deviations (SILVA; DIBAI FILHO; FAGANELLO, 2011).

These postural deviations lead to a decrease in lung expansion due to chest rigidity, which, in turn, compromises the natural movement of breathing, leading to progressive limitation of lung ventilation (PEREIRA, 2006).

Such changes require physical therapy treatment so that there is a process of rehabilitation of patients with Parkinson's disease. This treatment is developed with motor exercises, such as, for example, training in gait and activities of daily living, relaxation therapy and breathing exercises (ARAÚJO, 2007).

With this, the compromised quality of life can present a decline according to the symptoms, degree of the disease and its progression, therefore, it is necessary to elaborate an adequate intervention strategy in order to minimize the symptoms and slow down the disease progression, through knowledge of factors related to the perception of quality of life (SILVA; DIBAI FILHO; FAGANELLO, 2011).

Due to all the changes mentioned above, it is possible to observe the difficulty that people with Parkinson's disease have when it comes to quality of life and functional independence. Thus, the general objective of this research is to analyze through questionnaires if there is really a change in the quality of life and how this affects the lives of these individuals.

Taking into account the characteristics of the pathology and the above, the following question arises: Is there a decrease in the quality of life of the individual with Parkinson's? Is it possible to see which changes are present in these people's lives, measuring through specific questionnaires for this pathology?

In view of this, it motivated the choice of the research topic, as it is of great importance to collect data to

analyze the quality of life of these individuals and how they behave in the situation.

Thus, the general objective of the research was to evaluate the quality of life and health profile in individuals with Parkinson's disease. The specific objectives were to assess the quality of life of these individuals and their health profile.

## II. METHODS

### TYPE OF RESEARCH

The survey is a descriptive one, with a cross-sectional design and a quantitative-qualitative approach.

#### As for the goals

The study was defined as descriptive and with a quantitative approach. In order to demand from the investigator information about what he wants to study, descriptive research intends to describe the facts and phenomena of a given reality. Seeks to answer questions without interfering with reality, observes the motivation for that action, and may aim to become familiar with a phenomenon or discover a new perception or analyze points of view from different sources (FONSECA, 2012).

#### As for technical procedures

For technical procedures, the study was characterized as a cross-sectional research, which is carried out through data collection that can be carried out through interviews, observations or search for information or data in databases and documents (SILVEIRA, 2009).

#### As for the approach

Finally, presenting a quantitative approach, which is based on the use of measurable data with the use of questionnaires, measurement and precision calculations, elaboration of indexes and scales and statistical procedures explaining its existence, relationship or influence on another variable, with concern with what is common to most situations. It seeks to analyze the frequency of occurrence to measure the veracity or not of what is being investigated (FONSECA, 2012).

This type of approach is tied to the formulation of hypotheses through verification, demonstration, tests and mathematical logic that require a relationship between cause and effect to support the conclusion in statistical data and thesis. (ZAMBELLO et al., 2018).

#### Sample and Location

The sample consisted of 11 individuals, of both sexes, aged between 40 and 80 years and diagnosed with Parkinson's disease.

## Ethical procedures

The project was submitted for proper approval by the Ethics Committee of the Alto Vale of Rio do Peixe University (UNIARP) according to the recommendations of resolution 466/12 of the national health council for scientific research with human beings.

After proper approval, through opinion number 4,143.053/2020, data collection started, through the dissemination of the survey on the social networks Facebook®, Instagram® and Whatsapp®.

## Procedures for data collection

To meet the objectives proposed in this study, data collection was performed through a mixed online questionnaire, developed on the Google Docs® platform, available at this link <<https://forms.gle/ypDt1GoT2v3NLiwS8>>.

The capitulation of the participants took place through the dissemination of the questionnaire link on the academic and supervisor's social networks Facebook®, Instagram® and Whatsapp®. The collection period took place between the months of July to September/2020.

The evaluation consisted of questions referring to the general characteristics of the participants, applying the questionnaire on the Nottingham Health Profile (PSN) and another that assessed the quality of life (PDQ-39) in individuals with Parkinson's. These were answered by the participants with Parkinson's, and if the participant could not answer the questionnaire alone, it could be helped by a family member or even a professional responsible for their care. The questionnaires that were used are described below:

### 1. Questionnaire of general characteristics of participants:

It is a targeted questionnaire containing information that characterizes the participants, such as: name; age; education; physiotherapeutic treatment is performed; among other questions, being closed and multiple choice.

### 2. Nottingham Health Profile Questionnaire (PSN):

It is a comprehensive questionnaire to assess quality of life, originally developed to assess the quality of life in patients with chronic diseases. It uses an easy-to-interpret language and offers a simple measure of the individual's physical, social and emotional health, being considered clinically valid to distinguish patients with different levels of dysfunction and to detect important changes in the patient's health status over time. It refers to a self-administered questionnaire, consisting of 38 items, based on the disability classification described by the World

Health Organization, with answers in the yes/no format. Items are organized into six categories that include energy level, pain, emotional reactions, sleep, social interaction, and physical skills (TEIXEIRA-SALMELA et al., 2004).

### 3. Quality of Life Questionnaire for Individuals with Parkinson's (PDQ-39):

It is a widely used questionnaire and a specific scale for this pathology. It consists of 39 questions and divided into domains, namely: mobility, consisting of 10 items; daily life activity, with 6 items; emotional well-being, 6 items; stigma of the disease, 4 items; social support; 3 items; cognition, 4 items; communication, 3 items; and physical bodily discomfort, with 3 items (BRIDGES et al., 2017).

As an alternative answer, it presents five options: "Never"; "rarely"; "sometimes"; "often" and "always" (VASCONCELOS et al., 2015). The score ranges from 0 to 4, which is never equal to 0; every now and then it equals 1; sometimes equals 2; often equals 3; always equals 4 (BRIDGES et al., 2017).

The overall score ranges from 0 to 100, where 0 means less problem and 100 means a higher level of problem and worse quality of life. This score is divided by the domains mentioned above. In the emotional well-being domain, the score ranges from 0 to 24, which brings questions about how you felt in the last month; in the Stigma domain, where questions about situations that the person lived in the public are addressed, the score ranges from 0 to 16; in the social support domain, it ranges from 0 to 12; in the cognition domain, it ranges from 0 to 16, addressing issues related to concentration, memory, among others; in the communication item, it ranges from 0 to 12 and aims to assess whether the individual has the ability to communicate; in the body discomfort domain, it ranges from 0 to 12 (BRIDGES et al., 2017).

The score for each domain is calculated according to the following formula: the sum of the patient's scores for each question, divided by the result of the multiplication of 4 (the maximum score for each question) and the total number of questions in each division. Your result should be multiplied by 100. The total score ranges from 0 to 100, where 0 means less problem and 100 means a higher level of problem and consequently worse quality of life (LANA et al., 2007).

## III. RESULTS AND DISCUSSION

The sample consisted of 11 patients, aged between 70 and 80 years (45.5%), with complete higher education (54.5%), married or in a stable relationship (63.6%) who manifested the onset of symptoms between

60 and 70 years (63.6%), with a time of 5 to 10 years since the diagnosis of the disease (63.6%), practitioners of physical activity (90.9%) and physiotherapy (81.8%), these data appear in Table 1 below.

Table1 – Sample profile.

	N	%
<b>Gender</b>		
Feminine	3	27.3
Male	8	72.7
<b>Age</b>		
40 to 50 years	1	9.1
51 to 60 yearsold	two	18.2
61 to 70 yearsold	3	27.3
71 to 80 yearsold	5	45.5
<b>education</b>		
incompleteelementaryschool	two	18.2
Complete primaryeducation	two	18.2
Incomplete high school	1	9.1
completehighereducation	6	54.5
<b>Marital status</b>		
Married/consensual union	7	63.6
Divorced	4	36.4
<b>Onsetofsymptoms</b>		
30 to 40 years	two	18.2
41 to 50 yearsold	1	9.1
51 to 60 yearsold	1	9.1
61 to 70 yearsold	7	63.6
<b>diseasediagnosis time</b>		
between 1 to 5 years	3	27.3
between 6 to 10 years	7	63.6
between 11 to 15 yearsold	1	9.1
<b>practicephysicalactivity</b>		
Yea	10	90.9
No	1	9.1
<b>Performphysiotherapy</b>		
Yea	9	81.8
No	two	18.2

Source: Author (2020).

Table 2 shows the individual results obtained through the Nottingham Health Profile Questionnaire, where the maximum score is 38 points. When the score is

closer to zero, it is indicative of the worst perception of health, and the closer to 38 the score, the better is the perception of health. Through the results, it is possible to



observe that the sample reached an average score of 13.7 ( $\pm 8.1$ ) being indicative of a worse perception of health. The individual score is shown in Table 2 and Graph 1.

The concept of quality of life is related to several elements within self-esteem and personal wellbeing and encompasses several aspects such as functional capacity, socioeconomic level, emotional state, social interaction, intellectual activity, self-care, family support, lifestyle, among other factors. Its variable is the sociocultural level, age group and individual personal aspirations (VECCHIA et al., 2005).

In general, quality of life is represented by the degree of satisfaction found in family, love, social and environmental life, and with the changes resulting from the disease, there is a decrease in quality of life, resulting in limitation of activities and partial or total dependence (SILVA; DIBAI FILHO; FAGANELLO, 2011).

The results presented by the sample corroborate the work by Goulart et al. (2004), who carried out a study evaluating the functional performance and quality of life (PSN) among adults and elderly individuals and a group with Parkinson's patients, thus, the final analysis of the

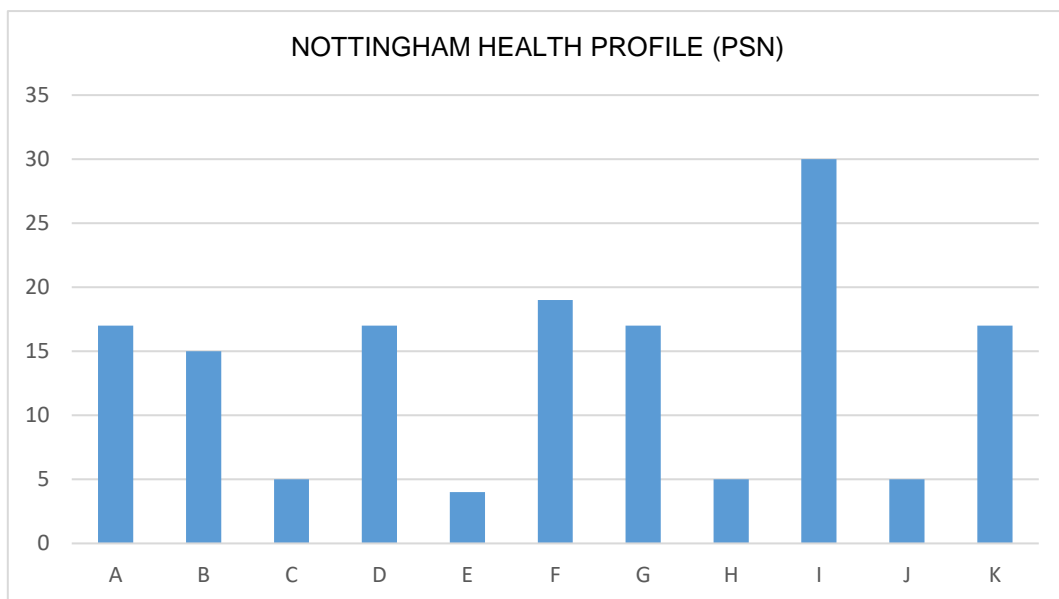
data also found a worse perception of quality of life in individuals with Parkinson's when compared to adults and the elderly.

Table.2:– Score from the Nottingham Health Profile (PSN) questionnaire.

Participant	Individual score
A	17
B	15
C	5
D	17
E	4
F	19
G	17
H	5
I	30
J	5
K	17

Source: Author (2020).

Graphic 1 – Score from the Nottingham Health Profile (PSN) questionnaire.



Subtitle: Individual Score

Source: Author (2020).

Table 3 shows the results obtained through the PDQ-39 questionnaire, in which the overall score values range from 0 to 100, where 0 means less problem and 100 means a higher level of problem, and consequently worse quality of life. It is possible to observe that the evaluated items were presented at a medium level, representing a

regular quality of life, with 45.8% in the final score average.

The dimensions with the highest score were mobility and social support with 50%, activity of daily living with 55.4%, and body discomfort with 58.3%.

The quality of life of these individuals and their impairment may decline according to the symptoms, the degree of the disease and its progression, thus, it is necessary to develop an adequate intervention strategy in order to minimize symptoms and slow down the progression of the disease, through knowledge of factors related to the perception of quality of life (SILVA; DIBAI FILHO; FAGANELLO, 2011).

Thus, this individual's mental and emotional impairment is directly affected according to the evolution and secondary complications of the disease, resulting in a worsening in the quality of life and in his level of capacity. Because of this, by understanding the stage of the disease and seeking the appropriate treatment, it is necessary to maintain and improve the quality of life, aiming at the physical and psychological well-being of those who have the disease (VASCONCELOS et al., 2015).

With the evolution of the disease, new changes arise that lead to compromised quality of life within other dimensions of the questionnaire, such as motor symptoms, cognition, bodily discomfort, emotional well-being and communication. Thus, the dimensions of activity of daily living and cognition showed a difference between the mild and severe groups, and moderate and severe (NAVARRO-PETERNELLA; MARCON, 2012).

Disorders that detract from the perception of quality of life are related to the development of motor activities, thus, the two domains that presented the highest levels of impairment were mobility and the activity of daily living, involving situations of leisure or bathing, where the motor support must be adequate (SILVA; DIBAI FILHO; FAGANELLO, 2011).

In the study carried out by Souza et al., (2007) which aimed to assess the usefulness of the questionnaire in question, comparing groups of patients with and without motor fluctuation, found a higher score in the mobility, activity of daily living, communication and body discomfort domains in the group of patients with motor fluctuation. Thus, when compared to patients with more than 5 years of disease evolution and patients with 5 years or less of the disease, the first group shows a worse score in relation to the PDQ-39, when compared to the first years of the disease. Thus, the results presented by the sample confirm the study by this author.

Table 2 – Score result of the Quality-of-Life Questionnaire for Individuals with Parkinson (PDQ-39).

	Average score eachquestion	Final score (%)
Mobility	20.0	50.0

daily life activity	13.3	55.4
Welfare	9.3	38.8
Stigma	5.1	21.3
Social Support	14.0	50.0
cognition	5,6	46.7
Body Discomfort	7.0	58.3
total score	74.3	45.8

Source: Author (2020).

#### IV. FINAL CONSIDERATIONS

Parkinson's is a pathology that causes negative impacts on quality of life, self-esteem, social and economic aspects, but mainly physical and psychological changes to patients with the disease.

With this study, it was possible to analyze, through the questionnaires, that the quality of life of the participants is greatly affected due to the symptoms and degree of the disease, mainly in terms of mobility, activities of daily living and bodily discomfort, which can lead to depression and resulting in a worse perception of health.

The greatest difficulty faced in carrying out this study was the small number of individuals with Parkinson's to answer the questionnaire, in which those who participated were very helpful due to the level of complexity of the questionnaire. Another difficulty encountered was the scarcity of literature with the same methodology. It is suggested that the methodology of this study be associated with a treatment protocol, thus being able to observe the effectiveness of physiotherapy in restoring the quality of life of patients with Parkinson's.

Thus, physiotherapy has a fundamental role in the treatment, prevention of disease progression and especially the promotion of health for these patients, through exercises that help with mobility, balance and help maintain the individual's condition to reintegrate him into society with a good quality of life.

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# The impact of Debt Financing on Performance of Small and Medium Enterprises in Ghana

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**Keywords— Debt Financing, Small and  
Medium Enterprises, Financial  
Performance, Economic Growth.**

**Abstract** — *Small and Medium Enterprises (SMEs) are an essential part in the growth of the economy and industry as a whole. But in the long run, capital is needed to boost their performance hence the need to finance their operations primarily through debt. The scarce research on debt financing of SMEs leads to the purpose of this study to analyze the impact of debt financing on SMEs performance in Ghana. The SMEs sample used for the analysis was taken from Ghana Stock Exchange (GSE) database, which has forty-two (42) companies listed. It contains a comprehensive array of financial statements and balance sheets for companies active in Ghana. For the purpose of the study, 8 SMEs were selected based on their stated capital of not less than GHC 300,000. A five-year time frame financial account reports from 2015 -2019 consecutive year period were used for this study. Also, the study hypothesis was tested using multiple regression analysis. From the results of the study, debt-financed through both short and long term have a detrimental impact on SMEs' financial performance. With the intention to destitute credit and loan control policies, the study recommends that SMEs utilize their debt significantly. The diversification of their revenue streams, is essential to amateur down payment modes for trade credits and practice proper financial bookkeeping records. It is also suggested that transparency in payment schedules and necessity of training their employees on a regular basis. The employment of knowledgeable interior and exterior auditors to advance interior control systems and keeping of records is also advantageous for SMEs in accessing loans.*

## I. INTRODUCTION

The key aspect influencing the progress of Small and Medium Enterprises (SMEs) in both developing and developed nations across the globe is debt financing (Jepkorir & Gichure, 2019). In view of Begg & Portes (1993) business debtors in Central and Eastern Europe (CEE) also struggle to meet scheduled periodic interest payments to creditors, even banks or other companies. Given the fact that excessive debt could well drain out the investment of owners. Whilst most of the fastest-growing businesses are usually funded predominantly with equity. Kose et al. (2020) suggest debt accountability and efficient

debt management can help minimize funding rates. And further states it could improve debt sustainability as well as mitigate fiscal risks. The liability for businesses, precisely SMEs to receive funds from the government is quite limited. At the same time, others that cannot accept imbursement seek trade loans, short-term loans, and long-term loans from manufacturers, family, mates, commercial banks, and microfinance institutions (Olawale et al., 2010). In most developing countries majority of SME activities are performed in the informal sector. This also plays a major role in economic development. Perhaps to ensure

efficient growth for SMEs is essential to depend on debt financing through the acquisition of resources.

In respect to the views of (Addaney et al., 2016; Meher & Ajibie, 2018) with describing SMEs as a significant tool to economic growth which is comprehensively acknowledged in developing countries. Corresponding to decrease on the unemployment burden, in as much as there is an increase on income to the people and productivity in the industrial sector. Increased labor supply and productivity gains have indeed been contributory factors to Ghana's economic growth over the last two decades, reporting increased Gross Domestic Product (GDP) growth from (International Monetary Fund, 2019). The immense achievements of SMEs to the economic development and growth of the economy are quite tremendous. (Sam Mensah, 2004). The Registrar General Department initiated an online procedure for the registration of new business, which lead to a massive turnout in 2017. Sole Proprietorship registrations accounted for 58,504 of the nearly 87,000 companies registered in 2017, including online registrations reported by (Acquah-Hayford, 2018). He further stated in his report on The Business and Financial Times that; Company Limited by Shares registrations accounted for 21,700 and Company Limited by Guarantee registrations accounted for 5,754. Also, corresponding to the report from Ghana Statistical Service (GSS, 2012) SMEs account 70% of all industrial establishments, contributing about 70% of GDP and accounting for about 92% of Ghana's businesses. And over 60% of the working labor force is also consumed by SMEs market with majority in rural areas (GSS, 2012).

Begg & Portes (1993) perceived that the limitations of the business budget no longer bite, and the price mechanism loses much of its relevance in resource reallocation. Given the view of Lin (2020), the asset-liability ratio represents the ratio between a company's borrowed capital and its own capital. He further stated that debt leverage ratio indicator is used when addressing the topic of debt finance from the viewpoint of the business sector. With the operation of business through debt, leverage comes as an essential tool. Through the analysis and understanding of cooperating financial risk that would be encountered. Financial leverage can be used as a performance indicator for SMEs. Specifically for bank loans in the maximization of returns from the acquisition of investment. Hence, corporate debt is represented as leverage ratio = total corporate debt / GDP; (Lin, 2020) simplified, the debt leverage ratio as used as asset-liability ratio = liability / asset corresponding to the issue of debt leverage for certain corporations.

SMEs may contrarily be posed to face a vital challenge of financial resources, which may stifle the company's growth in performance and continuity. This circumstance poses a challenge for SMEs to improve the firms' results, as banks and other organizations evaluate their financial performance before doing business with them (Quaye et al., 2014). Moreover, past researches (Abor, 2004; Agyapong & Attram, 2019; Agyei, 2018; Fatoki, 2012; Kira & He, 2012; Obuya, 2017; Ye & Kulathunga, 2019) especially emphasizes the availability of finance, managerial competency, and financial literacy. Which have been highlighted as major factors influencing SMEs' success. These researches did not concentrate on how debt financing affects long-term and short-term financial efficiency in organizations. Hence resulting in a research gaps needed to be addressed. Precisely, the effort of this research paper has been purposed on the impact of financing through debt on the performance of Small and Medium Enterprises on economic growth in Ghana. This research work has motivated the zeal to fill this void and adds to the body of knowledge on the current debate about the impact of debt financing on SMEs' performances. From International Monetary Fund (2019) the increases in working population and human resources make up roughly half of GDP growth since 1990. Obviously, most of these people are employed by SMEs. Hence the need to solicit their funding in order to boost the activities aiming for effectiveness and efficiency in their performance. Furthermore, total factor productivity accounts again for the third, and physical capital accumulation accounts for the remainder (International Monetary Fund, 2019). These in some way attribute to the enhancement in the performance of SMEs. Factoring all these into consideration, it is essential to address the issue that affects SMEs performance relating to finance through debt.

## II. LITERATURE REVIEW

### 2.1. Theoretical Review

Debt financing theories attempt to enlighten the contributions to the overall cost of capital and the company's value as the compositions of debt financing investments change (Jepkorir & Gichure, 2019). In the process of investigating the relationship between the variables selected for this research work with the extent of theories investigated. This study assumed some theories as guidelines for this research paper.

#### 2.1.1. The Anticipated Income Theory

Financial factors should determine the worth of a company as economic income instead of accounting earnings. As the economic gain signifies the company's underlying earnings and cash flows. For the fact that, the

Anticipated Income Theory proposes that loan payments be related to a borrower's predicted income. Hence the performance of the firm (SMEs) is an essential factor to be considered in debt financing. Sales, earnings per share, and a firm's growth rate can be used to evaluate a company's (SMEs) performance. It corresponds with accounting-based performance which could be skewed by accounting standards. Though the measurement could be subjective and historical in their implementation. Also, debt finance may enhance the expansion of SMEs in this research context. If accounting statements and theories are geared toward the viewpoint that SME management wishes to enhance their performance.

#### 2.1.2. Modigliani and Miller theory

In view of the Modigliani and Miller theory of capital structure that depicts the value of capital structure selected by a company does not affect its value. The value of SMEs will be maximized as it uses more debt than equity in its capital structure. With total capital cost decreased as debt would include in capital structure and profitability be increased (Modigliani & Miller, 1963). By contradicting this theory which might not be favorable with imbalance market in Ghana as a developing economy especially for SMEs. Akeem et al. (2020) stated that high cost of debt financing and tax shields on debt would impact the valuation of a business where it affect both cost of capital and the returns of investors.

#### 2.1.3. The Agency theory

Also the concept of Agency theory could be considered as a sustainable tool in SMEs operations. Which could be used to examine and solve relationship problems among corporate principals as shareholders and their agents as company executives. There is evidence to suggest that the agent will never behave in the interests of the principal since relationships on both sides act as price takers (Jensen & Meckling, 1976). Meanwhile, it is extremely difficult for the principle or the agent to assure that the agent makes the best choice from the principle's perspective at no expense. Irrespective of the fact that the principle expects the agent to behave within the principal's best interests in an agency relationship.

#### 2.1.4. The Keynesians economic theory

Keynesians' economic theory was developed during the world economy Great Depression around 1930's by John Maynard Keynes as an income and expenditure model (Amadeo & Brock, 2021). This new economics theory holds that the government should raise demand in order to boost inflation. As a result, the notion argued that an optimal level of economic performance may be attained. While downturns can be averted by stimulating market demand with government monetary policies.

Criticisms resulting from increased company growth, not consumer demand, according to supply-side economists, will strengthen the economy. The acknowledgment on government responsibility with the fiscal policy was directed toward businesses. Given rise to the new Keynesian theory in the 1970s. When deficit spending would encourage people to save money rather than promote demand or economic growth (Amadeo & Brock, 2021). The Keynesians Theory may have arose many economist and school of thought criticisms.

### 2.2. Empirical Review

Good debt management and accountability can help cut borrowing costs, improve debt sustainability and reduce fiscal risks (Kose et al., 2020). Since borrowed funds were normally transferred to uses that did not increase export profits, productivity, or potential output. It has led many researchers to question the acquisition of debt with implicit findings. Many research works have been carried out on the impact of exterior debt borrowing on the economy. While a few focused on the impact of debt financing on corporate performance. Given that their findings from these investigations are quite contradictory. In respect to Slav'yuk & Slaviuk (2018) survey on the tendency of indebtedness in 2008 – 2009 due to financial crisis on developing and advanced countries. Which stated that current needs and financial debt becomes an essential source of investment and development in the economy. And further factors it burdens the economy when growth turns to be unlimited. Irrespective this could also be avoided through effective and efficient skills in debt management. This corresponds to Samuel et al. (2013) study on the Ghanaian economy, which states foreign direct investment serves as key source of economic growth in contributing to capital, technology, and management expertise. However, criticisms on the effect of external borrowings was argued on the drags debt as on the growth of the economy (Anning et al., 2015; Cunningham 1993). When debt reaches a certain level, it raises the debt rate which might not be favorable (Cunningham, 1993). But policymakers can manage and anticipate developing risks via supervision, avoiding financial shocks.

In order to operate efficiently and effectively, businesses require capital. They have the option of employing internal cash, debit, or equity to fund their operations successfully. The funding from financial institutions are used to raise debt finance. The financing role of microfinance institutions (MFIs) has favorable influence on SMEs (Quaye et al., 2014). The survey also highlighted certain risk mitigation measures employed by MFIs in awarding loans to SMEs. When assets are wisely invested, businesses may look forward to a bright future

(Rahman et al., 2019). Thus business performance comes as a result of the investment made in firms. As Meher & Ajibie (2018) study states debt finance has a favorable impact on the financial performance of SME firms, both in the short and long term. Respectively, debt overhangs could stifle investment for lengthy periods of time if bankruptcy laws are followed correctly. Also, deepening the financial markets can assist in mobilizing domestic savings, with a safer stable source of capital than international borrowing.

SMEs help to create a new economic performance that is more equitable. Regardless of the ability of SMEs to support and nurture economic progress in the Ghanaian economy. There are many identified studies with fundamental roadblocks impeding SMEs' contribution to national development with inaccessibility to capital (Antwi et al., 2013; Prezas, 1987; Quaye et al., 2014). Tiny businesses in Ghana will start tiny and ultimately disappear small, with little ability to effectively grow in terms of output or profitability.

The literature research included studies in many fields pertaining to the function of debt financing on SMEs' performance. Many SMEs have failed as a result of poor loan financing, which has forced them out of business (Anane et al., 2013; Meuleman & De Maeseineire, 2012). Suffering the consequence of business competitive environment and insufficient policy decisions to maintain their sustainability. The existence of several researches dealing with SMEs situations in Ghana would typically confirm a close examination of the literature research. Debt financing could also project to boost SME growth prospects. In this context, the research focused on the impact of financing through debt on the performance of SMEs in Ghana.

### 2.3. Objective of the Study

1. To define the effect of short-term loans on SMEs performance.
2. To determine the impact of long-term loans on SMEs performance.

#### 2.3.1. Hypotheses of the Study

**H<sub>01</sub>:** Short term loans has no significant impact on SMEs performance.

**H<sub>02</sub>:** Long term loans has no significant impact on SMEs performance.

## III. RESEARCH METHODOLOGY

### 3.1. Methodology

The steps corresponding to the scientific approach used to research the theories are; Review the previous studies on the importance of debt financing. Special emphasis on the relevance regarding debt finance on performance of SMEs in various industries ranging from food processing, real estate, and stationaries. And review the contributions of the growth on the performance of SMEs in Ghana. To examine the relevance of debt financing on the performance of SMEs in the sector. With an appropriate focus to moderating role of the SMEs performance efficiency in economic growth as a knowledge gap. The key methods of this study develop an econometric model of Multiple Linear Regression Model. It is used to test the relationship of debt financing on performance of SMEs on with their short and long term loan. And also a survey on retrospective implication to the economic growth study on companies like SMEs in their business operations. The focus objective of the analysis is to determine the effect of growth performance on SMEs sustainability through debt financing.

Multiple Linear Regression model would be employed as an econometric model. It assesses the association between two or more independent variables and single or multiple dependent variables. The econometric model representing the dependent and independent variables;

$$Y_i = \beta_1 + \beta_1 X_1 + \beta_2 X_2 + \epsilon$$

Where;  $Y_i$  ( $i = 1, \dots, 3$ ) represents Profit Margin, Return on Equity, Return on Asset.

$X_1$  represents Short Term Loan

$X_2$  represents Long Term Loan

$\epsilon$  represents Error Term

### 3.2. Study Sample

Secondary data is mainly used for the purpose of this study. The SMEs sample used for the study was taken from database of the listed companies on the Ghana Stock Exchange (GSE). The data from GSE dataset are used to derive the variables for the study. It contains a comprehensive array of financial statements and balance sheets for companies active in Ghana, with 42 companies listed on their database. For the purpose of this study, 8 SMEs were selected based on their stated capital of not less than GHC 300,000. These SMEs consist of different industries being in operation for about a decade, and the analysis obtained from the financial statement and balance sheet reflecting a five-year period from 2015-2019 was used for the study.

Table 1: Measurement of Variables

Variables	Measurement	Type of Variable
Profit Margin Ratio	Gross profit / Sales or Turnover	Dependent
Return on Assets	Net Income / Total Assets	Dependent
Return on Equity	Net Income / Total Equity	Dependent
Current Ratio	Current assets / Current liability	Dependent
Long term debts ratio	Long term loan / Total loan	Independent
Short term debt ratio	Short term loan / Total loan	Independent

Table 2: SMEs listed under GSC

Symbol	Company Name	Sector	Year Listed
ALW	Aluworks LTD	Basic Material	1996
BOPP	Benso Oil Palm Plantation LTD	Consumer Goods	2004
CLYD	Clydestone ( Ghana ) LTD	Technology	2004
CMLT	Camelot Ghana LTD	Industrial	1999
HORDS	HORDS LTD	Consumer Goods	2015
MAC	Mega African Capital LTD	Financial	2014
SAMBA	Samba Foods LTD	Consumer Goods	2015
SWL	Sam Wood LTD	Consumer Service	2002

3.2.1. Study Variables

Two sets of variables, dependent and independent variables are employed in this study. The dependent variable which is presumed to be influenced by the other variables. The dependent variable to be considered in this study is performance of SMEs using profit margin, return on asset, and return on equity. As a performance measurement indicator to determine the financial performance of SMEs through debt financing. Whereas independent variables are the cause of influence. Hence, the independent variables to be considered are short term loans and long term loans as the debt finance measurement indicator for this study. In order to capture the moderating

effect of SMEs performance on the relationship between debt financing and the value of SMEs these variables are significant.

IV. FINDINGS AND DISCUSSIONS

For this study, the standard deviations, as well as the means for all variables relating to the study, were computed to ascertain a fair opinion regarding the path of each variables, thus; return on assets, profit margin ratio, short term debt ratio as well as long term debt ratio. The descriptive statistics for the dependent and independent variables are displayed inside the tables below.

Table 3: Descriptive Statistics

	Min	Max	Mean	Standard Deviation	Skewness	Kurtosis
<b>Profit Margin Ratio</b>	0	3.622	0.631	0.249	(0.741)	0.105
<b>Liquidity Ratio</b>	0	3.243	0.578	0.121	0.981	0.075
<b>Return on Asset</b>	0	2.641	0.512	0.269	0.803	0.196
<b>Long-term Debt Ratio</b>	0	2.624	0.384	0.225	-0.813	0.41
<b>Short-term Debt Ratio</b>	0.02	0.933	0.513	0.330	0.944	0.269



<b>Performance</b>	0	4.342	0.728	0.224	0.231	0.330
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Observation from the Table signifies the average of profit margin (PMR) at 63%, liquidity ratio at 57%, and ROA at 51%. Also, an indication as resultant from long term loans and short term loans from Enterprises shows averages of 38% and 51% respectively. Corresponding

from the values, all standard deviations are valued at below the mean showing a small coefficient of variation. Substantially, there is a minimum and maximum range of variation.

Table 4: Correlation analysis

	<b>Profit margin ratio</b>	<b>Liquidity ratio</b>	<b>Return on asset</b>	<b>long term debt ratio</b>	<b>short term debt ratio</b>
<b>Profit margin ratio</b>	1				
<b>Liquidity ratio</b>	0.347**	1			
<b>Return on asset</b>	0.253**	0.036	1		
<b>long term debt ratio</b>	0.068*	-0.145*	-0.043*	1	
<b>short term debt ratio</b>	-.485**	-.367**	-.340**	-0.126	1

\* At 0.01 (1%) confidence level, correlation is significant (1 tailed).

\*\*At 0.05 (5%) confidence level, correlation is significant (2 tailed).

By looking at the Pearson correlation, it clarifies that the variables are related to each other to some extent. The correlation analysis table, reveals that the long-term debt ratio has a significantly negative association with the liquidity ratio. Thus, (r = -0.145, value < 0.05). This outcome translates that the long-term borrowings or debts of the companies selected had an adverse effect on performance, in this case liquidity ratio. From this same results, the long term debt ratio has a negatively significant association with return on assets (r = -0.043, value < 0.05),

implying the long term borrowing or debt had a negative influence on return on asset.

On the short term ratio. It was revealed that it showed a negatively significant correlation with profit margin ratio, liquidity ratio and return on assets. Thus, (r = -0.485, value < 0.01), (r = -0.367, value < 0.01) and (r = -0.340, value < 0.01) respectively. These outcomes suggest that both short and long term debt ratio is adversely correlated with their performance measured in terms of return on asset, profit margin ratio and liquidity ratio.

Table 5: Results of Regression

	Model 1, Dependent Variable: Profit Margin Ratio		Model 2, Dependent Variable: Liquidity Ratio		Model 3, Dependent Variable: ROA	
	Beta	T	Beta	T	Beta	T
Long Term Debt Ratio	-0.005	-0.037	-0.157*	-2.092	-0.09	-1.043
Short Term Debt Ratio	-0.547	-6.595	-0.387*	-5.176	-0.347*	-4.591
ANOVA (F ratio)	16.726		0.43		0.49	
ANOVA (Prob)	0		0.273		0.384	
R Square	0.286		11.97		8.519	
Adjusted R Square	0.27		.000a		0	

Dependent variable: return on the asset; liquidity ratio; profit margin ratio

The regression results for this study is presented in table 5. The global statistics (adjusted R Square) shows that 27% of the variation in the predicted variable are caused by changes in the predictor variable. From m this table, there is more than enough evidence to suggest that long-term debt negatively affect all the dependent variables. Thus; liquidity, profit margin and asset yield having statistical outcomes of ( $\beta = -0.157$ ,  $p < 0.05$ ), ( $\beta = -0.005$ ,  $p < 0.05$ ) and ( $\beta = -0.09$ ,  $p < 0.05$ ) respectively. We then reject the null hypothesis, which states that long term debt has no significant influence on the financial performance of the selected firms

On the short-term debt ratio, the regression results were equally the same as with the long-term debt ratio. There was a negatively significant relation between short-term debt and liquidity, profit margin, and asset yield ( $\beta = -0.387$ ,  $p < 0.05$ ), ( $\beta = -0.547$ ,  $p < 0.05$ ) and ( $\beta = -0.347$ ,  $p < 0.05$ ) respectively. There is enough evidence not to accept the null hypothesis, which states that no significant relation exist between short-term debt and financial performance.

## V. CONCLUSION

To be more precise, the study employs both classic and unorthodox theories to motivate its empirical section. And it explains the influence of debt finance on the financial performance of SMEs precisely in Ghana. Modigliani & Miller (1963) amended their remark of 1958, noting that an increase in debt on a company's capital structure might result in greater performance because of tax-deductible interest payments. Accordingly from the data, it shows that SMEs financial performance in Ghana has been impacted through their debt finance. The use of debt has a statistically significant negative association with performance metrics, including liquidity, profit margin, and return on assets. And, contrary to popular belief, long-term debt-to-equity ratios show a statistically significant negative correlation with financing through debt. Hence, the empirical findings signify Long-term debts have a detrimental impact on SMEs financial performance. Similarly, short-term debts have a detrimental impact on SMEs performance in terms of ROA and liquidity, according to the research. As a result, debt-financed both short and long-term loans have a disadvantageous impact on SMEs' financial performance (Githaiga, 2015; Maes et al., 2019).

The outcomes of the study show that debt-financed loans, both long and short term, have a negative impact on financial performance. If SMEs are evaluated essentially to advance their financial performance. This necessitates capacity building in areas such as company management

and good financial record keeping. Which should be reflected in a reduction in loan processing time and borrowing costs. With the foregoing, it is reasonable to conclude that the government will benefit greatly from encouraging SMEs through training and skill development. This would help them to better use their loans by lowering the likelihood of their being credit rationed.

SMEs in Ghana have one viable alternative to create cooperative societies, which would allow them to share their risks when asking for bank loans. Banks are more inclined to work with groups as compared to individual SMEs, who may lack the necessary expertise and financial abilities to persuade banks in gaining money. As a result, for SMEs in Ghana to solely apply it is more likely profitable for commercial bank loans when they operate together as a group. It is vital to remember that commercial banks' primary objective is to make money. Corresponding to Agyei-Mensah (2010), financial statements and additional strategic performance indicators should be generated regularly, consistent basis, and compare to previous phases for the best outcomes.

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## Professionalization in higher Education, Teaching and plural Identities: Contemporary Challenges

## Profissionalização no ensino superior, docência e identidades plurais: Desafios Contemporâneos

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**Keywords**— *Professionalization. University education. Teaching.*

**Abstract** — *This manuscript discusses Professionalization in Higher Education in pandemic times, considering teaching and plural identities. In the course of its structure and functionality, it sought to systematize the evidence on the implications and benefits of Professionalization, given the entire configuration of its implementation in Brazil. This is a bibliographical and documentary research, with a qualitative interpretive nature. With regard to the conditions for the effectiveness of teaching practice in higher education, a verification mapping of the subjects' practice becomes effective, in which institutional actions arising from/financed by educational policies that are linked to the reports and the research. Our results pointed to the fact that in the professionalization process there is no single identity, but plural ones.*

**Resumo**— *O presente manuscrito discorre sobre a Profissionalização no Ensino Superior em tempos pandêmicos, tendo em vista a docência e(m) identidades plurais. No decorrer de sua estruturação e funcionalidade, procurou sistematizar as evidências sobre as implicações e benefícios da Profissionalização, diante de toda a configuração de sua implementação no Brasil. Trata-se de uma pesquisa bibliográfica e documental, de cunho qualitativo interpretativista. No que diz respeito às condições para efetividade da prática docente no ensino superior, torna-se eficaz um mapeamento de verificação da prática dos sujeitos, em que são (des)legitimadas ações institucionais advindas de/ financiadas por políticas educacionais que estão vinculadas aos informes e às pesquisas. Nossos resultados apontaram para o fato de que no processo de profissionalização não há identidade única, mas plurais.*

**Palavras-chave**— *Profissionalização. Ensino Superior. Docência.*

### I. INTRODUÇÃO

A discussão sobre a profissionalização no Ensino Superior no Brasil não é recente, mas remonta à virada para o século XXI, e tem-se constituído numa das problemáticas chaves das reformas educacionais. No

Brasil, essa preocupação tem sido objeto de reflexões críticas por parte de diferentes grupos de pesquisadores e associações (ABRALIN, ANPOLL, GELNE, ABRALIC), além de estar presente nos documentos da política educacional (NUÑES; RAMALHO, 2013). Historicamente, durante a gestão de Fernando Henrique Cardoso, foram

efetivados reordenamentos político-jurídicos, via reformas educacionais nos vários níveis de ensino; fundamental, médio, profissionalizante e superior, visando a adequação de políticas educacionais as recomendações dos organismos multilaterais (DIAS, 2010). Contudo, ainda que a educação, embora também provida pelo Estado, continue sendo gradualmente aberta ao setor privado e ao setor público não-estatal (BRASIL, 1988), nosso foco teórico-analítico se lança sobre a arena pública no País<sup>1</sup>. Nessas vias de argumentação, citamos o REUNI, o qual, embora tenha sido instituído apenas em 2007, “tem suas diretrizes implementadas no Brasil desde 2003 partindo das orientações do Banco Mundial para o ensino superior contidas em “La enseñanza superior: las lecciones derivadas de la experiencia” (DIAS, 2010, p. 301).

Diante disso, torna-se eficaz um mapeamento de verificação da prática docente, em que são (des)legitimadas ações institucionais advindas de/ financiadas por políticas educacionais que estão vinculadas aos informes e às pesquisas. É nesse sentido que “a profissionalização da docência surge como uma proposta para contribuir para o desenvolvimento didático e pedagógico dos professores” (NUÑES; RAMALHO, 2013, p. 1). É em meio a tais reflexões, principalmente em um contexto problematizado por questões pandêmicas críveis, como apontadas pela *Organização Mundial da Saúde* e pelo *Ministério do Brasil*, que situamos nossa pesquisa, para refletir sobre o atual momento de circunscrição da profissionalização no Ensino Superior, o que pressupõe debates sobre docência e identidade.

Assim, o objetivo dessa pesquisa consiste promover uma discussão teórica sobre a profissionalização no ensino superior no Brasil, especificamente no entendimento de que tal conceito não se desvencilha da multiplicidade de identidades para o docente. Os desafios contemporâneos, conforme apontados, dizem respeito ao atual cenário de crise instalado no Brasil em decorrência da proliferação da Covid-19. Inicialmente tecemos um constructo sobre a *Profissionalização no Ensino Superior e múltiplas identidades*, fazendo referência ao profissional que precisa assumir, em situações variadas, mais de um

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<sup>1</sup> No Brasil, desde a entrada no século XXI, a base governista promove a horizontalização das políticas públicas no sentido de uma maior responsabilização social, “fortalecendo a sociedade civil e promovendo flexibilização/descentralização para obter legitimidade” (DIAS, 2010, p. 299). Tais estratégias, seguindo as indicações construídas na Lei de Diretrizes e Bases da Educação - LDB, materializam-se no PNE (Plano Nacional de Educação) de 2001 e especialmente nas ações do PDE (Plano de Desenvolvimento da Educação) lançadas em 2007 pelo governo de Luís Inácio Lula da Silva.

papel a depender das condições em que se encontre. Em seguida, adentramos em *reflexões sobre a diversificação na Profissionalização* para passar aos *procedimentos metodológicos da pesquisa*. Após, constam as considerações finais.

## II. PROFISSIONALIZAÇÃO NO ENSINO SUPERIOR E MÚLTIPLAS IDENTIDADES

Partimos aqui de uma reflexão de Cunha, segundo a qual “[...] sendo a educação uma prática social, o exercício da profissão docente estará sempre circunstanciado a um tempo e a um lugar<sup>2</sup>, num desafio constante de reconfiguração de suas próprias especificidades” (CUNHA, 1999, p. 131). A partir desse ponto de vista, compreendemos que a profissionalização materializada no exercício da docência está vinculada a um termo caro no terreno das Ciências Humanas, chamado cronotopo, afinal de contas, conforme predisposto por Santana e Garcia (2019), faz-se imprescindível à responsabilidade humana considerar o tempo e o espaço como elementos centrais à composição e (re)construção de narrativas. Sobre essa perspectiva da Profissionalização concatenada à docência, Lopes (2014) nos ajuda a compreender que

A constituição de um corpo de saberes próprios ou específicos do ofício de ser professor **está na base dos processos de profissionalização** e do exercício da profissionalidade docente. Estes saberes são considerados como instrumentos vitais da atuação profissional dos professores. Foram os ventos do movimento internacional pela profissionalização do ensino que conduziram os pesquisadores a investirem esforços na caracterização e

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<sup>2</sup> Sobre a especificidade desse tempo e lugar, o que nos remete a práticas situadas, Santana e Garcia (2019, p. 67) compreendem que “Sob as lentes do *cronotopo*, considerar o tempo e o espaço como elementos centrais à composição e (re)construção de narrativas, assim como de sujeitos, é imprescindível, uma vez que orientam um processo de conscientização ativa dos seres humanos, não apenas como objetos ou indivíduos, mas como sujeitos axiológicos, dotados de querer e direitos quanto à sua inserção na sociedade. Cabe mencionar que não somos pioneiros na pesquisa sobre o cronotopo bakhtiniano, uma vez que questões relacionadas ao *chronos* (tempo) e ao *topos* (espaço), por fazerem parte dos domínios ético, existenciais humanos, estético e cognitivo, já instigaram muitos pensadores, e estudiosos a traçarem seus pontos de vista sobre este tema: antes de Cristo ganham destaque Platão (428-347 a.C) e Aristóteles (384 a.C.-322 a.C).

formalização do conhecimento profissional do professor. Nesse sentido, propomo-nos aprofundar a compreensão e a importância que a composição/legitimação desse corpo de saberes possui em sua interface com os projetos de conquista de maior profissionalização e, mais especificamente, com os processos de construção de exercício mais eficaz da profissionalidade docente (LOPES, 2014, p. 6, grifos nossos).

Quando nos referimos a esses sujeitos, protagonistas desse cenário profissionalizador, referimo-nos a “profissionais das diferentes áreas do conhecimento, mas que, por alguma razão, acabam chegando a ser professor do ensino superior” (MEDEIROS, 2005, p. 73). É preciso reconhecer que diversos docentes do ensino superior sentem na pele o desvalor dessa instância, já que, quando questionados pela profissão que exercem, identificam-se “primeiramente como sendo o médico, o dentista, o advogado, o contador, o físico, o engenheiro, o jornalista, o radialista, seguido, às vezes, pela identificação de professor universitário” (MEDEIROS, 2005, p. 73), isso porque “responder apenas professor pode dar margem a uma identidade socialmente inferior” (MEDEIROS, 2005, p. 73).

O momento histórico se faz importante, ao reconhecermos que estamos diante de uma das maiores crises pandêmicas que acometeram a humanidade, classificada como *emergência de saúde pública de interesse internacional* pela Organização Mundial da Saúde – OMS (2020). Nessas reflexões, concordamos com Lopes (2014) sobre a importância do tempo histórico, pois,

Embora o saber do professor carregue as marcas de suas subjetividades, estamos diante de um saber que é social, ou seja, que está enraizado na cultura de uma instituição – a escola – e, mais amplamente, no interior de uma determinada sociedade. A profissionalidade de qualquer grupo profissional está inextricavelmente conectada aos desafios, possibilidades e limites impostos pelo desenvolvimento histórico social, ou seja, só encontra concretude histórica e social no interior de um determinado tempo. Por isso, é importante sublinhar que, como revela a análise histórica da atividade docente, os processos de profissionalização e de conquista de maior profissionalidade não são lineares nem unívocos.

Na esteira de Hall (2012), “a identidade é um processo de articulação, uma suturação, uma sobredeterminação, e não uma subsunção” (HALL, 2012, p. 106). Pensando no caso do Ensino Superior em suas especificidades<sup>3</sup>, ancoramo-nos no pensamento de Santana e Melo, para quem “não se pode encontrar uma versão definitiva para a identidade, já que as identidades são plurais e construídas de acordo com os cenários em que os sujeitos estão circunscritos” (SANTANA; MELO, 2018, p. 155). Isso significa que creditamos o que é apontado por Contreras, quando se refere a “realizar juízos e decisões profissionais quando se dispõe de um conhecimento profissional do qual extrair reflexões, ideias e experiências com os que se pode elaborar tais decisões” (CONTRERAS, 2002, p. 83). Desse modo, além da *competência profissional*, a profissionalidade docente deve ser centrada em elementos que envolvam *obrigação moral* e *compromisso com a comunidade* (CONTRERAS, 2002).

### III. Reflexões sobre a diversificação na Profissionalização

Na ótica interpretativa de Gauthier (2006), a profissionalização nos direciona a dois processos diferentes, mas interdependentes: a profissionalidade<sup>4</sup> e o profissionalismo. O primeiro, mais relacionado a processos internos, “[...] consiste em um conjunto de características mais ou menos formalizadas de uma profissão em uma época determinada” (GAUTHIER, 2006, p. 167). O segundo é um processo externo que “[...] implica de

<sup>3</sup> No que tange ao ensino, afirma Roldão que “saber ensinar [...] é ser especialista dessa complexa capacidade de mediar e transformar o saber contencioso curricular (isto é, que se pretende ver adquirido, nas suas múltiplas variantes) – seja qual for a sua natureza ou nível – pela incorporação dos processos de aceder a, e usar o conhecimento, pelo ajuste ao conhecimento do sujeito e do seu contexto, para adequar-lhe os procedimentos, de modo que a alquimia da apropriação ocorra no aprendente – processo mediado por um sólido *saber científico* em todos os campos envolvidos e um *domínio técnico-didático* rigoroso do professor, informado por uma contínua postura *meta-analítica*, de *questionamento intelectual* da sua acção, de *interpretação* permanente e realimentação contínua (ROLDÃO, 2007, p. 101-102, grifos da autora).

<sup>4</sup> Sacristán (1995, p. 65) entende a profissionalidade como “[...] a afirmação do que é específico na acção docente. Isto é, o conjunto de comportamentos, conhecimentos, destrezas, atitudes e valores que constituem a especificidade de ser professor”. Como afirma Sacristán (1995, p. 65): “O conceito de profissionalidade docente está em permanente elaboração, devendo ser analisado em função do momento histórico concreto e da realidade social que o conhecimento escolar pretende legitimar: em suma, tem que ser contextualizado”.

alguma maneira um trabalho que tende a favorecer o reconhecimento pela sociedade da experiência que possuem os membros de um corpo profissional” (GAUTHIER, 2006, p. 168), o que, na percepção de

Lopes, estaria “relacionado, portanto, ao controle ocupacional e à elevação do status social da profissão” (LOPES, 2014, p. 7). A seguir, na figura 1, explicitamos os elementos-base da Profissionalização no Ensino Superior.

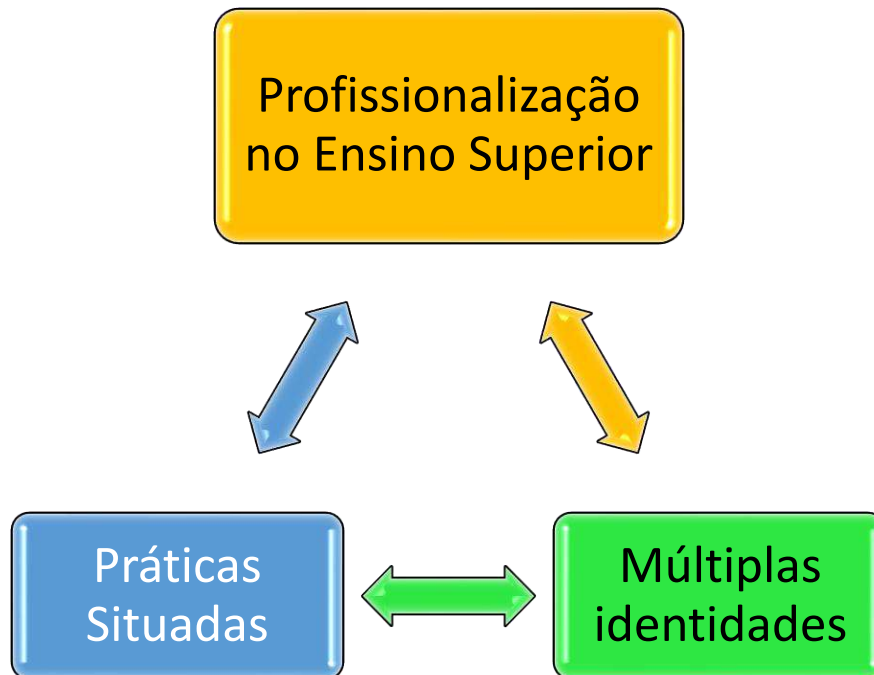


Fig.1: Base da Profissionalização no Ensino Superior

Fonte: acervo dos autores

O enunciado anteposto nos convoca a refletir sobre a existência de duas instâncias interdependentes no arsenal de constituição da Profissionalização no Ensino Superior: as práticas situadas e as múltiplas identidades do sujeito. Na percepção de Pimenta (1999), uma identidade profissional se edifica, além do exame constante dos significados sociais da profissão, do ato de revisitar tradições, a partir da “[...] reafirmação de práticas consagradas culturalmente”. Ou seja, “[...] práticas que resistem a inovações porque premeem de saberes válidos às necessidades da realidade” (PIMENTA, 1999, p. 19). Quando pensamos nas identidades múltiplas do sujeito profissional, necessário se faz recorreremos às palavras de Francelino, para quem os sujeitos

agem uns sobre os outros e produzem pontos de vista (posições axiológicas de sujeito). A língua é concebida como um sistema de formas em funcionamento, constituída por fatores externos como o contexto sócio-histórico, a posição ideológica dos sujeitos falantes, enfim, os

elementos linguísticos, que já vêm saturados pelas posições sócio-axiológicas de outrem, estão à disposição do sujeito para a produção dos mais diversos efeitos de sentido (FRANCELINO, 2007, p. 34).

Para Sobral (2009, p. 26), “as práticas supõem grupos humanos, não sujeitos isolados”. Logo, cada ato realiza-se mediante diálogos entre consciências concretas. Nesse direcionamento, Sobral (2009, p. 54) compreende que, o sujeito é um agente “que, em suas relações sociais e históricas com outros sujeitos igualmente responsáveis (inclusive apesar de si mesmos), constitui a própria sociedade sem a qual ele mesmo não existe” (SOBRAL, 2009, p. 54). Nessa arena de vozes, é preciso considerar a construção de espaços de reflexões e de trocas de conhecimento para efetividade da prática docente (AZAMBUJA, 2020) em práticas sociais situadas<sup>5</sup>

<sup>5</sup>No capítulo *Postulados do paradigma interpretativista*, Bortoni-Ricardo (2008) agrega ao docente a máxima de que a observação do mundo e dos fenômenos circundantes se conecta às práticas sociais dos indivíduos e aos significados que delas surgem. Desse modo, postula a



(BARTON; HAMILTON, 2000). A circunscrição das práticas situadas não constitui apenas um estado de latência nos domínios da profissionalização, mas demarca as fronteiras entre os atos gerais e particulares.

Nesse sentido, ponderar sobre a profissionalização em tempos pandêmicos<sup>6</sup> no painel da Docência Universitária requer um constante repensar da identidade profissional. Esta se afigura num processo evolutivo de experiências. Essa perspectiva de profissionalização do docente nos conecta a novas demandas, uma vez que têm sido evidenciadas “preocupações com a possibilidade de essa situação excepcional potencializar desigualdades, já que as condições de trabalho dos docentes e dos discentes, de domínio e acesso às novas tecnologias, de situações econômicas, sociais e de saúde física e mental são distintas” (FIOR; MARTINS, 2018, p. 03).

### **Procedimentos metodológicos da pesquisa**

Na perspectiva qualitativa de pesquisa (ROHLING, 2014; BORTONI-RICARDO, 2008), iniciamos a coleta de dados verificando estudos que protagonizassem a profissionalização desde a virada para o século XXI, mas inovando no sentido de averiguar suas incidências no atualcronotopo brasileiro. A seguir, dispomos o nosso gráfico 1.

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autora que “O docente que consegue associar o trabalho de pesquisa a seu fazer pedagógico, tornando-se um professor pesquisador de sua própria prática ou das práticas pedagógicas com as quais convive, estará no caminho de aperfeiçoar-se profissionalmente, desenvolvendo uma melhor compreensão de suas ações como mediador de conhecimentos e de seu processo interacional com os educandos. Vai também ter uma melhor compreensão do processo de ensino e de aprendizagem” (BORTONI-RICARDO, 2008, p. 32-33).

<sup>6</sup>Oliveira et.al., (2021, p. 45.919) compreendem que “a pandemia provocada pelo novo coronavírus (SARS-CoV-2) tornou-se uma problemática complexa e de alta gravidade, que afetou diretamente a vida de pessoas no mundo inteiro. Como uma das consequências foi acometer pessoas com graves problemas respiratórios (O GLOBO, 2021)” e tendo ocasionado mais de 470.000 (quatrocentas e setenta mil mortes no Brasil (MINISTÉRIO DA SAÚDE, 2021).

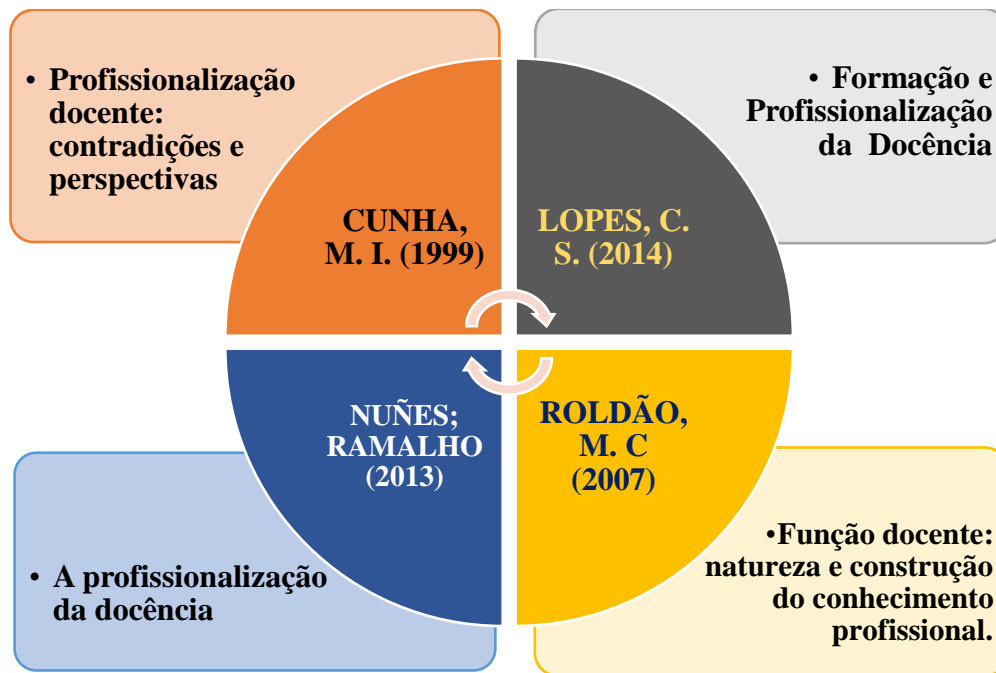


Gráfico 1: Estudos-base sobre Profissionalização

Fonte: acervo dos autores

Para solidificação de nosso estudo, recorreremos às pesquisas mencionadas, as quais nos direcionaram nas buscas por correlacionar profissionalização, docência e identidades plurais. As temáticas tiveram percentual de variabilidade por data, cuja diferenciação temporal máxima foi de 15 (quinze anos).

Trata-se de uma pesquisa qualitativa, que, segundo Minayo, “trabalha com o universo de significados, motivos, aspirações, crenças, valores e atitudes, o que corresponde a um espaço mais profundo das relações, dos processos e dos fenômenos que não podem ser reduzidos à operacionalização de variáveis” (MINAYO, 2001, p. 14). Classifica-se como um trabalho de cunho bibliográfico, uma vez que o movimento realizado nos artigos para firmamento do estudo agrega natureza teórica.

Na compreensão de Marconi e Lakatos (1992), “A pesquisa bibliográfica é o levantamento de toda a bibliografia já publicada, em forma de livros, revistas, publicações avulsas e imprensa escrita” (MARCONI; LAKATOS, 1992, p. 75). Nesse sentido, os critérios de seleção para o presente estudo estiveram na observação do rigor científico com que tratam a temática é circunscrita na *práxis* educacional brasileira, em um misto epistemológico de fatores objetivos da pesquisa, não excluindo indícios de subjetividade.

#### IV. PALAVRAS FINAIS

Esperamos ter alcançado os objetivos de nosso manuscrito, que consistiram em promover uma discussão teórica sobre a profissionalização no ensino superior no Brasil, especificamente no entendimento de que tal conceito não se desvencilha da multiplicidade de identidades para o docente. Tornou-se possível que fizéssemos um mapeamento de verificação da prática docente na esfera da profissionalização, em que são (des)legitimadas ações institucionais advindas de/ financiadas por políticas educacionais que estão vinculadas aos informes e às pesquisas.

Com esse estudo, verificamos como a profissionalização se constitui como elemento imprescindível para qualificações dos profissionais e alcance de excelentes resultados na atividade diária, sendo preciso considerar a construção de espaços de reflexões e de trocas de conhecimento para efetividade da prática docente. Constatamos, desse modo, que a circunscrição das práticas situadas não constitui apenas um estado de latência nos domínios da profissionalização, mas demarca as fronteiras entre os atos gerais e particulares do sujeito.

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# A New Paradigm of Ater Agroecological Founded on the Principle of Cooperation as Assumption of Endogenous Development

## Um novo Paradigma de Ater Agroecológica Fundado no Princípio da Cooperação como Pressuposto de Desenvolvimento Endógeno

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“Mestre não é quem sempre ensina, mas quem de repente aprende. (Guimarães Rosa).”

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**Keywords**— *Ater, Paradigm, NGO's/ Network, Agroecology, Endogenous development.*

**Abstract** — *The issue of the diffusionist model of Technical Assistance and Rural Extension (Ater) brought strong impacts to family farmers, the environment and society as a whole, which provoked reactions in the search for other alternatives and, as a result, debate on the agroecological Ater model, consequently the decentralized Ater networks, associativism, and as a background the sustainable rural development. Historically, rural economic elites have always imposed their interests to the detriment of small rural producers. Ater's initial milestone in the country begins with US support in the midst of the cold war, with the objective of inserting farmers into the capitalist market for inputs, machinery and financing, in addition to the post-war geopolitical alignment interest. Ater went through the next periods with the prescription of technological packages and the green revolution. With the redemocratization in the 1980s and liberal policies,*

rural extension was no longer a priority, nor was it government policy, becoming state government programs without federal resources. During this period, several social tensions arose and the emergence of effective actions by unions, associations, NGOs and cooperatives proposing a new model of rural development, until the period of struggles of the representations of family producers to implement the National Policy for Technical Assistance and Rural Extension (PNATER). After a brief period of structuring Ater with a focus close to the needs and interests of family farmers, whose compass was the implementation of an Agroecological Ater, there is currently a systematic effort to materially and symbolically deconstruct the achievements of this segment of producers together partner institutions of the Federal Government, by rural elites who mobilized in defense of their interests. What remains from now on, therefore, is to follow a path of political struggle that should never be abandoned with a focus on cooperation / associativism, networking and solidarity economy based on an agroecological land as an instrument of endogenous territorial development, particularly for sustainable rural development in its multidimensions. Therefore, the modest reflections exposed in this article stimulate the fundamental exercise that portrays a process of enlightenment in real life and the practice of struggles and conquests of family farmers.

**Resumo**— A questão do modelo difusionista de Assistência Técnica e Extensão Rural (Ater) trouxe fortes impactos aos agricultores familiares, ao meio ambiente e à sociedade como um todo, o que provocou reações na procura por outras alternativas e, em razão disso, pautou-se o debate sobre o modelo de Ater agroecológico, por consequência as redes de Ater descentralizada, o associativismo, e como pano de fundo o desenvolvimento rural sustentável. Historicamente, as elites econômicas do campo sempre impuseram seus interesses em detrimento dos pequenos produtores rurais. O marco inicial da Ater no país começa com apoio norte-americano em plena guerra fria, com objetivo de inserção dos agricultores no mercado capitalista de insumos, máquinas e financiamento, além do interesse de alinhamento geopolítico do pós-guerra. Atravessou Ater os próximos períodos com o receituário dos pacotes tecnológicos e da revolução verde. Com a redemocratização nos anos 80 e as políticas liberais, a extensão rural não era mais prioridade e nem política de governo, passando a ser programas de governos estaduais sem os recursos federais. Nesse período surgiram diversas tensões sociais e o surgimento de atuações efetivas de sindicatos, associações, ONG'S e cooperativas propondo um novo modelo de desenvolvimento rural, até chegar ao período de lutas das representações dos produtores familiares para implantação da Política Nacional de Assistência Técnica e Extensão Rural (PNATER). Após um breve período de estruturação da Ater com foco próximo às necessidades e aos interesses dos agricultores familiares, cuja bússola era a implementação de uma Ater Agroecológica, observa-se atualmente um esforço sistemático de desconstrução material e simbólico das conquistas desse segmento de produtores junto as instituições parceiras do Governo Federal, por parte das elites rurais que se mobilizaram em defesa de seus interesses. O que resta daqui para frente, portanto, é seguir um caminho de luta política que jamais deverá ser abandonado com enfoque na cooperação/associativismo, na articulação em rede e na economia solidária pautada numa ater agroecológica como instrumento de desenvolvimento territorial endógeno, em particular para o desenvolvimento rural sustentável em suas multidimensões. Portanto, as modestas reflexões expostas no presente artigo estimulam o exercício fundamental que retrata um processo de iluminação da vida real e da prática de lutas e conquistas dos agricultores familiares.

**Palavras-chave**— Ater; Paradigma; Rede/Ong; Agroecologia; Desenvolvimento Endógeno.

## I. INTRODUÇÃO

O presente artigo procura fazer uma apreciação crítica e sucinta aos modelos de Assistência Técnica e Extensão Rural (Ater) que transitaram modernamente na cena agrícola do país, como também pretende sinalizar para

as tendências e a necessidade de pensar e agir com outro modelo de atuação de Ater no âmbito da agricultura de base familiar, que leve em consideração nas suas diretrizes o desenvolvimento territorial endógeno, a agroecológica e o associativismo.

A parte inicial do artigo procura analisar os aspectos sociopolíticos e socioeconômicos na trajetória histórica da Ater e sua práxis voltada ao conjunto dos agricultores, particularmente na arena dos pequenos produtores agrícolas ou camponeses, também outrora designados de agricultores de baixa renda e contemporaneamente denominados agricultores familiares.

As partes subsequentes apresentam reflexões sobre a necessidade de introdução e/ou consolidação de outro paradigma de Ater que venha servir realmente como um instrumento adequado às expectativas do segmento dos agricultores familiares, o qual se distanciaria do modelo difusionista e tecnológico e se aproximava sucessivamente do modelo agroecológico, articulado em redes de colaboração e potencializado pela Internet/web, além de ressaltar as importantes contribuições do associativismo e das ONGs na introdução e consolidação de um novo modelo de Ater, que tem como um forte pilar de sustentação a agroecologia.

Por fim, o artigo traz em suas considerações finais um prognóstico esperançoso sobre o futuro da Ater voltado para o segmento dos agricultores familiares, pois a natureza da luta para determinação de um modelo de Ater apropriado aos interesses dos agricultores familiares se expande para outras áreas fundamentais da sociedade como um todo, em particular para o desenvolvimento sustentável em suas multidimensões.

## II. TRAJETÓRIA DA ATER NO PAÍS: EVOLUÇÃO HISTÓRICA E IMPASSES NO SÉCULO XX

A análise da trajetória histórica do serviço de Assistência Técnica e Extensão Rural (Ater) no país permite identificar e conhecer os pilares ideológicos, teóricos e práticos que sustentaram e condicionaram a institucionalidade da prática desse serviço junto à massa de agricultores. A Extensão Rural no Brasil foi oficialmente criada em 1948, no estado de Minas Gerais, como um serviço híbrido (público-privado), após o término da Segunda Guerra Mundial (1945) e início da Guerra Fria<sup>1</sup> (1947) simultaneamente com a implantação da Doutrina Truman<sup>2</sup>.

Em 1948, teve início a prestação dos serviços institucionalizados de Extensão Rural, com a implantação do Programa Piloto de Santa Rita do Passa Quatro (SP) e a criação da Associação de Crédito e Assistência Rural (ACARMG), através de um convênio firmado entre o governo de Minas Gerais e a American International Association for Economic and Social Development (AIA), com a finalidade de estabelecer uma política de melhoria da qualidade da produção agrícola e a fixação do homem no campo, de forma a vincular os agricultores ao mercado de financiamento, insumos, máquinas e produtos. (SOUSA, 2015).

Com referência à AIA, segue trecho que menciona a controversa atuação dessa associação norte-americana no Brasil:

Fundada sob a égide de um grupo de mais bem representados na figura de Nelson Rockefeller, a AIA foi uma agência filantrópica conhecida no Brasil principalmente por introduzir de forma sistemática os programas de extensão rural de acordo com o modelo norte-americano. Talvez diante desse fato e das conseqüências que o processo de modernização da agricultura trouxe para o Brasil e a América Latina, assim como o aprofundamento das relações políticas, econômicas e culturais entre Brasil e EUA durante a ditadura militar (1964 a 1985), muitas polêmicas envolveram o nome de Nelson Rockefeller no país, ora interpretado como um 'brilhante' homem de negócios, como um 'missionário', ora como um dos símbolos máximos do imperialismo

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<sup>1</sup>Guerra Fria foi um período de tensão geopolítica entre a União Soviética e os Estados Unidos e seus respectivos aliados, o Bloco Oriental e o Bloco Ocidental, após a Segunda Guerra Mundial. Considera-se geralmente que o período da Doutrina Truman vai de 1947 até a dissolução da União Soviética em 1991.

<sup>2</sup> Doutrina Truman é a designação da política externa implantada pelo EUA durante o governo do presidente Truman (1945 a 1953) e direcionada ao bloco de países capitalistas no início da Guerra Fria. Essa doutrina tinha como objetivo barrar a expansão do comunismo no mundo, especialmente em países capitalistas subdesenvolvidos da América Latina, entre os quais se destacava o Brasil.

ianque. (SILVA, p.1697, 2013).

De fato, o modelo americano de extensão rural tido como referência a ser copiada para a realidade brasileira nesse período se caracterizava entre outros aspectos pela criação de uma lacuna na relação entre técnico e agricultor, pois o conhecimento que tinha validade era unicamente aquele idealizado nas universidades e centros de pesquisa. Nesse *modus operandi* de extensão rural não dialógico, o conhecimento gerado nas universidades já surgia fragmentado e não considera o conhecimento e a tradição dos produtores rurais.

Enaltecida ou criticada por engenheiros agrônomos e ambientalistas como a agência que difundiu o modelo norte-americano de extensão rural para a América Latina, trazendo ‘desenvolvimento’ e/ou ‘devastação ambiental’, a AIA também teve importância crucial na implantação e adaptação tanto de programas de crédito e assistência técnica quanto de extensão rural na América Latina após a Segunda Guerra Mundial. (SILVA, 2013, p.1698).

Em meados de 1970, em pleno governo militar do presidente-general Ernesto Geisel, o serviço de Extensão Rural foi totalmente estatizado, criando-se o Sistema Brasileiro de Assistência Técnica e Extensão Rural (SIBRATER), coordenado em nível nacional pela Empresa Brasileira de Assistência Técnica e Extensão Rural (EMBRATER) e executada nos estados pelas Empresas de Assistência Técnica e Extensão Rural (EMATERs). A formatação desse sistema piramidal de extensão rural estava fundada num modelo de organização de caráter produtivo, industrial e comercial, direcionado à adoção de pacotes tecnológicos apropriados para simultaneamente padronizar as práticas produtivas e atenuar a dependência dos aspectos naturais dos agroecossistemas, atrelando a agricultura em geral à dependência dos produtos industriais dos pacotes tecnológicos (CAPORAL, 1998).

Os pacotes tecnológicos tinham por finalidade garantir maior produtividade agrícola por unidade de área por meio da utilização de sementes selecionadas, fertilização química do solo, utilização de agrotóxicos e mecanização de todo processo produtivo agrícola. As inovações tecnológicas para a obtenção de maior produtividade na agricultura ficaram denominada de “Revolução Verde.”

O uso de agrotóxicos, fertilizantes e sementes melhoradas e a mecanização das atividades trouxe lucro para alguns agricultores, mas também pobreza para os camponeses – aqueles que não foram expulsos de suas terras, acumularam dívidas devido ao alto preço de aquisição dos pacotes tecnológicos e precisaram vender suas propriedades – e diversos impactos para o meio ambiente – a partir da década de 1960, constatou-se que os fertilizantes e agrotóxicos poluíam a natureza e apresentavam riscos para a saúde dos trabalhadores (ALBERGONI e PELAEZ, 2007).

Por outro lado, os pilares ideológicos de negação da realidade agrícola e agrária do país projetaram uma imagem positiva de desenvolvimento e progresso acerca da Revolução Verde e do agronegócio com uso de seus pacotes tecnológicos e suas conexões com o mercado capitalista globalizado. Em contrapartida, edificou uma imagem preconceituosa e negativa da agricultura familiar, caracterizada nesse contexto como uma atividade atrasada e descreve o agricultor familiar como o personagem “*Jeca Tatu*” ignorante, colocando o saber do camponês abaixo do saber dos extensionistas rurais, guardiões do saber científico.

No findar do centenário a partir dos anos 80 se constata a derrocada do Estado desenvolvimentista brasileiro, as crises econômicas, os processos de redemocratização e a evidência do modelo neoliberal no país fecundado nos anos 80, porém atingindo seu apogeu nos anos 90. Tal cenário redesenhou o modelo de atuação do Estado e suas políticas públicas, inclusive quanto a extensão rural. Nesse aspecto, a pauta era reduzir o tamanho do Estado e fortalecer o mercado. Nessa lógica, a extensão rural não era mais política de governo, passando a ser programas de governos estaduais sem os recursos federais.

Nesse espírito, a primeira iniciativa de extinção da EMBRATER se deu no Governo Sarney, sob a forma de medida provisória. Entretanto, o Congresso Nacional da época rejeitou a medida provisória, resgatando do limbo essa empresa federal, que encabeçava o Sistema Nacional de Assistência Técnica e Extensão Rural (SIBRATER)

integrado por 27 estados federados, por meio das suas unidades locais de assistência técnica e extensão rural (EMATERs).

Enfraquecida politicamente no horizonte agrícola nacional, em seguida ocorreu a extinção da EMBRATER, em 1990, no governo do presidente Collor, que transferiu a atribuição dos serviços de Ater sob a responsabilidade dos estados e municípios. Os resultados da atuação dessa empresa estatal de âmbito nacional, criada no regime militar, se manifestaram no sucateamento de sua estrutura e na falta da qualidade dos serviços prestados aos agricultores em geral e sobretudo aos agricultores familiares, sempre os mais vulneráveis social e economicamente. Desse modo, a extinção da EMBRATER, além de representar a retirada de vultosos recursos transferidos aos estados, também repercutiu no fim de uma política nacional de Ater na área agrícola, sobretudo àquela voltada à agricultura familiar.

De outra parte, considerando que as políticas públicas nascem das contradições e tensões sociais (SILVA, 2018), com o processo de luta pela redemocratização surgem nessa aurora de século diversos novos atores no cenário no meio rural como sindicatos, ONG's e associações atuando em redes e executando ATER com foco no desenvolvimento territorial endógeno.

Abramovay (2000) evidencia que O desenvolvimento territorial tem solo fecundo nas redes de atores envolvidos para valorização dos atributos de uma região. O autor cita inclusive entre outros exemplos o caso do desenvolvimento do Vale do Silício nos Estados Unidos que se deu mais em consequência da atuação da rede de atores do que mesmo em função da localização geográfica ou investimento em atividade determinada, afirmando ainda:

Construir novas instituições propícias ao desenvolvimento rural consiste, antes de tudo em fortalecer o capital social dos territórios, muito mais do que em promover o crescimento desta ou daquela atividade econômica. O próprio crescimento urbano recente aumenta a demanda por novos produtos e novos serviços vindos do meio rural. O desafio consiste em dotar as populações vivendo nas áreas rurais das prerrogativas necessárias a que sejam elas os protagonistas centrais da construção dos

novos territórios. (ABROMOVAY, 2000).

Insta registrar ainda que nos anos 70 e 80 floresceram também os debates sobre agricultura alternativa com destaque para os anos 90, onde se intensificou a temática da agroecologia como fonte de desenvolvimento territorial. Tal realidade re-significou o modelo de ação, as perspectivas e as relações no meio rural. Essa dicotomia entre ausência do Estado decorrentes das políticas liberais e as ações em rede do terceiro setor impulsionou o modelo de ATER do Estado no próximo século, as políticas públicas e a legislação, mas também novos conflitos.

### III. MARCOS LEGAIS DA ATER NO SÉCULO XXI: CONQUISTAS E DESMONTES

No alvorecer do novo século enfim nascem políticas públicas democráticas e exitosas para a ATER. Conquistas foram se estabelecendo, mas os conflitos sociais continuaram por se firmar no campo, considerando a crescente insatisfação do modelo produtivo da classe dominante diante dos avanços sociais. Inobstante a regência do Partido dos Trabalhadores no Executivo Federal entre os anos de 2003 a 2016 as tensões sociais se intensificavam a cada ano, culminando no impedimento da Presidenta Dilma.

De início, em 2003, com a instalação do governo do presidente Lula, a Política Nacional de Assistência Técnica e Extensão Rural começou a ser implementada. Essa política de Extensão Rural propõe em seus objetivos a mudança de rumos em relação às práticas extensionistas que marcaram a história da Ater até então do país. Importante destacar nesse contexto que o serviço de ATER saiu da competência do Ministério da Agricultura, Pecuária e Abastecimento (MAPA) engajado com a política agrária do agronegócio para o MDA com estrutura e interesses voltados para a agricultura familiar, a reforma agrária e o associativismo.

Além disso, diversas articulações e políticas foram implementadas nos anos seguintes inclusive a que estabelece a adoção dos princípios da agroecologia e suas bases teóricas para o estabelecimento de estratégias de desenvolvimento rural sustentável associadas aos serviços de ATER prestados pelo terceiro setor, opostas àquelas que foram implementadas em sua trajetória do século XX, como foram citadas anteriormente no presente artigo:

Em 2003, com a criação da PNATER, a prestação dos serviços de Ater no país mudou muito em relação ao período de 1948 a 1990 onde só as empresas públicas e estaduais executavam os mesmos. Com



esta política, estes serviços passaram a ser executados por duas diferentes categorias: o serviço estatal, exercido pelas empresas públicas e oficiais de Ater associadas à ASBRAER e o serviço não estatal, exercido por ONGs, organizações privadas, empresas de serviços técnicos (cooperativas de técnicos e escritórios de projetos agropecuários); instituições de ensino médio e superior, pelos movimentos sociais e por organizações e representações dos agricultores familiares. (PETTAN, 2010, p.216).

Formalmente, a Política Nacional de Assistência Técnica e Extensão Rural fora instituída em nosso ordenamento jurídico no ano de 2010, após vários processos, articulações e execuções de políticas públicas para a ATER nessa primeira década. Assim é que adveio a promulgação da lei 12.188/2010 que Instituiu a Política Nacional de Assistência Técnica e Extensão Rural para a Agricultura Familiar e Reforma Agrária - PNATER e o Programa Nacional de Assistência Técnica e Extensão Rural na Agricultura Familiar e na Reforma Agrária – PRONATER (BRASIL, 2010).

É de suma importância observar nessa norma os princípios e objetivos da PNATER, fortalecendo e estruturando em um conjunto de articulações os serviços de ATER, associativismo, economia solidária e uma agricultura de base ecológica. Constata-se que no art. 3º, I, III e IV, a lei referencia como princípios da Política Nacional de Assistência Técnica e Extensão Rural para a Agricultura Familiar e Reforma Agrária o desenvolvimento rural sustentável, compatível com a utilização adequada dos recursos naturais e com a preservação do meio ambiente; a adoção de metodologia participativa, com enfoque multidisciplinar, interdisciplinar e intercultural, buscando a construção da cidadania e a democratização da gestão da política pública e a adoção dos princípios da agricultura de base ecológica como enfoque preferencial para o desenvolvimento de sistemas de produção sustentáveis.

E ainda no art. 4º I, II e IX estabelece como objetivos da PNATER promover o desenvolvimento rural sustentável; apoiar iniciativas econômicas que promovam as potencialidades e vocações regionais e locais e apoiar o associativismo e o cooperativismo, bem como a formação de agentes de assistência técnica e extensão rural.

No mesmo caminho, no ano de 2012 foi aprovada no mesmo espírito outra norma federal que foi o Decreto de nº 7.794 que instituiu a Política Nacional de Agroecologia e Produção Orgânica, fixando como instrumento da PNPO em seu art. 4º, VIII a assistência técnica e extensão rural (BRASIL, 2012).

Portanto, diante da vigência dessa lei 12.188/2010 (BRASIL, 2010) e do Decreto de nº 7.794/2012 (BRASIL, 2012), consolidou-se a estrutura legal de um novo paradigma de ATER agroecológica no âmbito da agricultura familiar fundado nas redes de articulação. O espírito de tal norma é a fecundação do desenvolvimento territorial endógeno ao elevar a categoria de lei federal o apoio ao associativismo e o cooperativismo nas ações de ATER para fomento de uma agricultura de base ecológica.

Nessa perspectiva da legislação, GANANÇA (2006) em dissertação de mestrado, tratando sobre o universo do associativismo em regimes democráticos, registra que várias lutas sociais a partir dos anos 80 direcionaram o foco para construção e defesa de políticas públicas universais e garantidoras e a ação coletiva do associativismo contribuiu para a conquista e efetivação de direitos políticos, civis e sociais.

De conseguinte, o braço operacional da PNATER foi estabelecido por meio do Projeto de Lei nº 5.740/2013, que autorizou a criação de Agência Nacional de Assistência Técnica e Extensão Rural (ANATER), assinado pela Presidente da República em 6 de junho de 2013 e encaminhado ao Congresso Nacional em 10 de junho do mesmo ano. Entretanto, desde a idealização da Agência, ainda são questões em aberto, a determinação das diretrizes de atuação, a definição do público beneficiário e da forma de gestão da Agência. Neste sentido, havia elevado risco do segmento da agricultura familiar ficar mais uma vez fora do protagonismo dos serviços de Ater, que lhe foi historicamente e sistematicamente negado pelo Estado brasileiro. (THOMSON et al., 2018).

A ANATER foi finalmente instituída pelo Decreto 8.252 de 26 de maio de 2014 (BRASIL, 2014) no governo da presidente Dilma Rousseff, conforme disposto no art. 1º da Lei nº 12.897, de 18 de dezembro de 2013 (BRASIL, 2013), que criou a ANATER. Essa Agência presta serviço social autônomo, sem fins lucrativos, de interesse coletivo e de utilidade pública.

Essa agência tem recebido duras críticas de setores dos movimentos sociais ligados ao Movimento Agroecológico, por acreditar que a Agência desconsideraria todo debate de uma extensão com princípios

agroecológicos. O movimento durante o III Encontro Internacional de Agroecologia (EIA) redigiu uma moção de repúdio acusando a nova lei de um “retorno ao difusionismo tecnológico”, visto como um de seus retrocessos, pelo movimento agroecológico. [...]Esses contextos de disputas ilustram bem a existência e a persistência do tensionamento político ideológico presente na esfera da política brasileira de ATER e, de um modo geral, na política agrária, repercutindo, por conseguinte, na política agrícola. (FRANCO, et al., 2019, p.276).

De outra parte, em 2016, na esteira do recorrente desmonte do Estado por parte do mandatário máximo de plantão, foi extinto por Michel Temer o Ministério de Desenvolvimento Agrário (MDA), após o afastamento da presidente Dilma Rousseff. A partir daí, a ANATER, órgão então vinculado ao MDA, se ausentou da participação no Conselho Nacional de Desenvolvimento Rural Sustentável (CONDRAF), que tem como finalidade deliberar sobre o Plano Nacional de Desenvolvimento Rural, que abriga as diretrizes, os objetivos e as metas do Programa Nacional de Fortalecimento da Agricultura Familiar (PRONAF).

As consequências do referido desmonte foram a marginalização do segmento da agricultura familiar no acesso a serviços de Ater pública, além da redução das ações dirigidas para agroecologia e convivência com o semiárido nordestino. Renascia aqui as ações neoliberais como política de governo institucionalizando em diversas ações o enfrentamento e desmantelamento do novo paradigma de ATER que promovia o desenvolvimento endógeno a agricultura de base ecológica.

Em 2019, no início do governo do presidente Bolsonaro, a ANATER passou por mudanças expressivas em sua relação institucional com a União. Assim, por força da Lei nº 13.844 de 18 de junho de 2019 (BRASIL, 2019) foi extinta a Secretaria Especial de Agricultura Familiar e do Desenvolvimento Agrário da Casa Civil da Presidência da República (SEAD), responsável pelo Contrato de Gestão entre a ANATER e a União, transferindo todas as obrigações e direitos decorrentes do referido contrato para o Ministério da Agricultura, Pecuária e Abastecimento (MAPA). Assim, foi conferida a gestão dos projetos e atividades de Ater direcionada tanto ao agricultor familiar como a outras

categorias de produtor rural ao MAPA, através da Secretaria de Agricultura Familiar e Cooperativismo (SAF).

Além dessas mudanças na estrutura e no processo de funcionamento da ANATER, houve cortes significativos na dotação orçamentária da Agência nos últimos anos, com repactuação de todos os contratos em vigência, inclusive com rescisões seletivas de contrato com alguns estados. A redução orçamentária de 2017 para 2019 foi da ordem de 51% do orçamento para a assistência técnica e extensão rural. Assim, os contratos firmados pela ANATER deveriam ser readequados tendo como referência o parâmetro orçamentário de corte de mais da metade dos valores previstos, no mínimo.

Tendo como prática recente, por parte do Governo Federal, a realização de cortes no orçamento anual da ANATER, em reunião da Frente Parlamentar da Agricultura Familiar, em outubro de 2020, na Câmara dos Deputados, não foi diferente, pois o Executivo Federal promoveu redução de 40% no orçamento de Ater para 2021. Comparativamente à proposta orçamentária de 2020, o item promoção da agricultura familiar sofreu uma queda de 16%, mas em relação a 2019 a redução foi de mais de 90%. Além disso, houve redução de 33% para aquisição e distribuição de alimentos da agricultura familiar (HOLLAS, 2020).

A luta pelo controle do aparelho estatal além de levar ao relativo controle das políticas públicas, das atividades e dos recursos alocados no orçamento de instituições especializadas em agricultura e Ater, também se reveste de importância simbólica de controle de poder por parte da elite do segmento da agropecuária no país. Exemplo disso é a atual ministra da agricultura do governo do presidente Bolsonaro, que foi presidente da Frente Parlamentar Agropecuária, conhecida como bancada ruralista. Esse agrupamento congrega em torno de 200 parlamentares da Câmara dos Deputados e do Senado ligados ao patronato rural e ao agronegócio. Diante dessas insígnias do novo comando na agricultura do Governo Federal, a pesquisadora Regina Bruno, observando as atitudes das elites dirigentes do campo brasileiro, ilumina *via crucis* ser atravessada pelos agricultores familiares:

[...] a relação do patronato rural e agroindustrial com os agricultores familiares faz parte de uma história de exploração e de subordinação e pressupõe a utilização dos mecanismos de dominação simbólica cuja finalidade é apagar ou naturalizar as desigualdades sociais a fim de legitimar regras de inclusão e exclusão que fazem

parte dessa relação. A fala das elites agroindustrial é emblemática e expressa o pensamento hegemônico dos grupos sociais dominantes no campo brasileiro.(BRUNO, 2016, p.153).

Encerrando a década, o que de resto se observou no atual cenário da Ater oficial em 2020 foi um sistemático desmonte da estrutura e dos processos técnico-administrativos fruto das conquistas sociais do início do século. Tais articulações são fruto agora de um projeto neoliberal de extrema direita no Governo Bolsonaro, literalmente comprometido com políticas voltadas para o agronegócio, o fortalecimento do latifúndio, o desmatamento e os agrotóxicos. Inclusive, o controle de um orçamento reduzido e insuficiente para atender às necessidades de Ater e o desvirtuamento das diretrizes programáticas que anteriormente dialogavam com os princípios firmados na PNATER revelam a atual realidade de incertezas e descaminhos, destacando dentre eles os princípios da Agroecologia como eixo orientador das ações de Ater.

Nessa reflexão, podemos dizer:

A criação de uma instituição deveria fortalecer o seu público beneficiário, mas a criação e atuações políticas de “cima para baixo” que vem sendo seguidas pela ANATER indica uma intensa desconstrução das trajetórias e acúmulos arduamente conquistados nas últimas décadas de uma ATER pública que busca a inclusão, em diversos aspectos, da agricultura familiar. (LIMA, 2018, p.48).

Em meio a tantas incertezas, contradições e desmontes de políticas públicas conquistadas e efetivadas na primeira década do século voltadas para a agricultura familiar de base ecológica, fora promulgada no Estado de Pernambuco a Lei nº 17158 de 08 de janeiro de 2021 que instituiu a Política Estadual de Agroecologia e Produção Orgânica e estabelece as diretrizes para o Plano Estadual de Agroecologia e Produção Orgânica do Estado de Pernambuco. Estatui a presente lei entre outros objetivos no art. 5º, IV, que o Estado poderá financiar, por meio de editais públicos, projetos de organizações não governamentais, de cooperativas e de associações de agricultores familiares, de empreendimentos familiares e de economia solidária

orientados para a promoção da transição agroecológica e de sistemas orgânicos de produção agropecuária (PERNAMBUCO, 2021).

Tal norma é fruto de incansáveis articulações nesses vinte anos do vigésimo século em todo o país e não somente ação fragmentada no Estado de Pernambuco, revelando também que está viva a resistência voltada para o desenvolvimento territorial endógeno impulsionado com ações coletivas, associativismo e economia solidária de agricultura de base ecológica

Diante dessa estrutura legal vigente no país sobre a ATER estabelecida nas primeiras décadas desse centenário, constata-se uma grave antinomia legislativa com a edição de normas que promovem o desmonte de políticas públicas voltadas para a agricultura familiar no atual governo, e, de outro lado a plena vigência das normas federais de nº 12.188/2010 (BRASIL, 2010) e do Decreto de nº 7.794/2012 (BRASIL, 2012) orientadas pelos princípios constitucionais do art. 187, IV da Carta Magna que define que a política agrícola será planejada levando em conta especialmente a assistência técnica e extensão rural (BRASIL, 1988).

Diante desse choque de princípios e contradições legislativas em nosso ordenamento jurídico, necessário se faz estabelecer reflexões sobre os novos paradigmas da ATER no país como um caminho/proposta para soluções de impasses seculares de lutas de classes estabelecidas no campesinato.

#### **IV. REFLEXÕES SOBRE AS ARTICULAÇÕES NACIONAIS DE ATER NO SÉCULO XXI E AS DESCONSTRUÇÕES RECENTES**

As construções sociais e de representação da agricultura familiar no país se formaram com a mobilização dos agricultores familiares e trabalhadores rurais na luta por direitos.No curso dessa trajetória, houve poucas conjunturas em que o Estado favoreceu e apoiou os movimentos desses trabalhadores do campo em suas reivindicações como acima destacado. Assim o fez em 2012 apoiando a realização da 1ª Conferência Nacional de Assistência Técnica e Extensão Rural sobre Assistência Técnica e Extensão na Agricultura Familiar (CNATER),em Brasília (DF), cujo tema central dos debates foi Ater para a Agricultura Familiar e Reforma Agrária e o Desenvolvimento Sustentável do Brasil Rural, a partir dos princípios e objetivos da Política Nacional de Assistência Técnica e Extensão Rural (PNATER), mais conhecida como Lei de Ater. No período de 23 a 26 de abril, aproximadamente, mil pessoas participaram da 1ª CNATER. Essa Conferência foi resultado dos 200 encontros preparatórios, que mobilizaram cerca de 40 mil participantes em todo o país.

Durante a 1ª CNATER foram formuladas e aprovadas mais de 150 propostas que estabelecem diretrizes, estratégias e prioridades para PRONATER. No conjunto das propostas apresentadas foi assegurada a universalização dos serviços de Ater para os diferentes públicos, como agricultores familiares, indígenas e quilombolas, e a equivalência dos serviços prestados pelas entidades governamentais e não governamentais. Também foi proposto um novo modelo de gestão da política pública de Ater, além da consolidação dos serviços de Ater voltados para sistemas de produção de base ecológica. De acordo com o Ministro do MDA, A 1ª CNATER foi importante, pois referendou a Lei de PNATER e também sinalizou claramente que as entidades não governamentais(ONGs) e o público que elas assistem tem que ser prioridade na gestão do MDA (CRESOL, 2012).

Por sua vez, a 2ª Conferência Nacional de Assistência Técnica e Extensão Rural (CNATER) foi realizada no período de 31 de maio e 3 de junho de 2016, em Brasília. Após ampla mobilização das diversas instâncias de governo e da sociedade civil. A participação somou mais de 40 mil participantes do meio rural brasileiro, os quais homologaram 30 propostas para o documento final do evento, como também aprovaram a carta final do evento.

Com o slogan “Ater, agroecologia e alimentos saudáveis”, a 2ª CNATER teve como objetivo estabelecer e consolidar estratégias e ações prioritárias para promover a universalização da Ater pública e de qualidade aos agricultores/as familiares do país, visando ampliar a produção de alimentos para todos. A 2ª CNATER foi um evento do Ministério do Desenvolvimento Agrário (MDA), sob a coordenação do Conselho Nacional de Desenvolvimento Rural Sustentável (CONDRAF) e se inseria na estratégia de fortalecimento de espaços e formas de diálogo e participação social, que vinha sendo desenvolvida pelo Governo Federal. (IPEA,2016).

Em 2020, após o quadriênio da realização da derradeira CNATER, deveria ser realizada portanto a terceira edição da Conferência, porém, depois do desmonte do MDA e da desfiguração das parcerias com a ANATER, os caminhos agora a seguir deverão ser outros que não àquele do Estado articulador e promotor das duas edições anteriores exitosas.

Diante disso e refletindo sobre as possíveis alternativas sobrevividas da conjuntura de transição política no Executivo Federal iniciada em 2017 e considerando a ausência dessa articulação nacional como política de governo, as associações, ONG's, sindicatos, cooperativas e as organizações dos agricultores familiares precisam deste modo ampliar a apropriação dos bons frutos decorrentes do legado da parceria entre o Governo Federal e as

representações da agricultura familiar no país, em particular as estratégias de desenvolvimento sustentável, com ênfase na agricultura familiar e nos princípios da Agroecologia, como orientação para a promoção de estilos de agricultura socioambiental e economicamente sustentáveis.(CAPORAL et al., 2004).

Não se pode desconsiderar que os recursos orçamentários do Governo Federal para Ater serão sem dúvida mais difíceis de serem obtidos nessa conjuntura. Se a parceria com o Governo Federal para Ater nessa perspectiva é muito complexa para os estados federados, o que dizer das parcerias diretas com as entidades do setor não governamental de Ater, que sobrevivem, em grande medida, dos recursos oriundos dos editais e das chamadas públicas para prestarem serviços aos agricultores familiares e aos povos tradicionais? Nada mais que o sufocamento do associativismo, das ações coletivas e da ATER de cunho social voltada para uma agricultura de base ecológica impulsionadora do desenvolvimento territorial endógeno.

As reflexões e as informações oriundas do mundo acadêmico e das entidades do terceiro setor que tem histórico de lutas e serviços prestados ao segmento da agricultura familiar no país mostram alguns esboços de possíveis alternativas que poderão ser adotadas daqui para frente em apoio às ações de Ater voltadas para o segmento de produtores familiares. É importante afirmar que o caminho a ser elaborado é complexo, mas é um caminho de luta política que jamais deverá ser abandonado. Portanto, as reflexões aqui expostas deverão ser um exercício fundamental de um processo de iluminação da vida real e da prática de lutas e conquistas dos agricultores familiares.

## **V. UM NOVO TEMPO: INSTRUMENTOS DE COOPERAÇÃO E INOVAÇÃO A SERVIÇO DA ATER AGROECOLÓGICA COMO ESTRATÉGIA DE DESENVOLVIMENTO ENDÓGENO**

O novo paradigma de ater agroecológica no âmbito da agricultura familiar requer antes de tudo não conceber o Estado como único formulador e executor de políticas públicas. Por essa concepção, Abu-El-Haj(1999) dissertando sobre o debate em torno do capital social entre o culturalismo de Robert Putnam e o novo institucionalismo de Peter Evans, assevera:

Nesse sentido, as burocracias governamentais, por mais efetivas e preparadas que sejam, autonomamente não teriam o poder político necessário para conduzir isoladamente as políticas

públicas. Esse fato não fere o princípio da coesão burocrática como condição imprescindível da defesa da autonomia do Estado no momento de sua exposição à sociedade (ABU-EL-HAJ, 1999).

Não é por demais citar que o próprio Putnam (1996, p. 103) reconhece o grau de desenvolvimento da sociedade norte-americana pelo seu alto grau de capacidade de constituir associações em todos os níveis da sociedade, asseverando inclusive que “as associações civis contribuem para a eficácia e a estabilidade do governo democrático, não só por causa de seus efeitos “internos” sobre o indivíduo, mas também por causa de seus efeitos “externos” sobre a sociedade”.

Por esse viés, com o fim da Empresa Brasileira de Assistência Técnica e Extensão Rural (EMBRATER), passaram a existir nos estados entidades privadas, associações comunitárias, sindicatos, cooperativas e Organizações Não Governamentais (ONGs) que passaram a ofertar serviços de extensão rural aos agricultores familiares, atividade que anteriormente era exercida primordialmente pelo Estado por meio das Empresas de Assistência Técnica e Extensão Rural (EMATEREs). No processo de contratação das citadas entidades, o Estado lança uma chamada pública para que as entidades credenciadas junto à instituição estatal de Ater possam enviar suas propostas. A chamada pública é dividida em lotes. Cada lote tem um vencedor, o qual dá origem a um novo contrato de execução, monitorado e fiscalizado pelo Estado.

As entidades não estatais tem assim papel fundamental na assessoria técnica aos agricultores e agricultoras familiares à medida que essas organizações já dialogam no dia-a-dia com estas famílias, conhecem suas necessidades, sabem quais são suas demandas e fomentam a cooperação como instrumento de desenvolvimento rural, impulsionando a economia solidária.

Da mesma forma, as famílias já têm uma relação de confiança com as organizações de base, pela própria atuação regular e as vezes cotidianas que essas entidades mantêm com os atores locais e, em muitos casos, os agricultores familiares fazem parte da gestão dessas organizações, havendo, portanto, uma compreensão mais afinada e comprometida com a realidade local, tanto na execução como no acompanhamento e avaliação das atividades.

A título ilustrativo, podem-se observar por meio dos relatórios de monitoramento e fiscalização do Estado e de visitas técnicas de órgãos financiadores de projetos, que muitos resultados exitosos no trabalho de extensão

rural acontecem sobretudo nas comunidades onde esse serviço é prestado por entidades não estatais que impulsionam a economia solidária, gerando desenvolvimento territorial, democracia e igualdade entre os cidadãos.

Nessa lógica, Singer (2002) afirma que “a chave dessa proposta é a associação entre iguais em vez do contrato entre desiguais”, pontuando que “para que tivéssemos uma sociedade em que predominasse a igualdade entre todos os seus membros, seria preciso que a economia fosse solidária em vez de competitiva. Isso significa que os participantes na atividade econômica deveriam cooperar entre si em vez de competir”.

Convém notar que o fortalecimento da economia solidária, do associativismo comunitário, do cooperativismo e dos grupos solidários de ajuda mútua decorre do trabalho da cooperação, que têm uma escuta ativa e presente junto aos agricultores familiares em face da busca em atender as suas principais demandas, e também por motivá-los para o trabalho cooperativo. Esses consensos terão de ser construídos, tanto pela comunicação dos sujeitos, pelo diálogo e interlocução de seus saberes, quanto pela prática social de seus afazeres pela vida. Essa visão abre espaço ao associativismo e cooperativismo (FRANTZ, 2012, p.8).

O serviço de Ater prestado pelas entidades não estatais tem uma atenção especial com as redes de articulação e cooperação que lutam por melhorias na vida das famílias, mesmo diante de tantas dificuldades. Assim, a economia solidária é uma saída possível e real que atende às necessidades dessas famílias.

Nesse sentido, FRANTZ declara.

A economia cooperativa solidária, ao mesmo tempo em que contém as frustrações, as dúvidas, as incertezas e perguntas dos sujeitos, constitui-se também em um processo educativo e pedagógico em direção a um mundo mais justo e mais seguro para todos. Apresenta-se como uma nova utopia a reconstruir relações sociais sufocadas pela ideologia do egoísmo individualista, a serviço da racionalidade do lucro em desfavor do homem (FRANTZ, 2012, p.32).

Muitos são os exemplos de associações, cooperativas e outras formas associativas formais, que acessam recursos públicos e investem na melhoria da infraestrutura de

produção das famílias, como também em formações sociopolítica e produtiva dos associados, visando constituir uma nova realidade para estes sujeitos sociais, emponderando-os para enfrentar, via de regra, as políticas assistencialistas do Estado.

De acordo com a presidente da Cooperativa Agropecuária Familiar de Canudos, Uauá e Curaçá (Coopercuc)<sup>3</sup>, o trabalho eclesial da Igreja nas comunidades e o acompanhamento desse trabalho pelo Instituto Regional da Pequena Agropecuária Apropriada (IRPAA), através da assessoria técnica focada no trabalho da convivência com o semiárido. Contribuíram para despertar um novo olhar das mulheres que vivem nesta região (Curaçá, Uauá e Canudos) sobre a utilização dos recursos naturais disponíveis na caatinga, a exemplo do umbu, maracujá do mato, umbu-cajá etc. para gerar renda familiar. Com base nas observações e tirocínio da equipe técnica, foi possível as famílias camponesas se conscientizarem que era possível desenvolver habilidades para aproveitar economicamente do potencial da produção de doces para comercialização no mercado externo a partir dos frutos da caatinga e desta forma se organizarem para criar uma cooperativa que hoje é referência de cooperação no Brasil e no mundo.

Assim como nesse exemplo anterior, há muitos outros que mostram a importância das organizações da sociedade civil na execução da assessoria técnica. O Estado reconheceu este protagonismo do associativismo e das ações em redes, quando criou uma política de Ater descentralizada, atendendo a demanda deste setor. No entanto, com as mudanças de governo, excepcionalmente as políticas públicas voltadas ao pequeno agricultor são alteradas de acordo com os interesses econômicos dominantes.

E, tendo em vista as rupturas na gestão estatal sobre as políticas públicas, gerando insegurança jurídica e econômica, as Redes descentralizadas de Ater de diferentes alcances (municipal, estadual e nacional) deverão ser fortalecidas na perspectiva da agroecológica sob o signo da economia solidária como fundamento de desenvolvimento endógeno. Deverão também serem intensificados os esforços junto ao legislativo federal, mais especificamente em relação à Frente Parlamentar da Agricultura Familiar,

como também abrir espaços nos orçamentos municipais para a constituição de um Fundo de Ater, destinado para esse importante segmento produtivo e socioeconômico da sociedade brasileira, que produz grande parte dos alimentos da população.

Essas frentes de compromissos, entre outras, são imperativas na presente conjuntura e se afiguram como um exercício de construção e de luta a ser investido com determinação daqui para frente, visando fazer face à crise estrutural dos serviços de Ater no país, agravada pela crise sanitária que impõe a imperiosa necessidade de reconstrução da economia nacional nos próximos anos. A cooperação e a articulação em redes se apresenta nesse palco como instrumento de resistência e democracia capaz de alterar essa realidade social propondo um novo paradigma de ATER nesse espírito:

[...] quanto mais ricas as redes e conexões que operam nas estruturas sociais, mais chances de causar impactos positivos na democracia, tornando as instituições políticas mais eficazes. A existência dessas redes permite que os indivíduos acessem esses recursos sociais na constituição de relações que beneficiam outros indivíduos. Por esses mecanismos – as redes e conexões – as normas de reciprocidade e de confiança tendem a se desenvolver na direção das virtudes cívicas, estimulando sentidos de coletividade, sendo esta a chave da relação entre capital social, associativismo e democracia (LUCHMANN, 2014).

Em relação às redes de articulação de Ater, tem-se informações sobre as redes de abrangência nacional e regional atuantes há algum tempo nos territórios da agricultura familiar, de povos tradicionais, assentamentos de reforma agrária, associações de pequenos produtores rurais,

treinamento sobre beneficiamento de frutas, já eram articuladas, unidas, produtivas. Aí foi só esperar mais uma safra de umbu, que vai de dezembro a abril, para começar a vender as delícias que saíam de suas cozinhas. Apresentaram antes as geleias para os vizinhos, que aprovaram, queriam mais. Em seguida, foram para a feira e, de lá para cá, ganharam o mundo. Em 2004, a Coopercuc foi oficializada, com quarenta e quatro cooperados. Hoje, passam de cento e quarenta, trabalhando com dignidade e alegria (ASA, 2020).

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<sup>3</sup> Eis que, no final da década de 1980 chegaram à cidade, em missão, três freiras para chacoalhar a vida pacata daquelas mulheres que se revezavam entre as tarefas da casa e os cuidados com as cabras, galinhas e hortas de subsistência. As religiosas começaram a trabalhar com a comunidade a questão da participação da mulher na geração de renda e nas decisões políticas. Logo, mulheres de comunidades vizinhas se juntaram a elas. Primeiro as de Curaçá, depois, as de Canudos. Quando, no final da década de 1990, tiveram

cooperativas de pequenos agricultores e criadores, etc. As atuações de redes nacionais se expressam nesses segmentos por meio da construção do conhecimento agroecológico, notadamente nos campos da Ater, da Educação e da Pesquisa, conservação e o uso sustentável da biodiversidade, protagonismo das mulheres, abastecimento e construção social de mercados, soberania e segurança alimentar, reforma agrária e direitos territoriais de povos e comunidades tradicionais, acesso e gestão das águas, questão dos agrotóxicos e dos transgênicos, normas sanitárias para produtos da agricultura familiar, crédito para financiamento da agricultura familiar (Pronaf) entre outros. (ANA, 2018).

Por seu turno, no âmbito das redes de cunho regional destaca-se a Rede Ater Nordeste,

[...] que é constituída por 16 entidades integradas em espaços político-organizativos formados por dezenas de organizações de base (sindicatos, associações, cooperativas, grupos informais, etc.) que, por sua vez, articulam milhares de famílias agricultoras. A assessoria das entidades a essas redes sociais de inovação vem cumprindo papel de crescente relevância na promoção do desenvolvimento da agricultura familiar nos diversos territórios em que atuam. ((LIMA, 2018, p. 28).

Segundo a bibliografia consultada, a Rede Ater Nordeste foi criada em 2003 e tem por foco a construção coletiva da transição agroecológica, vislumbrando a implantação de um modelo de política de extensão rural ajustada ao Nordeste brasileiro.

Como se pode observar estas entidades tem um capital social que possibilita incidir diretamente na política pública. As relações de confiança, cooperação e ajuda mútua são fundamentais para que essas entidades se articulem em redes, a exemplo da Rede Ater Nordeste já citado, a Articulação de Agroecologia Baiana (AABA), Fórum da Agricultura Familiar da Bahia (FBAF) e também a Articulação do Semiárido (ASA).

A ASA é uma rede que defende, propaga e põe em prática, inclusive através de políticas públicas, o projeto político da convivência com o

Semiárido. É uma rede porque é formada por mais de três mil organizações da sociedade civil de distintas naturezas – sindicatos rurais, associações de agricultores e agricultoras, cooperativas, ONGs, OSCIP, etc. Essa rede conecta pessoas organizadas em entidades que atuam em todo o Semiárido defendendo os direitos dos povos e comunidades da região. As entidades que integram a ASA estão organizadas em fóruns e redes nos 10 estados que compõem o Semiárido Brasileiro. (ASA, 2020).

Como se vê, as entidades da sociedade civil são protagonistas no trabalho de base, são essas organizações que fazem a luta política para defender os direitos das populações, principalmente do meio rural. Para PUTNAN, a consciência que cada cidadão tem de seu papel e de seus deveres, em conjunto com seu compromisso de igualdade política, constitui o cimento moral da comunidade cívica. Essa, por sua vez, é o outro lado da moeda do capital social, o único capital que cresce na média em que é usado (ARAUJO, 2003, p.19, apud, PUTNAN, 1995).

No conjunto das redes, a perspectiva agroecológica é um valor consagrado e a partir do qual deverá ser trabalhada a sustentabilidade dos sistemas agrícolas. Todavia, o lastro econômico e financeiro para sustentar as ações autônomas de Ater Agroecológica, no âmbito das redes, não é claramente identificado e caracterizado.

Outro aspecto a destacar além da questão da cooperação em rede, da economia solidária e dos recursos financeiros para operar as ações de Ater Agroecológica em rede, diz respeito à necessidade de inovação de tecnologias e avanços educacionais por meio da Internet e seus aplicativos. Visa estimular e transmitir processos sociais de inovação agroecológica por meio das redes de Ater a outros agentes sociais envolvidos no processo de construção dialógico de saberes.

Dentro desse contexto dinâmico da Ater, novas perspectivas tecnológicas e educativas, baseadas nas tecnologias disponíveis nas redes sociais educativas viabilizadas pela Internet já são usadas no âmbito da assistência técnica e extensão rural. As novas ferramentas e veículos disponibilizados pela Internet devem alcançar cada vez mais as comunidades organizadas de agricultores familiares, como também podem melhorar a interação dessas comunidades como os agentes de Ater, que, por sua vez,

utilizando os meios e recursos de comunicação da Internet, viabilizam uma maior e melhor interação por meio das redes de Ater.

Alia-se a esse contexto, a nova proposta de extensão rural que preconiza um novo papel ao extensionista, muito mais crítico e transformador, em que são exigidas novas competências técnicas, cognitivas e políticas diante dos desafios éticos e socioambientais do espaço rural (COELHO, 2005; SOUSA, 2019).

Sem dúvida, as redes de Ater, qualquer que seja a sua dimensão e seu alcance, estarão melhor habilitadas para prestarem serviços e dialogarem com os agricultores familiares e suas organizações com o emprego de ferramentas que operam em plataforma de compartilhamento e interação *online*, de uso livre, gratuita, com suporte técnico, disponível em App para celular Android, em que o profissional extensionista e o agricultor familiar podem se conectar e colaborar uma parte com a outra pela Internet.

As dificuldades para um maior acesso às TICs no meio rural decorrem – além das próprias condições socioeconômicas dos agricultores familiares – de diversos aspectos, como por exemplo, da carência de capacitação de extensionistas rurais para que possam adquirir habilidade no uso das Redes Sociais Educativas *online*; acesso aos equipamentos digitais; disponibilidade de rede Wifi ou rede sem fio para uso de computadores (laptops e desktops), dispositivos móveis (smartphones, tablets, etc.) e outros equipamentos (impressoras e câmeras de vídeo) para se conectarem à Internet.

Identificar as boas práticas e as adequadas ferramentas de tecnologias de informação e comunicação (TICs), para seu uso a serviço da extensão rural na agricultura familiar é uma tarefa a ser realizada sobretudo pelas representações dos agricultores, cooperativas, Ongs e também pelas redes sociais públicas e privadas de apoio aos agricultores.

## VI. CONSIDERAÇÕES FINAIS

O futuro da Ater voltado para o segmento dos agricultores familiares está situado em um contexto particularmente contraditório e incerto, envolto numa herança histórica de tensões sociais entre uma minoria da elite latifundiária do país patrocinada pelo Estado

desenvolvimentista no século passado, pelo Estado neoliberal do século vigente e uma maioria de excluídos no meio rural. O cenário é de desigualdade e competição que não alimenta o desenvolvimento territorial. Compete às representações, movimentos sociais, frentes organizadas dos agricultores familiares e as forças auxiliares da sociedade sobre a maneira como enfrentar essas principais tensões, desafios estruturais e conjunturais.

Além disso, a luta para determinação de um modelo de Ater adequado aos interesses dos agricultores familiares se expande para outras áreas fundamentais da sociedade como um todo, em particular para o desenvolvimento sustentável em suas multidimensões. Nesse sentido, Maria de Nazareth Baudel Wanderley relaciona variados temas que se constituem nos desafios a serem enfrentados no futuro imediato:

Trata-se, entre outros temas, da preservação dos recursos naturais, dos desafios tecnológicos face às exigências bioéticas, ambientais e sociais, da disputa de espaços produtivos entre a produção de alimentos e de matérias-primas voltadas para a geração de energia, das relações produção-consumo associadas à garantia da qualidade dos produtos e das formas de produzir, da eliminação da pobreza extrema e da consolidação da democracia pelo reconhecimento dos sujeitos de direito que vivem no campo. (WANDERLEY, 2014, p.42).

Por tal horizonte, a igualdade social, a sustentabilidade e o desenvolvimento territorial endógeno tem enfoque numa ATER de cunho agroecológico a orientar a extensão rural. Tal enfoque se articula com a construção de saberes em rede, com a cooperação/associativismo e com a economia solidária em um sistema perfeitamente imbricado. A Extensão Rural Agroecológica seria nesse entendimento um instrumento de resistência e desenvolvimento territorial para alterar a realidade social e os desmontes das políticas públicas ocorridas nos últimos anos.

Por fim, é importante reafirmar que o caminho a ser trilhado é complexo, mas é um caminho de luta política que jamais deverá ser abandonado. Portanto, as modestas reflexões expostas no presente artigo estimulam o exercício fundamental que retrata um processo de iluminação da vida



real e da prática de lutas e conquistas dos agricultores familiares.

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# Constructive Cost Model II Metrics for Estimating Cost of Indigenous Software

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**Keywords**— *COCOMO II, Cost-estimation, Indigenous software, Nigeria's Computing environment*

**Abstract**— *There is growing concern over the frequent cases of cost overruns, and underestimation in software cost, especially, indigenous software products. This has a lot to do with the choice of Cost-estimation tools, techniques and models deployed. Constructive Cost Model (COCOMO) II model has been adjudged as the most reliable and accurate. However, the existing cost drivers/variables of this model (COCOMO II) do not capture fully the uniqueness of Nigeria's computing environment. This paper has highlighted the strengths and weaknesses of COCOMO II considering the hierarchy of COCOMO. A new algorithm was proposed to effectively enhance the cost estimation effort of indigenous software in Nigeria*

## I. INTRODUCTION

Software development has become an essential concern [1] because many projects are still not completed on schedule, with under or overestimation of efforts leading to their particular problems [2]. Therefore, to manage the budget and schedule of software projects [2], various software cost estimation models have been developed. Accurate software cost estimates are critical to both developers and customers [3]. They can be used for generating the request for proposals, contract negotiations, scheduling, monitoring, and control.

Cost estimation includes the process or methods that help us in predicting the actual and total cost that will be needed for our software and is considered as one of the complex and challenging activities for software companies. Their goal is to develop cheap software and at the same time deliver good quality products. Software cost estimation [4] is used basically by system analysts to get an approximation of the essential resources needed by a particular software project and their schedules. Important parameters in estimating cost are size, time, effort, etc. The process of software estimation focuses on four steps.

A variety of cost estimation models was developed in the last two decades, including commercial and public models as well [5]. Constructive Cost Model (COCOMO) II is one of the most sophisticated estimation models that allow one to arrive at fairly accurate and reasonable estimates. Estimation helps in setting realistic targets for completing a project. This enables one to obtain a reasonable idea of the project cost. The value chain consists of the creators, distributors, resellers, and consumers.

Cost estimation is one of the most challenging tasks in Software Development. Many system projects have failed in the past due to an inaccurate estimate of the actual cost of delivery. This had happened because an effective software estimation model had not been deployed by software organizations at the inception of software development. Underestimating the costs has resulted in management getting software with inadequate functionality, poor quality, under-staffing (resulting in staff burnout), and failure to complete on time. This has also led to project abandonment. Overestimating a project can be just about as bad for the organization! This results

in too many resources being committed to the project and delays the use of your resources on the next project or during contract bidding; result in not winning the contract, which can lead to loss of jobs. A solution to this malady is being sought by developing the COCOMO II cost estimation model to minimize this risk. Without reasonable accurate cost estimation capability, project managers cannot determine how much time and manpower cost the project should take and that means the software portion of the project is out of control from its beginning. With this development, system analysts cannot make realistic hardware-software trade-off analyses during the system design phase. Where the estimation is flawed, software project personnel cannot tell managers and customers whether their proposed budget and schedule are realistic.

Coming to local industries, there is a growing concern about how our indigenous software products are initiated and planned. For any new project, it is necessary to know how much it will cost to develop and how much development time is needed. These estimates are needed before development is ultimately initiated. In many cases, estimates are made using past experiences as the only guide. This should not be the case because projects differ in many respects, and hence past experiences alone are not enough. To achieve reliable cost and schedule estimates, several options abound: delay estimation until late in the project; use decomposition techniques to generate project cost and schedules estimates; develop empirical models for estimation or acquire one or more automated tools. Unfortunately, the first option is not practical, even though attractive. The other options are used to establish the scope and cost estimates in advance. The cost estimate must and should be provided upfront. Amongst many cost-estimation tools, techniques, and models, COCOMO II is the most reliable and accurate. This is because, COCOMO II mathematical equation is expandable and extendable to accommodate more variables (cost drivers), to suit unique and peculiar computing environments. Introducing and extending the COCOMO II model to reflect the country's unique environment gives a better, reliable and accurate prediction of cost, effort, and duration required for the successful delivery of software projects on schedule.

### Hierarchy of Constructive Cost Model

The Constructive Cost Model (COCOMO) is a widely used algorithmic software cost model. It was proposed by Boehm [6]. It has the following hierarchy-

- a) Model 1 (Basic COCOMO Model):-The basic COCOMO model computes software development effort and cost as a function of program size expressed in estimated lines of code

(LOC) [7]. Being the first of the COCOMO set of models, the formula used by this model is:

$$\text{Effort} = a*(KLOC)*b \quad (1)$$

where, KLOC - denotes the code size, and a, b – constants such that value of these constants [8] depends on the type of project, which is whether it's organic, semi-detached or embedded.

- b) Model 2 (Intermediate COCOMO Model): This takes the Basic COCOMO effort and schedule computation as its starting point. It then applies a series of multipliers to the Basic COCOMO figures. It takes into account factors such as required product reliability, database size, execution and storage constraint, personnel attributes, and the use of Software tools. In this, we obtain nominal effort estimation and the value of constants a, b differs from that of basic COCOMO. The formula used in this model is:

$$\text{Effort} = a*(KLOC) b* EAF \quad (2)$$

Here the effort adjustment factor is represented by EAF.

- c) Model 3 (Detailed COCOMO model): This model is slightly better than the Intermediate one. It has 17 cost drivers, instead of 15 which the Intermediate Model has. This works on each sub-system separately and serves as a boon for large systems made up of non-homogenous subsystems.

Constructive Cost Models presume the system and software requirements to be stable and predefined. But usually, this situation is not always valid. This model provides some advantages but it also has some disadvantages. Advantages: Simple to estimate cost. Disadvantages: Because estimation in the COCOMO model is done at the early stages of software development, many times it may lead to estimation failures.

As a result of these problems the newest version of COCOMO which is COCOMO II was developed in 1990 and uses a broader set of data. It uses source lines of code, function points, and object points as inputs. It also includes some modifications to the effort multiplier cost drivers of previous COCOMO. The obtained output is in the form of size and effort estimates later developed into a project schedule. Advantages: COCOMO II proves to be an industry-standard model, and has a clear and effective calibration process. Disadvantages: Calculation of duration for small projects is unreasonable.

## II. METHODOLOGY AND SYSTEM ANALYSIS

Object- Object-oriented analysis and design methodology

(OOADM) which is adopted in this study is a set of standards for the analysis and development of the COCOMO II software effort estimation. It uses a formal methodical approach to the analysis and design of information systems. Object-oriented design (OOD) elaborates the analysis models to produce implementation specifications. The main difference between object-oriented analysis and other forms of analysis is that by the object-oriented approach one organizes requirements around objects, which integrate both behaviors (processes) and states (data) modeled after real-world objects that the system interacts with. In other traditional analysis methodologies, the two aspects: processes and data are considered separately.

**Sources of Data / Methods of Data Collection**

To carry out a detailed analysis of the existing system, both primary and secondary data will be collected from different sources. Both secondary and primary data were used to get facts on the subject. Primary data was collected from actual institutions and secondary data was collected from the literature review that includes understanding and observing available COCOMO 11 software effort estimation. Secondary data was also gathered from several sources to carry out an insightful investigation into the existing systems, their working procedures, and their mode of operation. Secondary data include internet sources, journals, books, newspapers, and COCOMO 81.

- a) Data Collection Tools: Due to the sensitive nature of the study, the methods used for primary data collection were limited to the person(s) involved who were reluctant to have any written document from them, the result was the following methods:
- b) Person/Telephone Interviews: This is done by interviewing software project key players from their personal experience on areas on the COCOMO 11 software effort estimation that were prone to misuse by users.
- c) Prototype System: This method proved to be very useful. Even though the software projects developers were reluctant to give information on the subject when provided with a prototype system.

**Analysis of the Existing System**

An analysis is made according to the current comparison and based on the principles of the algorithmic and non-algorithmic methods. For using the non-algorithmic methods, it is necessary to have enough information about the previous projects of a similar type, because

these methods perform the estimation by analysis of the historical data. Also, non-algorithmic methods are easy to learn because all of them follow human behavior. On the other hand, Algorithmic methods are based on mathematics and some experimental equations. They are usually hard to learn and they need much data about the current project state. However, if enough data is reachable, these methods present reliable results. In addition, algorithmic methods usually are complementary to each other, for example, COCOMO uses the SLOC and Function Point as two input metrics, and generally, if these two metrics are accurate, the COCOMO presents the accurate results too. Finally, for selecting the best method to estimate, looking at available information of the current project and the same previous project's data could be useful.

COCOMO II model: It is a collection of three variants, Application composition model, early design model, and Post architecture model. This is an extension of the intermediate COCOMO model and is defined as:-

$$\text{Effort} = 2.9 (\text{KLOC})^{1.10} \tag{3}$$

Table 1 shows the advantages and disadvantages of existing method.

Method	Type	Advantages	Disadvantages
COCOMO	Algorithmic	Clear results, very common	Much data is required; It is not suitable for any project.
Expert Judgment	Non-Algorithmic	Fast prediction, Adapt to especial projects	Its success depend on expert. Usually is done incomplete
Function Point	Algorithmic	Language free. Its results are better than SLOG	Mechanization is hard to do, quality of output is not considered.
Analogy	Non-Algorithmic	Works based on actual experiences, having especial expert is not important	A lots of information about past projects is required, In some situations there are no similar project.
Parkinson	Non-Algorithmic	Correlates with some experience	Reinforces poor practice
Price to win	Non-Algorithmic	Often gets the contract	Generally produces large overruns
Top-down	Non-Algorithmic	Requires minimal project detail, Usually faster and easier to implement, System level focus	Less detailed basis, Less stable
Bottom-up	Non-Algorithmic	More detailed basis, More stable, encourage individual commitment	May overlook system level costs, Requires more effort, More time consuming

**III. ANALYSIS OF THE PROPOSED SYSTEM**

This research has generated algorithmic effort estimation for COCOMO II measurement. The proposed system is built to help all the practitioners measure the size of computerized business information systems. Such sizes are needed as a component of measurement of productivity in system development and maintenance activities and as a component of estimating the effort needed for such activities. Nowadays, software developers recognize the importance of the realistic estimates of effort to successful management of software projects and having realistic estimates at an early stage of the project life cycle which allow the project manager and development organizations to manage resource effectively. The process starts with the planning phase activities and is refined throughout the development.

The proposed system is designed to establish better and more realistic estimations for software projects. The system is designed and built with an infusion of some dummy variables and also features a user-friendly graphic user interface (GUI).

The study introduces certain cost drivers that are peculiar to Nigeria’s computing environment and indeed the third world countries. These are issues that relate to our computing Environment. They are Indigenous Environmental Cost Factors.

The following are the new values added in the proposed system and are summarized in Table 2:

- I) Power Supply (PS)
- II) Corporate/Social Responsibilities (COSR)
- III) Public Relations Needs/Goodwill (PRN)
- IV) Governmental Policies.(GTP)

**COCOMO II Model Structure and Its Variables**

Upon data collection, the following variables were proposed. Definitions of the variables are explained below. Effort is a dependent variable referring to the total man-hour effort required to build a software project. Independent variables include *Development kit (Dev-kit)*, *Designer-experience (Designer-exp)*, *No-of-programmers (No-prog)*, *Complexity (Comp)* and *Education-level (Edu-level)*.

- a) Effort: This variable emphasizes the effort (man-hour) spent by project developers to design application software. Effort is measured either in man-hour or man-month depending on the size of software projects. In the study, one considers man-hour is because the software projects are small to medium. Some software projects didn't last several months. For those software projects studied, only the time spent in analyzing and designing by project designers is counted. While

the time spent to discuss with clients and end-users is excluded. The measurement used to count the effort is the total number of man-hours for a single software project. The software company has a very good practice to record detailed information, such as time spent for each project, the number of project designers assigned to a project, and the development tool used, of each developed software project. Therefore, the data collection process was easy and straightforward.

- b) Dev-kit: This variable is to measure the complexity of the system development kit used by project designers. Usually, the complexity of a development kit correlates to the time required to develop software projects, as a good development kit can make programmers more productive during system development. When a suitable development kit is used, it can support the construction process by automating tasks executed at every stage of the system development life cycle. It facilitates interaction among project designers by diagramming a dynamic, iterative process, rather than one in which changes are cumbersome. It is also a useful tool to enable project designers to clarify end user's requirements at the very early stage of the system development life cycle. CASE tool is the common development kit used to support the development process in many companies. This factor is measured with a five-point Liker-like scale ranging from (1) very low productivity to (5) very high productivity.

Table 2: Indigenous Environment (New) Cost Factor

Cost Drivers	Rating	Values
Power Supply (PS)	Very Poor	1.75
	Poor	1.5
	Good	1.1
	Excellent	1.0
Public Relation Need (PSN)	Normal	1.0
	Abnormal	1.5
Government Policies (GTP)	Consistent	1.0
	Inconsistent	1.5
Corporate Social Responsibilities (COSR)	Rural	1.75
	Semi-Rural	1.5
	Urban	1.2

- c) Designer-exp: This variable is to measure the actual working experience of project designers designing application software in the computer industry. The experience of project designers in

developing software projects and the experience in a specific kind of programming language are key determinants. By common sense, an experienced project designer can reduce the number of errors to program codes if he has good mastering of that type of programming language and has several years in developing software projects. This leads to a minimum time in developing and maintaining programs in the future. Thus, the more the number of years of service that a designer serves in the industry, the higher the level of working experience the designer has gained. We take the average of years of experience among the team members if there is more than one participates in a project.

- d) No-prog: This variable is to count the number of project designers working collaboratively as a team. To make sure a late project can be completed on time, there are project designers who often add extra programmers. Sometimes, this arrangement may not work well, especially when there is a lack of proper communication among project designers and no training offered before the development. This could slow down the development process and lead to many problems. However, the situation may not happen in our study, because the software projects developed by a team of project designers are small to medium in terms of LOC. A project designer is relatively easy to make an accurate estimate before a software project starts. Therefore, there are no additional members who are invited to a late project. For this variable, according to the detailed information of the developed projects, one is in an easy position to collect the number of project developers responsible for each project being developed.
- e) Comp: This variable refers to the degree of program complexity designed. A thorough understanding of the software development process improves the relationship between program complexity and maintenance effort. That is, the high complexity of software projects increases the difficulty of project designers to quickly and accurately understand the programs before they are developed or repaired. The higher the level of complexity of a program is, the greater the effort required by the project designer. Especially, when a program has highly interactive modules to communicate not only within it, but also with modules from other programs. This will increase the time required by

project designers in designing software projects. In the study, this variable is to measure and examine system specifications and design specifications prepared by the company during the analysis and design phases. Due to the characteristics of collected software projects, they all are business-oriented programs. The determination process for program complexity is under the control of project designers. For this variable, the data is collected using a five-point Likert-like scale ranging from (1) very low complexity to (5) very high complexity.

- f) Edu-level: This variable is to measure the level of education that a project designer has acquired in a related field. Many companies prefer to recruit programmers who are equipped not only with extensive working experience in the industry but also those who have well trained with at least a bachelor's degree or higher in a related field. Project designers with a higher level of education usually can solve programming problems more easily than those who don't. To measure the factor, we use a five-point Likert-like scale ranged from (1) very low level of education to (5) very high level of education.

A linear regression model is hypothesized following discussion of the variables and it is shown in the following equation:

$$Effort = \alpha + \beta_1 Dev\_kit + \beta_2 Designer\_exp + \beta_3 No\_pro + \beta_4 Comp + \beta_5 Edu\_Level \quad (4)$$

where:  $\alpha$ ,  $\beta_1$ ,  $\beta_2$ ,  $\beta_3$ ,  $\beta_4$ , and  $\beta_5$  are constants; *Dev\_kit* - Software Development tools/kits; *Designer\_exp* - Experience of the Software Designer; *No\_pro* - number of programmers; *Comp* - Complexity of Software; *Edu\_level* - the highest level of education. The full COCOMO II model includes three stages:

Stage I Supports estimation of prototyping or applications composition efforts.

Stage 2: Supports estimation in the Early Design stages of a project, when less is known about the project's cost drivers.

Stage 3: Supports estimation in the Post-Architecture stage of a project.

This version of COCOMO II implements stage 2 formulas to estimate the effort, schedule, and cost required to develop a software product. It also provides the breakdown of effort and schedule into software life-cycle phases and activities from both the Waterfall model and the M base Model. The M base model is fully

described in Software Cost Estimation with COCOMO II. The stages of the model are shown in Figure 1.

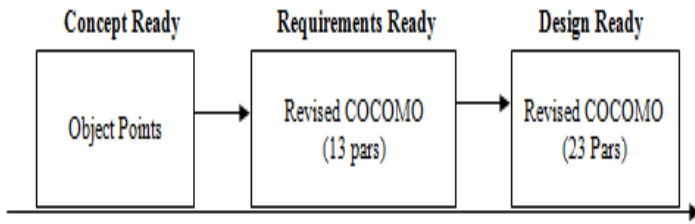


Fig.1: COCOMO Model Stages

**COCOMO 11 Model Effort Estimation Equations**

a) Effort Estimation: Obtaining the values of *A*, *B*, *EM<sub>i</sub>*, and *SF<sub>j</sub>* in COCOMO II is managed by calibrating the parameters and effort for the 161 projects in the model database. The main formula is below (Eq. 5) and acquires the size of the software development as input, combined with predefined constant *A*, an exponent *E* inclosing five scale factors, and 17 so-called effort multipliers.

The predefined constant estimates productivity in PM/KSLOC for the case where a project's economies and diseconomies of scale are in balance. Productivity alters as the exponent changes for the reason of non-linear effects on size. The constant is originally set when COCOMO II is calibrated to the project database which reflects a global productivity average.

The application size exponent is aggregated of five scale factors (*SF*) that describe relative economies or diseconomies of scale that are encountered for software projects of dissimilar magnitude. A project exhibits economies of scale if the exponent is less than one i.e. effort is non-linearly reduced. Economies and diseconomies of scale are in balance should the exponent hold a value of one. A project exhibits diseconomies of scale if the exponent is more than one i.e. effort is non-linearly increased in Eq. (7).

Boehm, [9] selected the scale factors in a foundation on the underlying principle that they have a significant exponential effect on effort or productivity disparity. As seen from the below formula, the five scale factors are summed up and utilized to establish a figure for the scaling exponent.

Cost Drivers: Cost drivers are characteristics of software development that influence effort in carrying out a certain project. Unlike the scale factors, cost drivers are selected based on the rationale that they have a linear effect on effort. There are 17 effort multipliers (*EM*) that are utilized in the COCOMO II model to emulate the development effort. What will be exposed in the subsequent review was

that every multiplicative cost driver is assigned the same rating level with the distinction being the combination of assigned weights. Annotated by [9] is the possibility to assign transitional rating levels and weights for the effort multipliers. They are furthermore leveled to establish a mean value that supplementary reflects upon a more reasonable figure 1. Even though the model specifies a finite number of cost drives, COCOMO II endows the user to define its own set of effort multipliers to better correspond to prevailing circumstances in any given development. Cost drivers are rated and founded on a sturdy rationale that they autonomously give details on a considerable source of effort and/or productivity discrepancy. Nominal levels do not impact effort whilst a value beneath/over one decreases/increases it.

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With the introduction of four 4 additional cost drivers (table 2), in the new system; the total number of cost drivers increases to 21, instead of 17. Thus, mathematical equations for the proposed system are extended thus:

$$PM = \prod_{i=1}^{21} (EM_i) \cdot A \cdot \left[ \left( 1 + \frac{REVL}{100} \right) \cdot Size \right]^{(0.9+0.01 \sum_{j=1}^5 SF_j)} + \left[ \frac{ASLOC \cdot \left( \frac{AT}{100} \right)}{ATPROD} \right] \tag{5}$$

where;

$$Size = KNSLOC + \left[ KASLOC \cdot \left( \frac{100-AT}{100} \right) \cdot \frac{(AA+SU+0.4 \cdot DM+0.3 \cdot CM+0.3 \cdot JM)}{100} \right] \tag{6}$$

and;



$$B = 0.91 + 0.01 \sum_{j=1}^5 SF_j$$

Table 3: Estimate effort

Symbol	Description
A	Constant, currently calibrated as 2.45
AA	Assessment and assimilation
ADAPT	Percentage of components adapted (represents the effort required in understanding software)
AT	Percentage of components that are automatically translated
ATPROD	Automatic translation productivity
REVL	Breakage: Percentage of code thrown away due to requirements volatility
CM	Percentage of code modified
DM	Percentage of design modified
EM	Effort Multipliers: RELY, DATA, CPLX, RUSE, DOCU, TIME, STOR, PVOL, ACAP, PCAP, PCON, APEX, PLEX, LTEX, TOOL, SITE
IM	Percentage of integration and test modified
KASLOC	Size of the adapted component expressed in thousands of adapted source lines of code
KNSLOC	Size of component expressed in thousands of new source of lines of codes
PM	Person months of estimated effort
SF	Scale Factors: PREC, FLEX, RESL, TEAM, PMAT
SU	Software understanding (zero if DM = 0 and CM = 0)

**Schedule Estimation Equation**

Determine the time to develop (TDEV) with an estimated effort, PM, that excludes the effect of the SCED effort multiplier.

$$TDEV = [3.67 \times (PM)^{(0.28+0.2(B-1.01))}] \cdot \frac{SCED\%}{100} \quad (7)$$

Where:

$$B = 0.91 + 0.01 \sum_{j=1}^5 SF_j \quad (8)$$

Scale Factors: Equation (8) defines the exponent, B, used in Eq. (7). Table 4 provides the rating levels for the COCOMO II scale drivers. The selection of scale drivers is based on the rationale that they are a significant source of exponential variation on a project's effort or productivity variation. Each scale driver has a range of rating levels, from Very Low to Extra High. Each rating level has a weight, W, and the specific value of the

weight is called a scale factor. A project's scale factors, W, are summed across all of the factors and used to determine a scaling exponent, B.

Table 4: COCOMO Scale Drivers

Symbol	Description
PM	Person months of estimated effort from Early Design or Post-Architecture models (excluding the effect of the SCED effort multiplier)
SF	Scale Factors: PREC, FLEX, RESL, TEAM, PMAT
TDEV	Time to develop
SCED	Schedule
SCED%	The compression/expansion percentage in the SCED effort multiplier

Table 5: Scale Factors for COCOMO II Early Design and Post-Architecture Models

Scale Factor	Very Low	Low	Nominal	High	Very High	Extra High
PREC	thoroughly unprecedented	largely unprecedented	Somewhat Unprecedented	generally familiar	largely familiar	thoroughly familiar
FLEX	rigorous	occasional relaxation	Some relaxation	general conformity	some conformity	general goals
RESL	little (20%)	Some (40%)	Often (60%)	Generally (75%)	Mostly (90%)	full (100%)
TEAM	very difficult interactions	some difficult interactions	Basically cooperative interactions	Large cooperative	highly cooperative	seamless interactions
PMAT	Weighted average of "Yes" answers to CMM Maturity Questionnaire					

In COCOMO II, the logical source statement has been chosen as the standard line of code. Defining a line of code is difficult due to conceptual differences involved in accounting for executable statements and data declarations in different languages. The goal is to measure the amount of intellectual work put into program development, but difficulties arise when trying to define consistent measures across different languages. Breakage due to changes of requirements also complicates sizing. To minimize these problems, the Software Engineering Institute (SEI) definition checklist for a logical source statement is used in defining the line of code measure. The Software Engineering Institute (SEI) has developed this checklist as part of a system of definition checklist, report forms, and supplemental forms to support measurement definitions.

**Post-architecture model**

COCOMO II helps in the reasoning about cost

implications of software decisions that need to be made, and for effort estimates when planning a new software development activity. The model uses historical projects as data points by adding them to a calibration database which is then calibrated by applying statistical techniques. The post-architecture model is utilized once the project is ready to be developed and sustain a fielded system meaning that the project should have a life-cycle architecture package that provides comprehensive information on cost driver inputs and enables more accurate cost estimates. All further references to COCOMO II can be assumed to be about the post-architecture model.

For the Rational Unified Process (RUP) model, all software development activities such as documentation, planning, and control, and configuration management (CM) are included, while database administration is not. For all models, the software portions of a hardware-software project are included (e.g., software CM, software project management) but general CM and management are not [9]. COCOMO II estimates utilize definitions of labor categories, thus they include project managers and program librarians, but exclude computer center operators, personnel-department personnel, secretaries, higher management, janitors, etc. A person-month (PM) consists of 152 working hours and has by [9] been found consistent with practical experience with the average monthly time off (excluding holidays, vacation, and sick leave).

It is of utmost importance for good model estimations to have a sufficient size estimate.[9] elucidates that determining size can be challenging and COCOMO II only utilizes size data that influences effort thus, new code and modified implementations are included in this size baseline category. Normal application development is typically composed of new code; code reused from other sources –with or without modifications – and automatically translated code. Adjustment factors capture the quantity of design, code, and testing that was altered. It also considers the understandability of the code and the programmer familiarity with the code.

COCOMO II expresses size in thousands of SLOC (KSLOC) and excludes non-delivered support software such as test drivers. They are included should they be implemented in the same fashion as distributed code. Determinants are the degree of incorporated reviews, test plans, and documentation. [9] Conveys that “the goal is to measure the amount of intellectual work put into program development”. The definition of a SLOC can be quite different in nature because of conceptual dissimilarities in different languages. As a consequence, backfiring tables are often introduced to counterbalance

such circumstances. This is fairly reoccurring when accounting size in diverse generation languages. However, an organization that specializes in one programming language is not exposed to such conditions. A SLOC definition checklist is made available in the Appendix and somewhat departs from the Software Engineering Institute (SEI) definition to fit the COCOMO II models definitions and assumptions. Moreover, the sidebar demonstrates some local deviations that were interpreted from the – to some extent – general guidelines. Code produced with source code generators is managed by counting separate operator directives as SLOC. Concurring with [9], it is divulged to be highly complex to count directives in an exceedingly visual programming system. A subsequent section will unearth the settlement of this troublesome predicament.

#### IV. HIGH LEVEL MODEL OF THE NEW SYSTEM

This section presents the model of the new system.

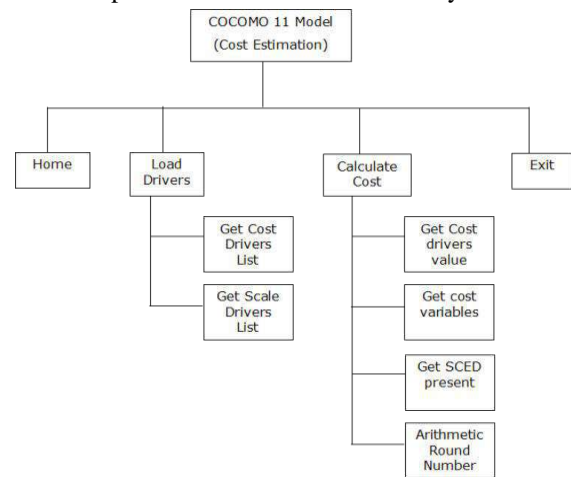


Fig.2: Block diagram of the high-level model of the Proposed System.

#### Application Composition Model

At the beginning of a project when the developer does not have any detailed design and maybe not even formulated the requirements, this model should be used. It is based on object points as an estimation of the software’s size. To calculate object points is a way to estimate the size of software, early in the development process. The very first thing to do when an object point analysis should be made is to identify screens, reports, and 3GL components. After that, the objects should be classified in the difficulty levels simple, medium, and difficult. In the same way, as with function points, every class and difficulty level is assigned a number that functions as weight.

**a) Advantages of the new system:**

1. It is an open cost model, in which all details are published. Very profound information is easily available.
2. COCOMO II adjusts to software reuse and re-engineering where automated tools are used for the translation of existing software.
3. It can be used to determine the actual size of the project by algorithmic methods as well as historical data or expert opinions.
4. The COCOMO II software cost estimation model provides a tailor-able cost estimation capability well matched to the major current and likely future software process trends.
5. It offers a clear and effective calibration process.
6. COCOMO II has effective tool support (also for the various extensions).
7. Well-documented, 'independent' model which is not tied to a specific software vendor
8. Algorithmic cost models like COCOMO II support quantitative option analysis as they allow the costs of different options to be compared.

**V. CONCLUSION**

An Effective software project estimation is one of the most challenging and important activities in software development. Proper project planning and control is not possible without a sound and reliable estimate. As a whole, the software industry does not estimate projects well and doesn't use estimates appropriately. We suffer far more than one should as a result and we need to focus some effort on improving the situation. Thus, the software engineering community has put tremendous effort to develop models that can help estimators to generate the accurate cost estimate of a software project. In the last three decades, many software estimation models and methods have been proposed, evaluated, and used.

There are many software cost estimation methods available including algorithmic methods, estimating by analogy, expert judgment method, top-down method, and bottom-up method. No one method is necessarily better or worse than the other but COCOMO II is preferred over other methods because it is the most suitable for large and lesser-known projects. COCOMO II has capabilities to deal with the current software process and is served as a framework for an extensive current data collection and analysis effort to further refine and calibrate the model's estimation capabilities. The COCOMO models provide clear and consistent definitions of processes, inputs, outputs, and assumptions, thus help estimators reason their estimates and generate more accurate estimates than using their intuition. The new system has both advantages and

disadvantages. But the advantages far outweigh the disadvantages thereby justifying the new system.

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# The Brazilian Public Policies for Rd & I in the Brazilian Electrical System (SEB), in Light of the Commitments of the Agenda 2030

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**Keywords**— *public innovation policies, Brazilian electric sector, RD&I, Agenda 2030.*

**Abstract**— *The purpose of this article is to analyze whether the Brazilian public policies (PP), materialized in the innovation program (RD&I) of the SEB through the R&DP and EEP, contribute or not to the Brazilian government's fulfillment of the commitments made with Agenda 2030 and the NDC goals, together with the Paris Agreement, concerning SDG 7. The methodological procedures adopted were bibliographic and documental research, involving the legislation that guides the RD&I regulated by ANEEL, as well as the analysis of 30 R&DP projects and 1,026 EEP projects. The R&DP has proven not to be aligned with the goals of Agenda 2030, especially with regard to the development of a culture of innovation in the SEB, besides being disconnected from the rest of the world in terms of the type and model adopted for innovation, patent generation, and continuous improvement. It showed improvement only in the profile of human resources used in the program. The EEP presented results aligned with Agenda 2030 and SDG 7 and Brazil's NDC, through the following indicators: i) investment avoided in energy generation; ii) energy saved; iii) demand withdrawn from the peak; iv) energy conserved. In addition, there are results in line with SDG 9 and 13 such as an increase in the supply of renewable energy and reduction of CO<sub>2e</sub> emissions in the system. The R&DP and the EEP together contribute R\$ 1.1 billion per year in innovation in the SEB, making an expected value of around R\$ 12.1 billion from 2020 to 2030.*

<sup>a</sup> In memoriam

## I. INTRODUCTION

Implemented two decades ago and regulated by the Brazilian National Electric Energy Agency (ANEEL), the Research and Development Program (R&DP)<sup>b</sup> and the

Energy Efficiency Program (EEP)<sup>c</sup> have been consolidated as a Public Policy (PP) of innovation for the Brazilian Electric Sector (SEB).

<sup>b</sup> The Research and Development Program (R&DP) is regulated by ANEEL, according to Law 9.991/2000.

<sup>c</sup> The Energy Efficiency Program (EEP) is regulated by ANEEL, according to Law 9.991/2000.

The SEB is in a structural transition process that started in the 1990s (Castro; Brandão, 2019). The electricity sector is an economic activity recognized as a natural monopoly, which until the 1980s, in Brazil, was purely state-owned. In the following decade, the privatization process in the SEB began, but without the removal of the monopoly condition, which makes the regulation of the sector essential (Castro; Brandão, 2019).

It is necessary to clarify that the electric power sector is still a monopoly, moving towards oligopoly in some federative units (FU) because it is characterized by the presence of market failures that do not allow the sector to reach an efficient Pareto equilibrium on its own (mankiw, 2001; Tirole, 2020). Regulation emerges as a force to try to reduce or even eliminate these failures when possible. The main characteristics for maintaining a monopoly or oligopoly are the high initial investment required (high infrastructure costs) and low marginal costs, which hinder the interest of more players offering the same good and service. Besides having financial entry barriers (because it is a capital-intensive sector), there are also other types of entry barriers, such as legal and regulatory (Tirole, 2020).

The peculiarities of this new condition led, in 1996, to the creation of ANEEL, which from the beginning of its regulatory activities began to be concerned with the evolution of the SEB companies. In 1999, actions coordinated by the Agency began to implement the R&D program in the sector, which culminated with Law 9.991/2000, the first legal framework for innovation programs in the SEB (ANEEL, 2020b; BRASIL, 1996).

Regulated by ANEEL, the R&DP and the EEP have undergone several evaluations, which identified, for example, that ANEEL adopted a linear perspective model of innovation, at least in what is called the first and second phase of the program: from 2000-2007 and 2008-2015, respectively (ANEEL, 2020; Binet *et al.*, 2015; Castro; Brandão, 2019). In 2016, the technological innovation programs of the SEB, regulated by ANEEL, entered their third phase, in search of an evolution of the innovation model, leaving the linear perspective to the systemic view, which includes an approach of a National Innovation System (NIS) (Castro *et al.*, 2017).

The concept of NIS is based on the systemic approach of knowledge, associated with innovation and "interactive learning as factors of sustained competitiveness" (Castro *et al.*, 2017). Thus, the aim is to promote a culture of innovation, stimulating RD&I in the SEB, through the creation of new equipment and improving the provision of services, in a way that can

contribute to energy security, moderation of tariffs, reducing the environmental impact of the sector, and Brazil's commitments to the Paris Agreement, Agenda 2030 (ANEEL, 2020b).

With Brazil's adhesion to the Paris Agreement, SEB's innovation PPs must align with the goals of Agenda 2030, according to SDG 7: Affordable and clean energy, SDG 9: Industry, innovation and infrastructure, and SDG 13: Climate action (IPEA, 2018, 2019).

A gap has been identified in the sense of analyzing the Brazilian RD&I PPs of the SEB, in light of the commitments made by Brazil, with the United Nations (UN) Agenda 2030 and in particular, the goals established in the Nationally Determined Contribution (NDC), with the Paris Agreement.

Thus, this study has as its research problem the following question: How will Brazilian public policies for the SEB innovation, developed through the Research and Development Program (R&DP) and the Energy Efficiency Program (EEP), regulated by ANEEL, impact Brazil's commitments to the 2030 Agenda?

To answer the proposed problem it was established as the objective of this article: to analyze whether the Brazilian public policies (PP), materialized in the SEB's R&DP and EEP, contribute or not to the Brazilian government's fulfillment of the commitments made with the 2030 Agenda and the NDC goals, together with the Paris Agreement, concerning SDG 7.

The justification for conducting this study is the fact that the R&DP and the EEP, regulated by ANEEL, are responsible for the dynamics of innovation in the SEB, which aims to constantly seek "the innovations needed to meet the challenges of the electric power sector, either by promoting the efficient and rational use of electricity, associated with actions to combat waste" (ANEEL, 2020b). This is an extremely relevant public policy for the electricity sector, as the two together form the largest innovation program in the SEB.

This paper is structured in five parts, the first being this brief introduction. The second part presents a literature review on the main concepts of the study. The third section describes the methodological procedures step by step. The fourth section presents the results generated by the analysis of the R&DP and EEP projects and their discussion against the literature and the goals of SDG 7 - of Agenda 2030 - and the NDC goals of Brazil, along with the Paris Agreement. The fifth and last section describes the final considerations about the research conducted, according to Figure 1, below:

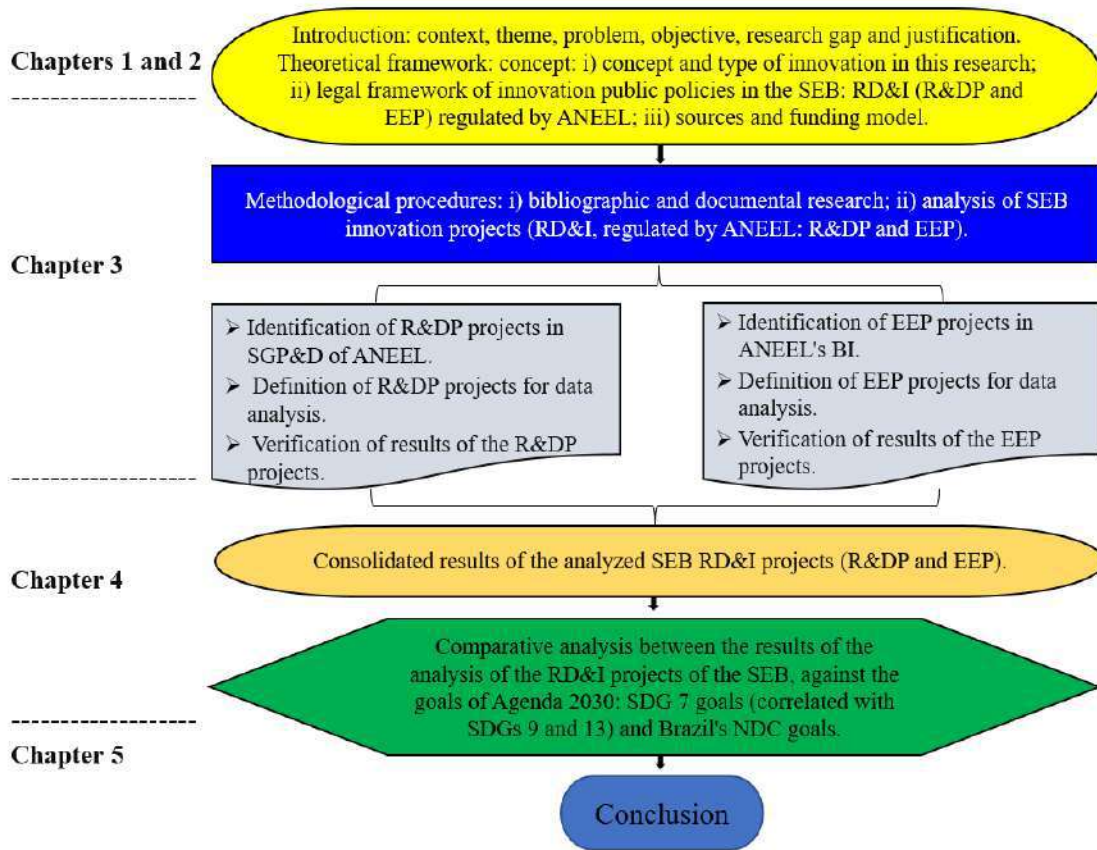


Fig.1: Structure of the method used in this article

Source: Elaborated by the authors.

## II. LITERATURE REVIEW

### 2.1 Innovation: concept, model, and management strategy

The process of organizational change has been accelerating in the last decades, with innovation as the driving force that occurs in the public and private sectors, following a dynamic of conceptual evolution, supported by models or forms of implementation and management strategy of an innovation policy.

#### 2.1.1 Innovation Concept

The concept of innovation in the context of this study follows that advocated by the Oslo Manual for the Organization for Economic Cooperation and Development (OECD), fourth edition, published in 2018, which includes the "requirement of measurability as an essential criterion for selecting concepts, definitions and classifications in this manual"(OECD/Eurostat, 2018, p. 20). According to OECD/Eurostat (2018, p. 20), innovation "is the implementation of a new or significantly improved product (good or service), or a process, or a new financial or business method, or a new organizational method in business practices, in the workplace organization, or

external relations."

For it to happen "product innovation must introduce a new or significantly improved good or service concerning its characteristics or intended uses", according to OECD/Eurostat (2018, p. 20). Significant improvements are understood to be: technical specifications, components, and materials, embedded software, ease of use, or other functional characteristics associated (OECD/Eurostat, 2018, p. 20).

The innovation of a process or innovation activity occurs from the "implementation of a new or significantly improved production or distribution method. Significant changes in techniques, equipment and/or software are included" OECD/Eurostat (2018, p. 21).

Besides product and process innovation, which is more frequent, there can still be marketing innovation and organizational innovation. In the former, the "implementation of a new financial or commercial method with significant changes in product design or packaging, product positioning, promotion, or pricing. In the second, the "implementation of a new organizational method in the company's business practices, workplace organization, or

external relations" occurs (OECD/Eurostat, 2018, p. 21).

The implementation of innovation programs necessarily involves the definition of models or ways to innovate, which depends on a careful analysis of the maturity stage of the market in which the organization operates (Christensen, 1997; OECD/Eurostat, 2018; Christensen, 2019).

### 2.1.2 Models or forms of innovation

As for implementation models, innovation can take the form of Schumpeter's creative destruction, incremental innovation, and radical or disruptive innovation (Christensen, 1997; OECD/Eurostat, 2018; Christensen, 2019).

When the form of innovation causes a technical change in the organization, it entails a redistribution of resources, including labor, across sectors and firms, which can generate creative destruction (OECD/Eurostat, 2018).

If the company operates in a stable and mature market, changes can happen continuously, following the rhythm of the market segment and moving in the incremental innovation model (OECD/Eurostat, 2018).

However, when the company operates in a volatile market environment, it needs to quickly introduce new products, new technologies, new processes, and new organizational models, and for this, it needs a form of radical or disruptive innovation (Christensen, 1997; Christensen, 2019). Even in stable markets that undergo major technological change, radical or disruptive innovation is recommended (Cabaneret al., 2016).

After defining the model or form of innovation, the organization must adopt a strategy to manage the implemented innovation model.

### 2.1.3 Innovation management strategy

For the organization to be successful with its innovation program, besides defining models and forms appropriate to the stage of maturity of the market in which it operates, it is necessary to make important strategic choices for the management of the program. There are two possible options for innovation management strategies:

closed innovation and open innovation (Chesbrough, 2003, 2010).

By adopting the closed innovation strategy, the organization minimizes the potential for results, because the closed model is based on the view that innovation is developed internally, without interactions with the environment, which is practically impossible. Open innovation assumes that firms can and should use external as well as internal ideas and pathways as they seek to advance their innovation process, using knowledge input and output flows intentionally to accelerate internal innovation and expand markets for external use (Chesbrough, 2003; 2010).

As this article deals with innovation in the electric sector, more specifically in the SEB, it is necessary to investigate what are the trends of changes that have been occurring in the sector worldwide and transport them to Brazil, so that the Brazilian society can enjoy the benefits generated by these innovations. They are a) reduction of disbursements with investments in energy generation, increased efficiency in distribution and lower costs for the final consumer, which can be provided by energy efficiency; b) flexibility of regulatory standards to encourage distributed generation; c) encourage RD&I for the development of fuel cells (hydrogen from ethanol and natural gas) that can increase the efficiency of renewable sources of solar and wind energy making them deployable<sup>d</sup> on a 24/7 or twenty-four hours a day, seven days a week basis (MME/SPE/EPE, 2018; Castro, Brandão, 2019; Miranda, 2019).

## 2.2 Institutional Structure of SEB

The SEB has an institutional structure, which is divided into the following segments: policies, regulation and supervision, institutional operation agents, and market agents, as shown in figure 2:

<sup>d</sup>Power plant dispatch is the set of instructions, actions, and control done by ONS in the processes of planning and scheduling, real-time operation, and post-operation (ENERGÊS, 2021). Available at: <https://energes.com.br/>

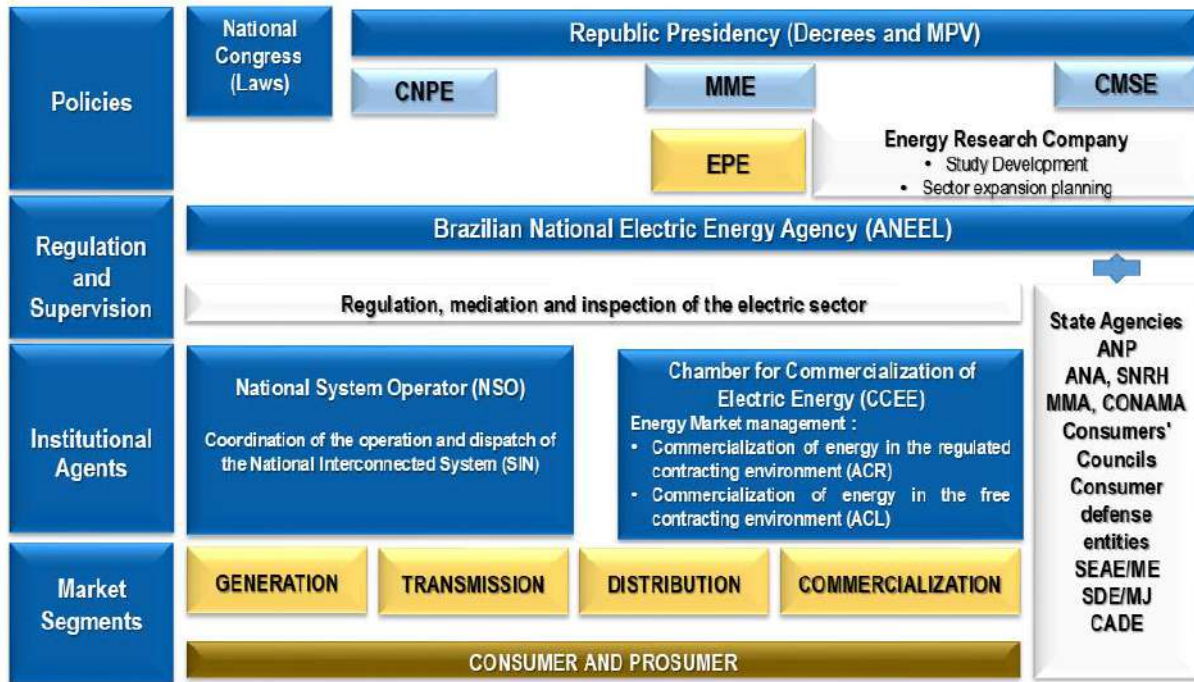


Fig.2: Institutional structure of the SEB

Source: elaborated by the authors, based on Brazil (1991; 2016) and ANEEL (2020).

The policy guidelines may be issued by the Brazilian National Congress (NC), through Laws; by the Presidency of the Federative Republic of Brazil (PR), through Decrees; by the National Energy Policy Council (NEPC), by the Ministry of Mines and Energy (MME), and by the Electric System Monitoring Committee (ESMC), through Resolutions, Ordinances, and Communications, respectively (ANEEL, 2018a).

ANEEL is responsible for the regulation, mediation, and inspection of the SEB, with the support of the National Water Agency (ANA), National Secretary of Water Resources (SNRH), National Petroleum Agency (ANP), Ministry of the Environment (MMA), National Environmental Council (CONAMA), State Electricity Agencies, Consumer Councils and consumer defense entities (ANEEL, 2018a).

The institutional agents of the SEB are the National System Operator (NSO), responsible for coordinating the operation and the dispatch of the National Interconnected System (SIN), and the Chamber for Commercialization of Electric Energy, which manages the energy market: a) energy commercialization in the regulated contracting environment (ACR); and b) energy commercialization in the free contracting environment (ACL) (ANEEL, 2018a).

The market agents are composed of the Generation (G), Transmission (T), Distribution (D), and

Commercialization (C) or (GTDC) companies and the consumers and prosumers of electricity (ANEEL, 2018a).

### 2.3 Public policies of innovation in the Brazilian electricity sector

The background of science and technology in Brazil is recent, since the university system is relatively new, having been consolidated during the first half of the 20th century. Brazilian public policies on innovation are even more recent and date from the end of the 20th century. For this study, only the PPs related to the electricity sector, this focus of this paper, will be analyzed.

#### 2.3.1 Innovation in the Brazilian Electric Sector (SEB)

The innovation in the SEB had as its initial milestone the creation of the Center for Electric Energy Research (CEPEL), which was "established by Public Deed, published on 01.21.74, and entered into by Eletrobras, Chesf, Furnas, Eletronorte, and Eletrosul", with an allocation of around 0.5% of Eletrobras' capital stock (CEPEL, 2017).

According to the bylaws, updated in 2017, the CEPEL (2017) "has as its main and permanent objective to preserve the capacity in research, development, innovation, qualification, and training in the area of electrical systems and related disciplines [...]".



With the privatization program of companies in the power sector that began in the 1990s, the need arose to create ANEEL to deal with the scenario that began to be drawn in the market, where private companies were providing public service through concessions (BRASIL, 1996).

From the regulation of the market, there was a need to raise the level of efficiency of the companies that operated in the sector, both those controlled by the public sector and those whose capital had been transferred to the

private sector, but which operated in the Generation, Transmission, and Distribution (GTD) of electricity.

In this context, a new regulatory framework for R&D in the SEB emerged, with Law No. 9.991 of July 24, 2000, which established the Energy Sector Fund (CTEnerg) and created the R&D Program (R&DP) and the Energy Efficiency Program (EEP) (ANEEL, 2017). The same law established the resources to finance the programs, according to Figure 3.

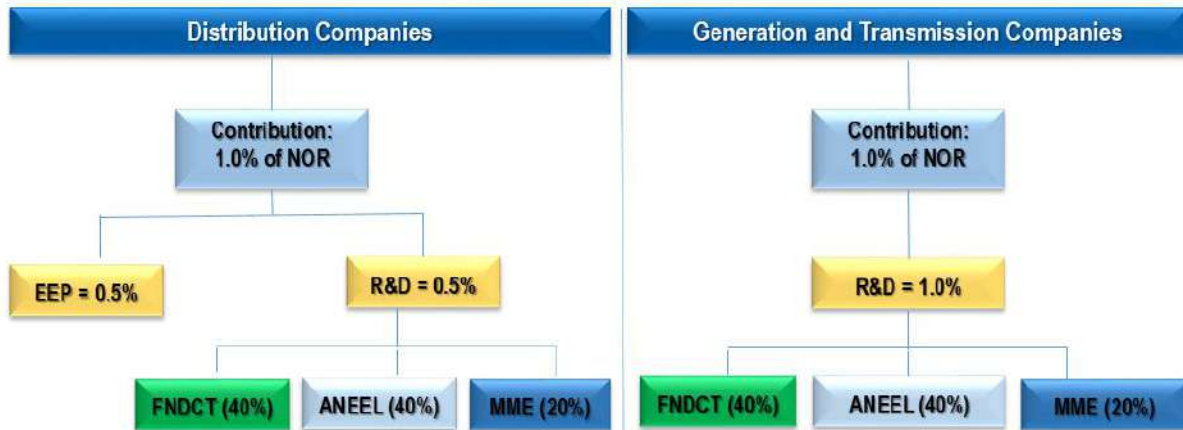


Fig.3: Origin and destination of resources to finance the SEB PP&D and EEP programs: contribution of the GTD segment companies

Source: elaborated by the authors, based on Brazil (1991; 2016) and ANEEL (2020).

As shown in figure 3, the Distribution companies contribute 1% of their Net Operating Revenue (NOR), being 0.5% for R&DP and 0.5% for the EEP. The companies in the Generation and Transmission segments contribute 1% to the R&DP of this niche market of G and T (BRASIL, 1991; 2016).

2.3.2 Research and Development Program (R&DP)

The objective of R&DP, regulated by ANEEL, "is to adequately allocate human and financial resources to projects that demonstrate the originality, applicability, relevance and economic viability of products and services,

in the processes, and end uses of energy" (ANEEL, 2020b).

The program seeks to promote a culture of innovation, stimulating research and development in the SEB, through the creation of new equipment and the improvement of services provision, in such a way as to contribute to energy security, tariff moderateness, the reduction in the sector's environmental impact and the country's technological dependence (ANEEL, 2020b). It should be noted that Law 9,991/2000 has been amended over time to meet the demands for updating R&DP, regulated by ANEEL. This can be seen in Table 1.

Table 1 – Minimum percentages of NOR that the SEB companies must invest in R&DP

Segment of operation	Legal framework - defines % of NOR for R&DP investment				
	Law No. 9.991/00 <sup>e</sup>	MPV No. 144/03 <sup>f</sup>	Law No. 10.848/04 <sup>g</sup>	Law No. 10.848/04 <sup>h</sup>	Laws <sup>i</sup> No. 11.465/07, 12.212/10, 13.203/15 and 13.279/16
Generation	0.50%	0.25%	0.40%	0.40%	0.40%
Transmission	0.50%	0.25%	0.40%	0.40%	0.40%
Distribution	0.25%	0.125%	0.30%	0.20%	0.20%

Source: Elaborated by the authors, based on ANEEL (2020).

<sup>e</sup> Percentages in effect from 07/24/2000 to 12/11/2003.

<sup>f</sup> Percentages in effect from 12/12/2003 to 03/14/2004.

<sup>g</sup> Percentages in effect from 03/15/2004 to 12/31/2005.

<sup>h</sup> Percentages in effect from 01/01/2006 to 03/29/2007.

<sup>i</sup> Percentages in effect from 03/30/2007 to 12/31/2022 - the laws change ways of operating the programs, but do not change the percentages of NOR set for investment in the R&DP program.

Currently, as far as the R&DP regulated by ANEEL is concerned, the regulation imposes that the resources be applied as follows: a) 40% of the resources must be collected to the National Fund for Scientific and Technological Development (FNDCT); b) 40% of the resources are destined to the execution of projects presented to R&DP, regulated by ANEEL, which are managed by the contributing companies themselves; and c) the rest of the resources, corresponding to 20%, must be passed on to MME (BRASIL, 1991; 2016).

### 2.3.3 Energy Efficiency Program (EEP)

According to the Procedures Manual of the Energy Efficiency Program (PROPEE), published by ANEEL, through the normative resolution 830/2018, the objective of the EEP is to "promote the efficient and rational use of electricity in all sectors of the economy through projects that demonstrate the importance and

economic viability of actions to combat waste and improve the energy efficiency of equipment, processes, and end uses of energy". This is aligned with the concepts of innovation recommended by the Oslo Manual such as innovation of products, services, and processes (ANEEL, 2018b; OECD/Eurostat, 2018).

In doing so, it "aims to maximize the public benefits of saved energy and avoided demand" under this program (ANEEL, 2018b). The actions of this program seek to implement efficient management of resources, with the "transformation of the electric energy market, stimulating the development of new technologies and the creation of rational habits and practices in the use of electric energy".(ANEEL, 2018b). See in Table 2 the changes in the legal framework of the EEP regulated by ANEEL.

Table 2 – Minimum percentages of NOR that the SEB companies must invest in the EEP

Segment of Operation	Legal framework - defines % of NOR for EEP investment	
	Law No. 9.991/00 <sup>j</sup> , Law No.11.465/07 <sup>k</sup>	Law No.13.280/16 <sup>l</sup>
Distribution	0.50%	0.40%

Source: Elaborated by the authors, based on ANEEL (2020).

<sup>j</sup> Percentages in effect from 07/24/2000 to 2006.

<sup>k</sup> Maintains the percentage in effect until April 2016.

<sup>l</sup> Maintains the percentage, but allocates 80% to EEP and 20% to PROCEL.

As of Law 13,280 of May 3, 2016, there was a change in the allocation of resources of the EEP, which

remained at 0.50% since its creation until April of that year. As of May of the same year, the Energy Efficiency

Program began to keep 80% of the resource allocation and to pass on the other 20% to the National Electric Energy Conservation Program (PROCEL).

When the company does not make the investment or has project amounts disallowed in the innovation programs regulated by ANEEL, both in R&DP and the EEP, the amounts must be accounted for and kept at the disposal of the programs and subject to the *Selic* rate remuneration (ANEEL, 2020b).

**2.5 The Brazilian Electric Sector and the 2030 Agenda - Paris Agreement**

To meet the commitments made by Brazil, with Agenda 2030 –The Paris Agreement - the RD&I PP of SEB should meet the following targets set in the NDC of Brazil: i) expand the use of renewable sources other than hydropower in the total energy matrix from a 28% to 33% share by 2030; ii) increase the use of non-fossil energy sources, expanding the share of renewable energy (wind, biomass and solar) other than hydropower in the electricity matrix to at least 23% by 2030; and iii) achieve 10%

efficiency gains in the electricity sector by 2030 (BID, 2017; Brasil, 2016). These goals will affect SDG 7 - accessible and clean energy - whose objective is to ensure reliable, sustainable, modern, and affordable energy for all and, by correlation, with SDG 9 - industry, innovation and infrastructure and SDG 13 - action against global climate change, due to the commitments made by Brazil with the 2030 Agenda (IPEA, 2018, 2019).

From this theoretical framework, it was sought to structure a set of methodological procedures to develop the research and reach the proposed goal.

**III. METHODOLOGICAL PROCEDURES**

The methodological procedures used in this study consist of a combination of methods and instruments, as a result of the different demands of analysis. Initially, support was pursued from the theoretical framework, especially with regard to the concept and type of innovation studied in this article, which has as its base the Oslo Manual (OECD/EUROSTAT, 2018; Marques, Diase Vianna, 2020). See the model in Figure 4, below.

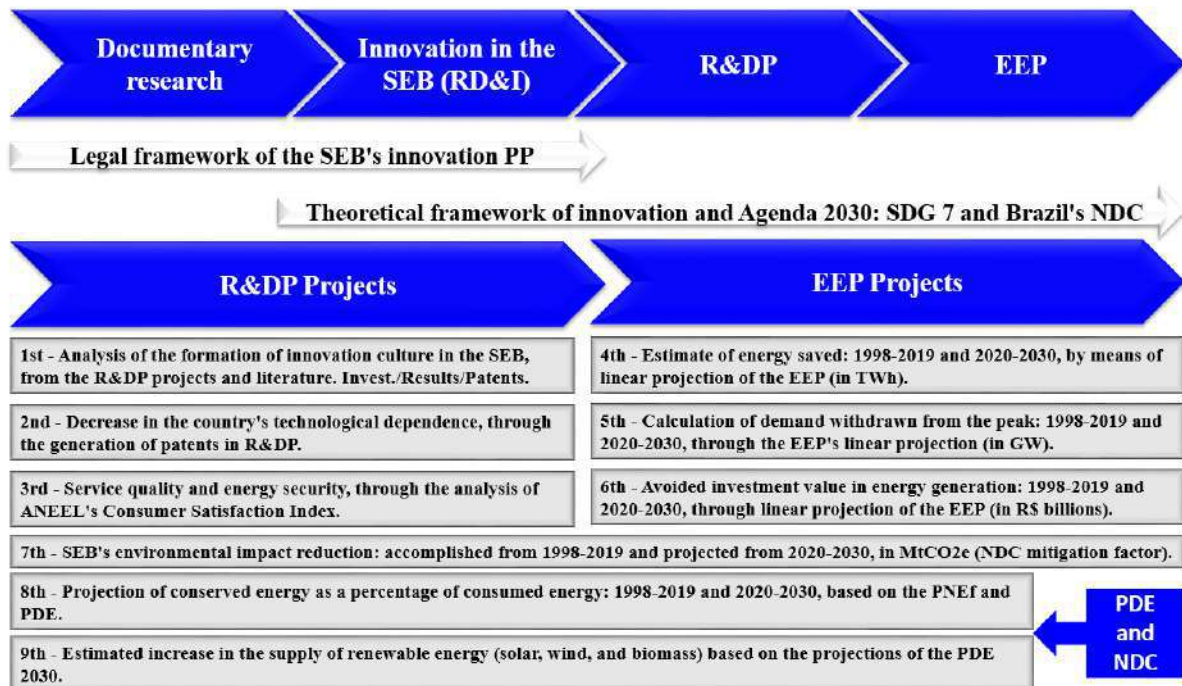


Fig.4: Graphic representation of the method used in the article

Source: elaborated by the authors.

The documental research began with the study of the theoretical framework that regulates innovation in the SEB or in the R&DI of SEB, which is divided into two programs: the R&DP and the EEP regulated by ANEEL, in

the period from 1998<sup>m</sup> to 2019<sup>n</sup>. The data survey for the mentioned period was carried out based on documents released by ANEEL.

<sup>m</sup> 1998 is the starting year of the R&DP and EEP Programs, regulated by ANEEL.

The projections of results of the R&DP and EEP of the SEB, from 2020 to 2030, were elaborated based on available literature and documents from the MME, EPE, and ANEEL, notably PDE, PNEf, and data released by ANEEL. The estimates for Energy Savings (ESA), Demand Withdraw from the Peak (DWP), Energy Savings Index (ESI), CO<sub>2</sub> Emission Reduction (RECO<sub>2</sub>), in megaton of CO<sub>2</sub> equivalent (MtCO<sub>2</sub>e) and Energy Conserved (ECON), were calculated according to the formulas and calculation memory described in items 3.1 and 3.2, below.

### 3.1 R&D Program (R&DP) regulated by ANEEL

Documentary analysis<sup>o</sup> was performed of the R&DP, through reports of projects registered in ANEEL's R&D Project Management System (SGP&D), for the period 2008 to 2019. A total of 2,918 projects have been registered, of which 905 are now in completed status. Of this total, 875 projects are from 2008 to 2016, before the ratification of the NDC (aNDC), and 30 projects from 2017 to 2019, after Brazil's ratified the NDC (dNDC). The option to analyze the 30 projects with completed status in SGP&D since they have results registered in the system. The justification for the division into two periods is the fact that Brazil's NDC with the Paris agreement was ratified by the Brazilian National Congress in 2016. Therefore, as of 2017, the RD&I PPs could legally incorporate actions aligned with the goals set in that commitment and that align with the objectives of the SEB innovation PP.

The analysis of the SEB R&DP results followed the analysis model in figure 4, items 1 to 3, as follows:

The first item of the model, which aims to identify whether the R&DP has been able to promote the culture of innovation in the SEB, was analyzed through a survey conducted on the website of 40 companies that account for 99.6% of the electricity supply market, to identify: i) if RD&I is structured in the company; ii) if the company publicizes RD&I on the website; iii) if the company advertises the public announcements of the RD&I editions; iv) if it publicizes the results of RD&I; v) if it announces that RD&I is open to startups. The formation of an organizational culture of innovation depends basically on four factors: whether it has a

structured innovation program, whether the program is disclosed on the organization's website, whether the company regularly publishes announcements of the program, and whether it discloses results from previous editions (Bin et al., 2015; CGEE, 2015; Castro et al., 2019). To check if the innovation model is open one should check if the program is open to startups (Cabanes, 2016; Chesbrough, 2003, 2010; C. Christensen, 1997; Christensen, 2019).

The second item of the analysis model, which is to create/develop new equipment and decrease the country's technological dependence, was the identification with the survey of the number of patents applied for the R&DP in the period from 1998 to 2019.

Next, the results of the third, which is to improve the provision of service and contribute to energy security, were calculated through the ANEEL Customer Satisfaction Index (ACSI), identified in the period from 2000 to 2019, released annually by ANEEL.

The survey of the profile of human resources involved in the program was carried out from the analysis of 30 projects, from the period 2017 to 2019, with completed status in ANEEL's SGP&D.

### 3.2 Energy Efficiency Program (EEP) regulated by ANEEL

The document analysis of the EEP projects was performed from 2008 to 2019 since the data available dates back to this period. This program is properly aligned with the commitments agreed in Brazil's NDC - Agenda 2030. This analysis was done by accessing ANEEL's Microsoft Power BI<sup>p</sup> and a spreadsheet with a list of ANEEL's EEP projects (2020). In both the BI and the spreadsheet, it was possible to filter the information: the number of projects, amounts invested per project and per year, amount of energy saved, and amount of energy withdrawn from the peak, resulting from the implementation of this program. It has been analyzed 1,026 EEP projects, which corresponds to the total number of projects available in the BI of ANEEL's program.

The analysis of the EEP projects contributed to generate data for three items of the analysis model (fourth, fifth, and sixth). The fourth, energy saved (ESA) in TWh, which includes ESA<sub>TWh(1998-2019)</sub> and ESA<sub>TWh(2020-2030)</sub> was obtained using equation 1:

<sup>o</sup>2019 is the year that ANEEL presents consolidated results of the R&DP and EEP Programs.

<sup>o</sup>The documentary research carried out in the R&DP project reports, where filters were performed in a spreadsheet from ANEEL's SGP&D, for projects with CONCLUDED status, which were separated into two periods: from 2008-2016 bNDC and 2017 to 2019 aNDC.

<sup>p</sup> Microsoft Power BI reports are under construction and may change at any time from June 2020. Available at: <https://www.aneel.gov.br/pt/programa-eficiencia-energetica>

$$ESA_{TWh(1998-2030)} = ESA_{TWh(1998-2019)} + \sum_{i=2020}^{2030} \left( \frac{VlrTotalInvest_i}{VlrInvest_{R\$/MWh_i}} \right) \times \frac{1}{1,000,000} \quad (1)$$

Where:

$ESA_{TWh(1998-2019)}$  and  $ESA_{TWh(2020-2030)}$  – is the amount of energy saved (ESA), for the period 1998 to 2019, added with the amount of ESA linearly projected for the period 2020 to 2030, obtained by analyzing the EEP projects (in TWh).

The demand withdrawn from the peak (DWP), which is the fifth analysis item, should be in GW, which includes  $DWP_{GW(1998-2019)}$  and  $DWP_{GW(2020-2030)}$  was obtained through equation 2:

$$DWP_{GW(1998-2030)} = DWP_{GW(1998-2019)} + \sum_{i=2020}^{2030} \left( \frac{VlrTotalInvest_i}{VlrInvest_{R\$/kW_i}} \right) \times \frac{1}{1,000,000} \quad (2)$$

Where:

$DWP_{GW(1998-2019)}$ , and  $DWP_{GW(2020-2030)}$  – is the amount of demand withdrawn from the peak (DWP), annually, for the period 1998 to 2019, added with the linearly projected DWP, for the period 2020 to 2030, using data from the analyzed EEP projects (in GW).

Energy savings, as well as off-peak demand, resulted in the sixth component of the proposed analysis model, investment avoided in energy generation (IAEG) in billions of reais (R\$ bi), referring to two periods:  $IAEG_{inR\$ bi (1998-2019)}$  and  $IAEG_{inR\$ bi (2020-2030)}$  according to equation 3:

$$IAEG_{inR\$ bi(1998-2030)} = IAEG_{inR\$ bil(1998-2019)} + \sum_{i=2020}^{2030} (DRPinkWxVlrInvestinR\$/kW) \times \frac{1}{1,000,000} \quad (3)$$

Where:

$IAEG_{inR\$ bi (1998-2019)}$  and  $IAEG_{inR\$ bi (2020-2030)}$  – is the value of the avoided investment in energy generation (IAEG), in the period from 1998 to 2019, added to the IAEG projected linearly, for the period from 2020 to 2030, based on the data of the analyzed EEP projects (in billions of Reais).

The seventh analysis item is the reduction of SEB's environmental impact and was verified from the reduction of CO<sub>2e</sub> emissions that occurred in the period from 1998 to 2019 ( $RECO_{2e}$  in  $MtCO_{2e(1998-2019)}$ ) and ( $RECO_{2e}$  of  $MtCO_{2e(2020-2030)}$ ) according to equation 4:

$$RECO_{2e_{inMtCO_{2e}(1998-2030)}} = RECO_{2e_{inMtCO_{2e}(1998-2019)}} + \sum_{i=2020}^{2030} \left( ESA_{in \frac{MWh}{year}} \times NDC \text{ Emission Factor in } tCO_{2e} / MWh \right) \times \frac{1}{1,000,000} \quad (04)$$

Where:

$RECO_{2e}$  em  $MtCO_{2e(1998-2019)}$ ) and ( $RECO_{2e}$  de  $MtCO_{2e(2020-2030)}$  – is the amount of CO<sub>2e</sub> emissions avoided in the period 1998 to 2019, added with the amount of CO<sub>2e</sub> avoided for the period 2020 to 2030 projected linearly, according to the NDC per emissions scenario.

The eighth item is the amount of conserved energy (ECON), which was calculated for the years 2020, 2025, and 2030 as provided in the NDC, equation 5:

$$ECON_i = \frac{ESA_i}{ECON_{acum_i}} \times 100 \quad (05)$$

Where:

ECON corresponds to the percentage of energy conserved (ECON), obtained from the amount of ESA in the year under analysis, divided by the amount of energy saved accumulated until the year of analysis (ECON<sub>acum</sub>), multiplied by 100 (in GWh), in period i= 2020, 2025 and 2030.

At last, the new goal, which foresees an increase in the supply of renewable energy, will be analyzed against what was projected in the 2029 PDE, with added projections based on the premises of the 2030 PDE, since this document has not been released yet.

### 3.3 Analysis of R&DP and EEP results versus Literature, Agenda 2030 (SDG 7) and Brazil's NDC with the Paris Agreement

The data from the two programs (RD&P and EEP) were consolidated in tables, figures (graphics), and charts. This was done to allow a comparative and critical analysis of the results achieved by the projects, with the literature, with the legal framework that regulates the SEB's innovation PPs and, mainly, with the goals set in the NDC, as well as in the 2030 Agenda, especially SDG 7, which is correlated with SDGs 9 and 13. Next is the model for analyzing the results of this article.

The analysis of the results followed the methodological procedures in Figure 4, according to the model proposed in Chart 1, below:

Chart 1 - Analysis model: SEB's RD&I PP results versus Agenda 2030 - Paris Agreement

What?	How? Analysis and results	Goals: Agenda 2030
1) Promote a culture of innovation, stimulating RD&I in the SEB (R&DP).	Theoretical framework and the SEB innovation PP (R&DP). Invest./Results/Patents	SDG 7 - Target 7.a, in correlation with SDG 9.
2) Create/develop new equipment and decrease the country's technological dependence.	Theoretical framework and quantity of patents applied for (R&DP).	SDG 7 - Target 7.a, in correlation with SDG 9.
3) Improve service provision and contribute to energy security.	ANEEL's Consumer Satisfaction Index (ACSI)	SDG 7 - Target 7.1, in correlation with SDG 9.
4) Energy Saved.	Quantity in TWh.	SDG 7 - Target 7.3, correlated with SDG 9
5) Demand withdrawn from the peak.	Quantity in GW.	SDG 7 - Target 7.3, correlated with SDG 9.
6) Avoided investment in energy generation.	In R\$ in the period of ANEEL's RD&I.	SDG 7 - Target 7.3, correlated with SDG 9.
7) Reduce SEB's environmental impact	Reduction of emissions of CO <sub>2</sub> e.	SDG 7, by correlation with SDGs 9 and 13.
8) Conserved Energy.	As % of the energy consumed, according to PNEE.	SDG 7 - Target 7.3 and NDC (10.0% target).
9) Increase the supply of renewable energy (solar, wind, and biomass).	As % of the Brazilian electric matrix.	SDG 7 - Target 7.2 and NDC (23.0% target).

Source: elaborated by the authors.

Therefore, the method and the analysis model are properly aligned with answering the problem situation and the objective of this article.

#### IV. RESULTS AND DISCUSSION

The results and discussion were conducted in such a way that the problem issue, which guides this article, was answered during the analysis of the results of the SEB's innovation PP, through the RD&I program regulated by ANEEL (RD&P and EEP). All this with regard to the literature and the goals of Agenda 2030, notably SDG 7 - Affordable and Clean Energy. Its goal is to "ensure reliable, sustainable, modern and affordable access to energy for all" and its five targets are the three finalists<sup>9</sup>: 7.1, 7.2, 7.3 and two implementation<sup>7</sup>: 7.a and 7.b (IPEA, 2018, 2019). It also includes the NDC targets

for energy conservation and increasing non-renewable energy sources (solar, wind, and biomass) (BID, 2017).

In this context, the correlation between SDG 7 and Brazil's NDC goals with the Paris Agreement, SDG 9 - Industry, Innovation and Infrastructure, and SDG 13 - Action Against Global Climate Change should be emphasized. Therefore, the results that impact these goals were highlighted in the analysis, but without addressing a specific goal (IPEA, 2018, 2019).

#### 4.1 Results of the RD&P regulated by ANEEL and the goals of Agenda 2030

The analysis of SEB RD&P projects, regulated by ANEEL, was carried out in two periods: from 2008 to 2016 before the NDC (bNDC) and from 2017 to 2019 after the NDC (aNDC), given the goals of Agenda 2030 of the Paris Agreement.

##### 4.1.1 RD&P Investments: Performed from 1998 to 2019 and Projected from 2020 to 2030

The data generated by RD&P is of great relevance to the innovation PP of the SEB, since in the period from

<sup>9</sup> According to the Agenda 2030, the final goals are those whose object relates directly (immediately) to the achievement of the specific SDG (IPEA, 2018).

<sup>7</sup> Implementation targets, in the 2030 Agenda document, the implementation targets refer to human, financial, technological, and governance resources (institutional arrangement and tools: legislation, plans, public policies, programs, etc.) needed to achieve the SDGs.

1998 to 2019 the data was- investment to the tune of R\$ 7.60 billion, in 4,247 projects that were approved by ANEEL, out of 6,061 (equivalent to 70.07% of the projects

submitted).From 2020-2030, the investment forecast is R\$ 550.00 million per year or R\$ 6.05 billion for the projected period (ANEEL, 2020b), as shown in Table 3, below.

Table 3 – R&DP data: 1998-2030<sup>s</sup>

<b>Consolidated R&amp;DP data: 1998-2030</b>	
<b>R&amp;DP Investment Value: 1998 to 2030</b>	<b>Values in billions of R\$</b>
Investment in the period: 1998 to 2019 (accomplished)	7,60
Investment in the period: 2020 to 2030 (projected)	6,05
<b>Total Investment (accomplished + projected)</b>	<b>13,65</b>
<b>Other R&amp;DP data: performed from 1998 to 2019</b>	<b>Qty in Units</b>
Presented projects	6 061
Approved Projects	4 247
Patents and Licenses	325
Active Researchers	1 200
Published Articles	3 900

Source: Developed by the authors based on data from ANEEL (2020), accomplished period (1998-2019). Projections elaborated by the authors in linear form (2020-2030).

<sup>s</sup> 1998 is the starting year of the R&DP - Between 1998 and 2019: period considered fulfilled. From 2020 to 2030 - data were projected by the authors in a linear fashion.

The RD&P also involved 1,200 researchers and generated 3,900 articles that were published over the period 1998 to 2019(ANEEL, 2020b).

Patents and Licenses area very relevant aspect in practically all RD&I programs, which would be no different in the RD&P regulated by ANEEL, but shows relatively shy results, with 325 patents and licenses, in the analyzed period from 1998 to 2019. This figure indicates that 7.65% of the projects generated this benefit, which presents an advance concerning the results obtained by Guedes (2012) that were 2.00% of patents, for the period 1998-2007.

4.1.2 Innovation culture in the SEB and the reduction of the country's technological dependence

Promoting a culture of innovation and reducing the country's technological dependence through RD&I in the SEB is a great challenge for the program, since the Brazilian market has always had low participation of national content. That's because the electrical sector is a business segment known as "supplier follower" where suppliers are directly responsible for innovation in the production chain (Castro et al., 2017a; 2015). A large part

of this production chain is developed outside Brazil because most of the supplying companies are globalized.

Brazil's situation regarding innovation in the power sector is quite uncomfortable, according to the 2018 Global Innovation Index: energizing the world with innovation (GII 2018)(Cornell University, INSEAD and OMPI, 2018).In the three rankings: i) Global Innovation Index; ii) Innovation Inputs Sub-Index; and iii) Innovation Outputs Sub-Index, occupying the following positions: 64th, with 33.44 points; 58th, with 43.40 points; 70th with 23.49 points. This ranking is calculated for 126 countries and the scoring scale is from 0.00 to 100.00 (Cornell University, INSEAD and OMPI, 2018).

In the analyzed sample, between 2017 and 2019 aNDC, the percentage of patents stood at 5.95%, below the 7.65% seen between 1998-2019, therefore, it does not show evidence that the SEB innovation PP, concerning the RD&P, is aligned with SDG 9, which aims to build resilient infrastructure, promote inclusive and sustainable industrialization and foster innovation (IPEA, 2018, 2019).

The results of this ranking show that Brazil is far from the indexes of nations with similar economies. A way out of this uncomfortable position is to achieve at least one of the implementation goals of SDG 7, especially 7.a - "by 2030, strengthen international cooperation to facilitate

access to clean energy research and technologies, including renewable energy, energy efficiency [...] and promote investment in energy infrastructure and clean energy technologies”(IPEA, 2018, 2019).

Although there are paths to follow, this study shows that 62.5% of the 40 SEB companies surveyed make no mention of whether or not they adhere to Agenda 2030 or, in particular, to SDGs 7, 9, and 13, either on their website or in their socio-environmental report. On the other hand, 37.5% expose on their website and in their socio-environmental report their corporate commitment to the UN-led Global Agenda. It is noticeable that even five years after the conclusion of the Paris Agreement, some Brazilian corporations have not yet realized that they are part of a signatory country of this global pact, with 17 Sustainable Development Goals.

Brazil may experiment with other types and models of innovation in the SEB, such as open, radical, or disruptive innovation (Christensen, 1997; OECD/Eurostat, 2018; Christensen, 2019; Marques, Dias e Vianna, 2020). For this to happen, it is necessary to examine the research results of this study carefully, because when analyzing data from 40 SEB companies, which account for 99.6% of the electric power supply market, 10.0% do not even announce their RD&I program. Only 15.0% of the 40 companies surveyed inform that their RD&I is open to startups, therefore, they are aligned with the innovation model considered ideal by the literature (Christensen, 2019). 90.0% of the companies announce RD&I and publish calls for proposals on the website, which means that the programs are open, but as 85% of them do not inform that their programs are open to startups, it can be concluded that the concept of radical or disruptive innovation does not apply to the innovation model adopted by these companies. This puts them behind other countries and Brazil itself since in 2020, 46% of large companies invested in startups to speed up their innovation programs (MONEYREPORT, 2021).

#### 4.1.3 Quality of services and energy security of the SEB

The ANEEL Customer Satisfaction Index (ACSI), created in 2000 by the regulator body to evaluate the performance of SEB companies, is composed of five variables, which are: i) perceived quality; ii) perceived value (cost-benefit ratio); iii) overall satisfaction; iv) trust in the supplier; and v) loyalty (ANEEL, 2020a). The data in figure 5 show there is nothing to celebrate, since over 19 years there has been practically no evolution.

In the two examples chosen: the company CPFL<sup>†</sup>, which operates in the state of São Paulo, including part of the São Paulo megalopolis, in 2000 stood at 71.72 and in 2019 reached 76.81, improving only 4.99% over this period. LIGHT<sup>‡</sup> inaugurated the ACSI in 2000, with 62.88 and, closed 2019 with 56.43, representing a drop of 6.45% from end to end, in the period analyzed and, staying below the ACSI Average over half the time of the index's existence. The choice of the companies CPFL and LIGHT, third and fifth in the ranking of SEB companies in consumer numbers of 2019<sup>‡</sup> is justified by the fact that they operate in the two largest metropolises in Brazil (the city of São Paulo and the city of Rio de Janeiro, respectively). The reason for excluding the companies CEMIG, ENEL, COPEL, first, second and fourth in the ranking is the fact that they operate in different environments (capital and countryside).

<sup>†</sup> CPFL is a large concessionaire and was chosen as an example since it is one of the companies that show good evaluation in the historical series from 2000-2019. CPFL is the 3rd largest company in the SEB in the total number of consumers in the 2019 ranking (Top 5).

<sup>‡</sup> LIGHT is a large concessionaire and was chosen for this analysis since it is one of the underperforming companies in the assessment in the 2000-2019 historical series. CPFL is the 5th largest company in the SEB in the total number of consumers in the 2019 ranking (Top 5).

<sup>‡</sup> Ranking calculated by the authors based on data from the Brazilian Association of Electricity Distributors (ABRADEE), 2019 data (ABRADEE, 2021).



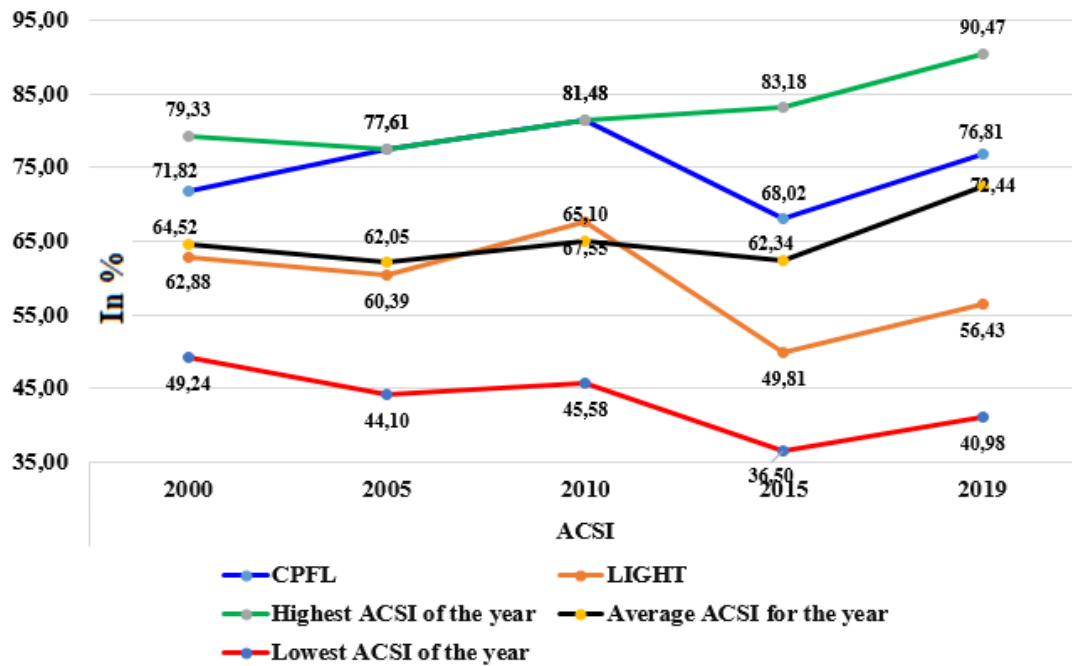


Fig.5: Evolution of ANEEL's consumer satisfaction index (ACSI), scale: from 0 to 100

Source: Elaborated by the authors based on data from ANEEL (2020).

It is also necessary to comment on the largest ACSI in each year since the line is ascending, from 79.33 in 2000 to 90.47 in 2019. Despite being increasing, the companies that occupy the first place in each year are small companies, with very low market share, that is, it is illusory information because the large companies with significant market share are around the score of CPFL (in the upper band) and LIGHT (lower band).

The ACSI results from its inception in 2000 to 2019 show that the SEB lacks a continuous improvement strategy for both service level and system reliability, and aligning with the goals of Agenda 2030 can be an important step towards quality improvement. SDG 7 has both an implementation target and an outcome target on this front: i) the implementation target is 7.b "by 2030, expand the infrastructure and improve the technology for

delivering modern and sustainable energy services for all"; ii) the outcome target is 7.1 "by 2030, ensure universal, reliable, modern and [...] access to energy services"(IPEA, 2018, 2019).

4.1.4 Human resources profile and integration with the market and academy

The analysis of the profile of human resources involved in the RD&P, considering the 30 projects analyzed, with completed status in the SGP&D of ANEEL, for the period 2017 to 2019, identified 510 professionals. They are 107 (one hundred and seven) PhDs, 110 (one hundred and ten) masters, 82 (eighty-two) specialists, 157 (one hundred and fifty-seven) higher education level and 54 (fifty-four) technical level, according to Table 4, below:

Table 4: Profile of human resources involved in the 30 projects analyzed from 2017 to 2019

Titration	Quantity	Professionals per project	% by titration
PhD	107	3.57	20.98
Master	110	3.67	21.57
Specialist	82	2.73	16.08
Higher	157	5.73	30.78
Technical	54	1.80	10.59
<b>Total</b>	<b>510</b>	<b>17.50</b>	<b>100.00</b>

Source: elaborated by the authors, based on a sample taken from the SGP&D of ANEEL (2020)

It should be noted that the 30 (thirty) projects analyzed were executed in partnership with Universities, Federal Institutes, Research Institutes, Foundations, and Consultancies, whose teams are mostly composed of masters and doctors, which account for approximately 60% of the staff.

These results show that there is an ongoing movement towards increased participation of academia in the innovation programs regulated by ANEEL. 100% of the projects in the sample analyzed are linked to academia, contrary to what was detected by the studies Laplane and Cavalcanti (2015) and CGEE (2015), which indicated low integration between academia and companies in the execution of innovation programs.

However, it should be noted that no international partnership was identified seeking support for R&D in the area of energy, as provided for in SDG 7 - target 7.a - "by 2030, strengthen international cooperation to facilitate access to clean energy research and technologies, including renewable energy, energy efficiency [...] (IPEA, 2018, 2019). To improve the RD&P performance it is necessary to accelerate the transition to the open innovation model, as proposed in the literature (Cabanes, 2016; Chesbrough, 2003, 2010; Christensen, 2019).

**4.2 Results of the EEP of the SEB regulated by ANEEL**

The results of the EEP, carried out from 1998 to 2019, and the projections of investments to be made from 2020 to 2030, presented below are i) investments in the EEP and investments avoided in energy generation (IAEG) by the EEP and; ii) energy saved (ESA) and demand withdrawn from the peak (DWP).

**4.2.1 EEP Investments versus EEP IAEG: 1998 to 2030**

The EEP had 4,850 projects executed, where R\$ 5.90 billion were invested, in the period from 1998 to 2019, and investments<sup>w</sup> of R\$ 6.05 billion are foreseen for the period from 2020 to 2030, which is equivalent to R\$ 550.0 million per year, for the next 11 years (ANEEL, 2020b). The values of the two cycles amount to R\$11.95 billion.

Investment in energy efficiency (EE) should be a priority for the SEB and Brazilian society since it generates an interesting synergistic effect since it can expand the use of the current installed capacity and avoid new investments in energy generation, as demonstrated in this study (De Castro et al., 2015, 2019).

The values invested in the EEP, in the period from 1998 to 2019 (accomplished) avoided investments in energy generation, of about R\$ 1.00 to R\$ 2.80, with IAEG in the amount of R\$ 16.56 billion. For the period from 2020 to 2030, the projections of this study indicate that the IAEG<sup>x</sup> for the period is of the order of R\$ 25.38 billion, raising the cost versus benefit ratio (RCB) to the ratio of R\$ 1.00 to R\$ 4.19. The IAEG for the period from 1998 to 2030 is R\$ 41.94 billion, enough to build an enterprise with an installed capacity of approximately 5,100 kW. See in figure 5 the benefit generated by the EEP by period: investment made in the EEP versus the value of the IAEG by the EEP.

<sup>w</sup> The value of the EEP investment from 2020 to 2030 was projected based on values corrected by the IPCA, referring to 1026 EEP projects analyzed in this study.  
<sup>x</sup> The IAEG from 2020 to 2030 was projected based on values corrected by the IPCA, referring to 1026 EEP projects analyzed in this study.

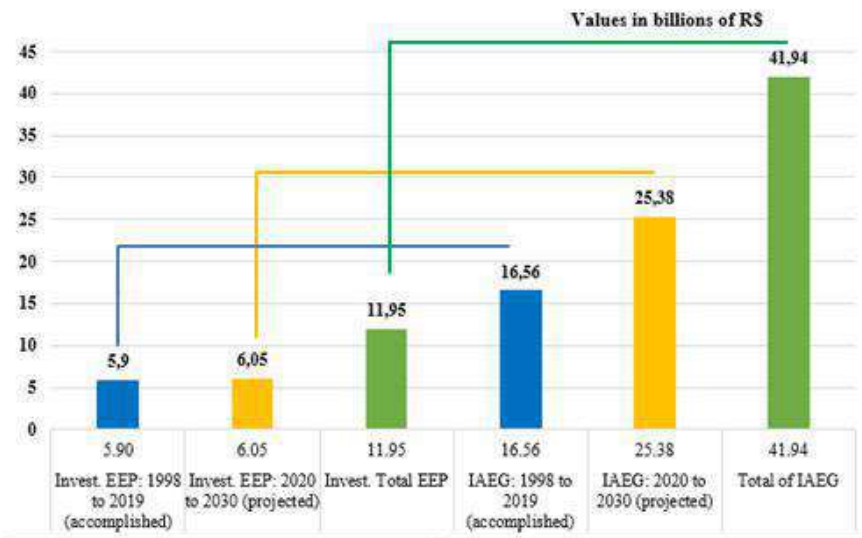


Fig.6: Investment values in the EEP versus IAEG by the EEP: 1998 to 2030

Source: Elaborated by the authors based on data from ANEEL (2020) and projections elaborated by the authors

Since the basis for expanding the production capacity of the SEB is still the HPP model, by avoiding investments in new large undertakings, the EEP is aligned with SDG 13, reducing the environmental impact of the sector.

4.2.2 Energy saved (ESA) and demand withdrawn from the peak (DWP): 1998 to 2030

The EEP is prodigious in generating combined results such as, for example, ESA and DWP. In the period from 1998 to 2019, the ESA is 63.0 TWh and allowed

power withdrawal at the peak or DWP of the order of 2.8 GW, which is equivalent to 40% of the power load of the northern region of Brazil or the corresponding to the consumption of 32.4 million households in Brazil for one year (ANEEL, 2020b). The projected ESA for the period 2020 to 2030 was estimated at 4.39 TWh and the DWP 1.07 GW, as the estimates in this study. The total ESA for the period 1998 to 2030 is expected to reach 67.39 TWh and the total DWP is expected to be 3.87 GW. See the data in Table 5.

Table 5 -Energy saved by the EEP: 1998-2030<sup>y</sup>(accomplished and projected)

<b>Energy Saved (ESA)</b>	<b>Qty. (in TWh)</b>
ESA - accomplished from 1998 to 2019 (in TWh/year)	63,00
ESA - projected from 2020 to 2030 (in TWh/year)	4,39
<b>Total ESA (accomplished + projected) in TWh/year</b>	<b>67,39</b>
<b>Demand withdrawn from the peak</b>	<b>Qty. (in GW)</b>
DWP in the period 1998 to 2019 (accomplished)	2,80
DWP in the period from 2020 to 2030 (projected)	1,07
<b>Total DWP (accomplished + projected) in GW</b>	<b>3,87</b>

Source: Elaborated by the authors based on data from ANEEL (2020) and projections elaborated by the authors.

<sup>y</sup> The Analysis involves the period 1998-2030, and from 1998-2019 the data released by ANEEL (2020) was used. From 2020-2030 the data were projected by the authors in a linear fashion.

EEP results in ESA and DWP meet SDG targets 7 - 7.3 "by 2030, increase the rate of energy efficiency improvement of the Brazilian economy" and 7.1 - "by 2030, strengthen international cooperation to facilitate access to clean energy research and technology, including renewable energy, energy efficiency [...] and promote investment in energy infrastructure and clean energy technologies"(IPEA, 2018, 2019). However, one should be aware of the fact that the monitoring of the results forecast for the period from 2020 to 2030 is fundamental to plan for possible course corrections since the projections are linear and any accident along the way can alter the expected results.

4.3 Energy conserved during the PNEf: 2011 to 2030 - achieved and projected

Energy conservation is one of the goals of Brazil's NDC with the Paris Agreement, which is present in the RD&I of the SEB, through the EEP regulated by ANEEL, which by saving energy plays the role of energy conservation. The projections of the 2010 National Program for Energy Efficiency (PNEf), which served as the basis for the NDC, predicted energy consumption of 439,548 GW in 2011, the year of the starting point of the

energy conservation program (MME, 2011).

In 2020, the forecast was for consumption without conservation of 674,693 GW, versus consumption with conservation of 638,700 GW. In 2025, consumption without conservation would be 832,775 GW, and consumption with conservation would be 767,067 GW. In the year 2030, energy consumption without conservation would reach 1,027,896 GW, and energy consumption with conservation would reach 921,273 GW, commitments of the NDC for the years 2020, 2025, and 2030 (BID, 2017).

This study verified what occurred in the period from 2011 to 2020 and then made projections for the period from 2020 to 2030, based on the PDEs of the same period, according to Figure 6, below. In the same period, energy consumption with conservation and without conservation was more or less on the same level due to long periods of economic crisis, including recession in the years 2015 and 2016, followed by low growth years between 2017 and 2019, and another recession in 2020 due to the Coronavirus pandemic (COVID-19). Therefore, in 2020, final energy consumption should be around 530,590 GW, practically the consumption level of mid-2014 (MME/EPE, 2018, 2020).

In 2025, projections indicate the energy

consumption without conservation would be 642,652 GW, and energy consumption with conservation would be 617,004 GW. In 2030, energy consumption without

conservation would reach 770,673 GW, and energy consumption with conservation would reach 716,795 GW. See Figure 7.

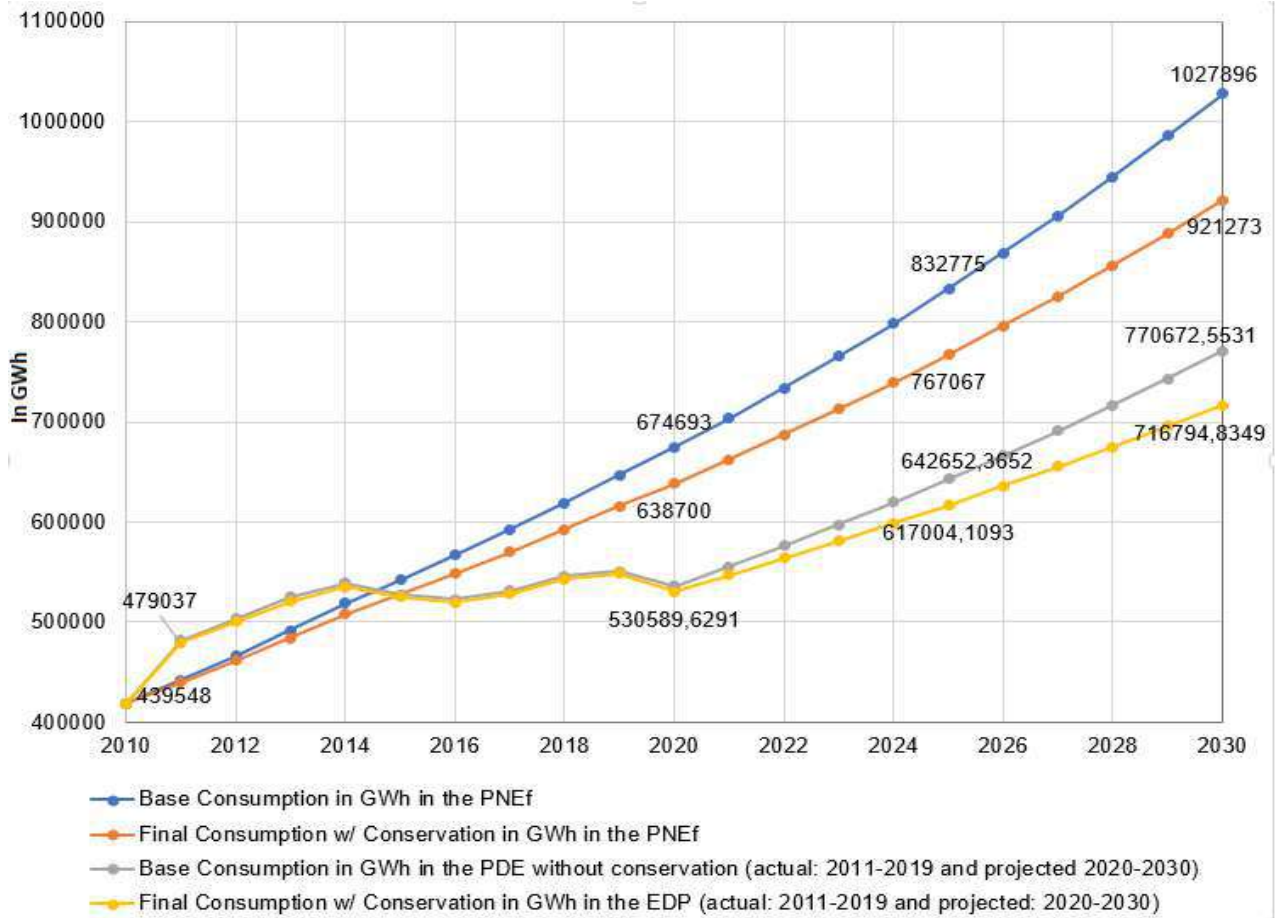


Fig.7: Energy consumption and conservation: 1998 to 2030 - accomplished and projected

Source: Prepared by the authors based on data from the PNEf (2011) and EPE (2020) and projections made by the authors based on the PDE 2030 (EPE, 2020).

The NDC targets for the years 2020, 2025 and 2030 are 4.0%, 8.0% and 10.0%, respectively (BID, 2017).The PNEf forecasted electricity conservation in 2020 of 5.33%, in 2025 of 7.89%, and 2030 of 10.37% (MME, 2011).The goal set in the NDC is compromised because the

projections of this study indicate that energy conservation should end 2020 with 0.99%, in 2025 it should reach 3.99%, and in 2030 with 6.99%, compared to the NDC goal: 4.0%, 8.0%, and 10.0%, for the respective years (BID, 2017; MME, 2011)As shown in Figure 8.

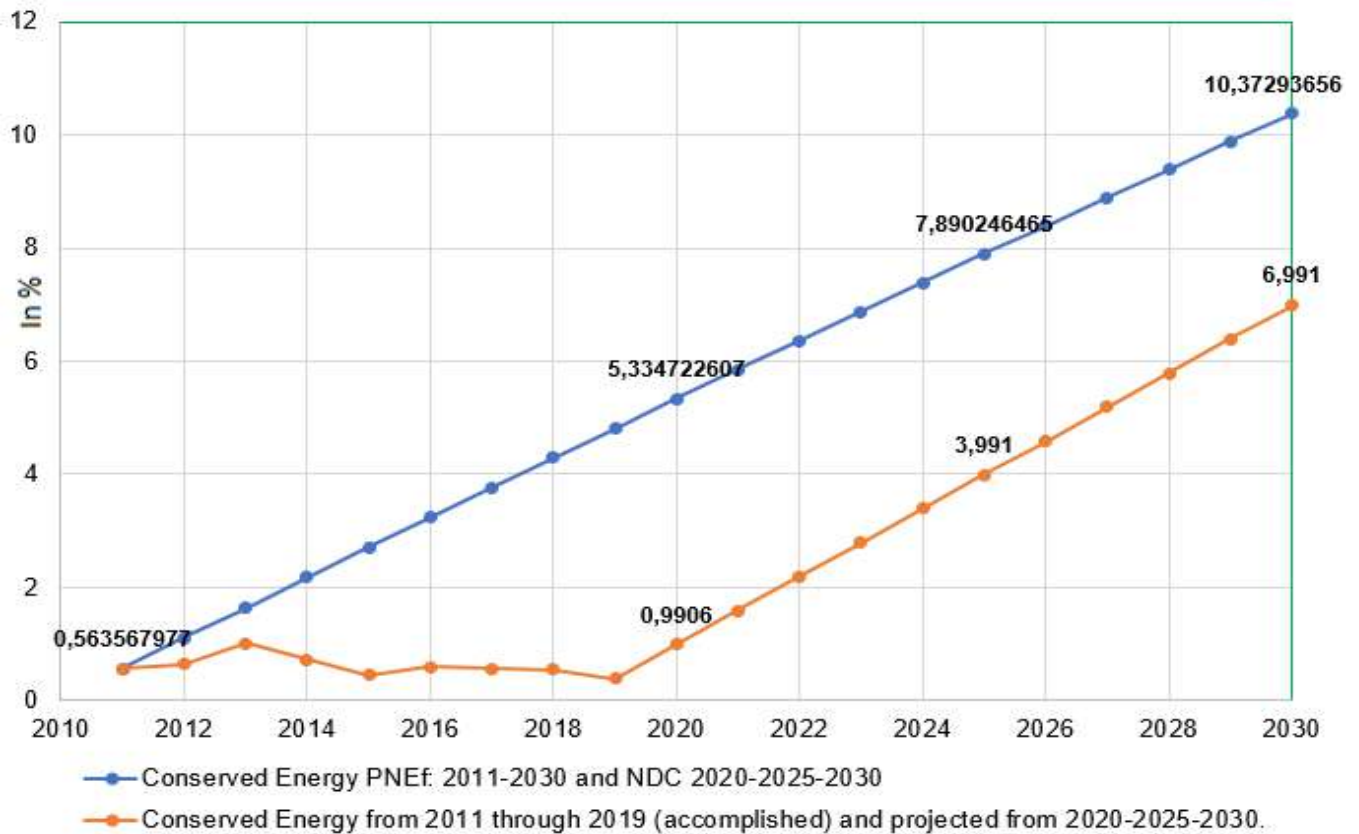


Fig.8: Electricity conservation: NDC target versus accomplished/projected

Source: Prepared by the authors based on the PNEf (MME, 2011), data from the PDE (MME/EPE, 2020) and projections prepared by the authors based on the PDE 2030 (MME/EPE, 2020).

**4.4 Increase the supply of renewable energy (solar, wind, and biomass)**

The increase in renewable energy supply from solar, wind, and biomass sources is foreseen in the commitments of Agenda 2030, both in the NDC and in SDG 7 - "by 2030, maintain a high share of renewable energy in the national energy matrix"(IPEA, 2019, p. 5). The NDC targets for renewable sources are as follows: i) expand the use of renewable sources other than hydropower in the total energy mix to a 28% to 33% share by 2030; ii) increase the use of non-fossil energy sources by expanding the share of renewable energy (wind, biomass and solar) besides hydropower in the electricity

mix to at least 23% by 2030 (BID, 2017; Brasil, 2016).

The projections made based on the PDE 2030 (MME/EPE, 2020) indicate that the participation of renewable energy sources - excluding hydroelectric power, therefore including only wind, biomass, and solar - should reach a total of 24% in 2030, according to a linear projection of the total variable of the Brazilian electricity matrix. This is against 23.00% of variable Brazil's NDC Target with the Paris Agreement, which meets target 7.2 of SDG 7, adjusted for Brazil, which is "by 2030, maintain a high share of renewable energy in the national energy matrix" (IPEA, 2019, p. 5;). See data in Figure 9.

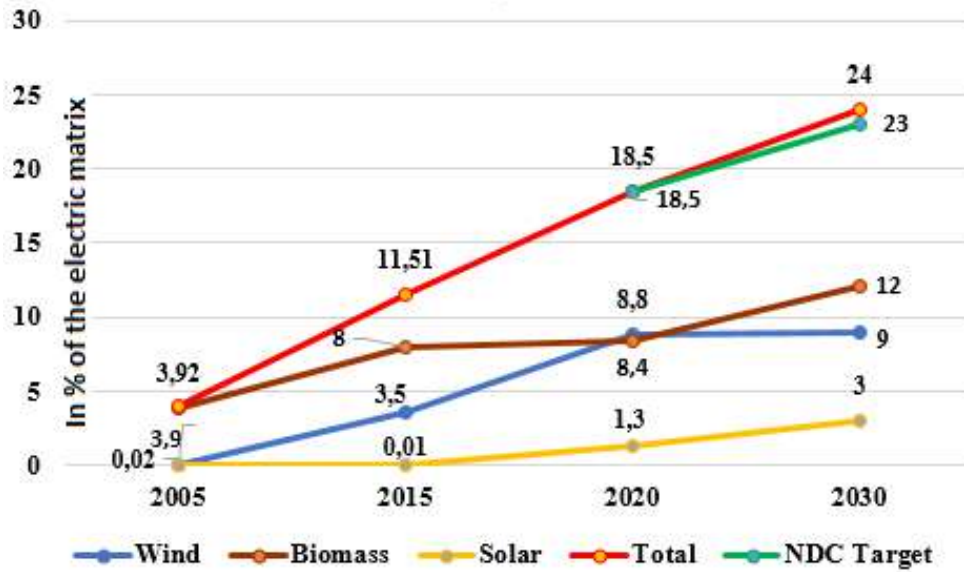


Fig.9: NDC target for renewable energy (wind, biomass, and solar) for 2030

Source: Prepared by the authors based on NDC (Brazil, 2016) and IBRD (2017), and MME/EPE (2020).

Thus, it can be inferred that the target set in the NDC for renewable energy (wind, biomass, and solar) for 2030 should be met if the pace of investment is maintained.

**4.5 Reducing the environmental impact of SEB: 1998 to 2030**

The reduction of CO<sub>2</sub>e emissions verified in the EEP projects, despite not being explicit as one of its objectives, should be seen as a positive externality of the program. That is also aligned with clean energy (SDG 7), to build resilient infrastructure, promote sustainable industrialization, and foster innovation (SDG 9) and take urgent action to combat climate change and its impacts (SDG 13), by correlation (IPEA, 2019).

According to the Brazilian Forum for Climate Change (FBMC), the key role of SEB is to contribute to the "reduction of emissions of the other sectors of the economy", since the sector is a net exporter of GHG emissions for the other business segments of the market (FBMC, 2018, p. 24).

Hence, for the SEB to be able to fulfill its role, it is fundamental that the Brazilian electricity matrix becomes increasingly cleaner and that the participation of

solar, wind, and biomass energy increases. That is especially considering the impact of climate change on the capacity to produce energy from hydric sources, due to the alteration of the rainfall regime, which impacts the volume of water in the reservoirs. Table 6 presents the estimates for the periods 1998-2019, as well as the projections of this study for the period from 2020 to 2030 (ANEEL, 2016, 2020b).

The emission reduction estimates of this study showed that in the worst-case scenario - pessimistic - the RECO<sub>2</sub>e is 1.617369 MtCO<sub>2</sub>e and in the best case scenario - optimistic - is 4.852106 MtCO<sub>2</sub>e, considering the scenarios and emission factors used in Brazil's NDC (BID, 2017). The FBMC, in 2018, predicted that energy efficiency actions at the consumption end, had a mitigation potential of the order of 2.33 MtCO<sub>2</sub>e, a value that occupies a midpoint between the worst and best case scenario estimates of this study (FBMC, 2018).

Therefore, it can be said that the SEB is aligned and well-positioned in relation to the rest of the world, when it comes to the global trend of decarbonization of the electricity sector, since the Brazilian electricity matrix has a high share of renewable energy, ending the year 2020 with a share around 85% and should reach 89% in 2030 (MME/EPE, 2020).

Table 6–Estimated CO<sub>2</sub>e emissions avoided with the EEP - accomplished: 1998-2019 and projected: 2030

		Periods	Qty. Estimated (in tCO <sub>2</sub> e)	Total Estimate (in MtCO <sub>2</sub> e)
<b>S C E N A R I O S</b>	Pessimistic	1998-2019	1.512.000	<b>1,617369</b>
		2020-2030	105.369	
	Pessimistic - Efficiency	1998-2019	1.701.000	<b>1,819540</b>
		2020-2030	118.540	
	Reference	1998-2019	3.276.000	<b>3,504299</b>
		2020-2030	228.299	
	Reference - Efficiency	1998-2019	1.764.000	<b>1,886930</b>
		2020-2030	122.930	
	Optimistic	1998-2019	4.536.000	<b>4,852106</b>
		2020-2030	316.106	
	Optimistic - Efficiency	1998-2019	2.079.000	<b>2,223882</b>
		2020-2030	144.882	

Source: Prepared by the authors based on data at ANEEL (2020) - accomplished, and projections by the authors based on the expectations of ANEEL's EEP, for the period 2020 and 2030.

## V. CLOSING REMARKS

The contribution of this article was to analyze the impact of the Brazilian innovation PPs of the SEB, more specifically on the research and development and energy efficiency programs, coordinated by the sector's regulatory agency, in the face of the goals set in Agenda 2030, especially in SDG 7 and Brazil's NDC.

The discussions held from the analysis of the SEB innovation PP - through the RD&I program regulated by ANEEL, which involved RD&P and EEP projects - show that there are considerable advances, with clear results accounted for. Nevertheless, there are also doubts, which fall mainly on the RD&P. For example, it was not identified research with a hydrogen-based fuel cell that is considered the RD&I frontier, capable of potentiating the renewable energy production units (solar and wind).

With regard to technological trends and challenges of the electricity sector in the world: digitalization, decentralization, and decarbonization, Brazil has advanced, but with a certain mismatch. In the first trend, digitalization, the RD&P of the SEB has contributed to the advancement of digital technologies that aim to improve the operational efficiency of the electricity system. This means investing in smart grids and preparing them for a new configuration, which includes the spread of distributed generation and energy efficiency. However, Brazil is still lagging behind the EU and the US (Marques, Dias e Vianna, 2020; ANEEL, 2020b; Castro, N. J.; Brandão, 2019; De Castro et al., 2015).

In the second trend, the decentralization of the electrical systems, the SEB should use it in a complementary way to the SIN, which is considered a

model with a good level of efficiency. However, with time the tendency is for integration to increase thanks to technological evolution, to smart grids, which allow bidirectional flows. The change from unidirectional to bidirectional flow facilitates the process of decentralization and makes it possible to add new sources of generation, including renewable ones such as solar and wind, which can be produced close to the final consumer (Castro *et al.*, 2017; WORLD ENERGY COUNCIL, 2017; MIT, 2016; NYISO, 2016; Collaço *et al.*, 2016; Schwab, 2018; Rifkin, 2012).

The third and last of the global trends, the decarbonization of the electric system, has already been overcome by Brazil, due to the concentration of hydro sources based initially on HPP and SHP. Today, the country is expected to move quickly to other renewable energy sources, such as wind, solar, and biomass, to reduce the dependence on hydroelectric power, due to climate change.

It is also observed that the results of the RD&P, which is in its third cycle - especially in the sample of projects analyzed in this study - are configured in at least three findings: i) the program is not aligned with the 2030 Agenda, especially with the goals of SDG 7, correlated with SDGs 9 and 13 and the NDC goals; ii) the innovation model does not contemplate open innovation, to take better advantage of the innovation potentials in the SEB; iii) the cost-benefit relationship or the impact of the program throughout the 21 years of existence is not proven (ANEEL, 2020b; IPEA, 2019; De Castro *et al.*, 2015; Cabanes, 2016; Chesbrough, 2003, 2010).

The EEP presented results aligned with the goals of Agenda 2030, both in the targets of SDG 7, correlated

with SDGs 9 and 13, and with the goals of Brazil's NDC, along with the Paris Agreement.

The R&DP projects are concentrated in the products: i) Concept or Methodology; ii) System; and iii) Software, which accounts for 76.67% in the period 2017 to 2019, against 53.54% in the period 2008 to 2016. The products generated in R&DP, when they reach the market and are associated with the supplies made by the international supply chain of inputs for the SEB, contribute to the EEP by providing process innovation, which meets the goals of energy efficiency: reduction of energy consumed, investments and environmental impact of the sector.

As for the financing sources of the SEB's innovation PPs, one can infer that it is one of the few programs with guaranteed resources through the R&DP and EEP since the resources for these programs have not been affected by contingencies from the national treasury (ANEEL, 2016, 2020b). This research has shown that there are other lines of credit available for RD&I in SEB, both at the National Bank for Economic and Social Development (BNDES) and the Study and Project Financing Agency (FINEP), either through non-reimbursable and reimbursable resources (BNDES, 2020; FINEP, 2020).

One of the limitations of this study was not dealing with tariff moderation. This is one of the goals of the RD&I of the SEB, and is aligned with Agenda 2030, SDG 7 - target 7.1 "by 2030, ensure universal, reliable, modern and affordable access to energy services", which due to its extent and importance will be presented in another article in the sequence (IPEA, 2019, p. 5).

It remains as a suggestion for future research the indications made by the FBMC (2018) to the Federal Government so that the SEB could meet the commitments signed in Brazil's NDC. This study did not identify actions in the innovation PPs of the SEB to i) expand centralized electricity generation from renewable sources, both centralized and distributed, in the interconnected system and isolated systems, as well as energy storage capacity; ii) repowering of hydroelectric plants; and iii) expansion of renewable energy in isolated locations (FBMC, 2018). All three indications have the potential to reduce the SEB's environmental impact and thus increase the sector's convergence with the 2030 Agenda.

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# Letters of Isolation: Reinvention of Existir

## Cartas do Isolamento: Reinvenção do Existir

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**Keywords**— Letter, Isolation, Old people.

**Abstract**— Social isolation, during the pandemic, motivated us to investigate what impacts it had on the lives of elderly people. The purpose of this article is to reflect the situations not yet experienced by elderly people. The objective of the research is to try to understand the meanings and experiences lived by more than 120 days of social isolation and to have a greater understanding of being at the risk group during a pandemic, through written letters and reports of experiences that come from the project called “Cycle Meetings”, through the workshop “Do fundo do Baú”, which is part of the Social Work with the Elderly (TSI) activity, linked to the Assistance Program, of the Social Service of Commerce - SESC, with the group called Plenitude. It is an exploratory research, with a qualitative approach, based on the analysis of its letters. In this way, we can conclude that the human being's need and capacity to reinvent itself to adapt to the new conditions imposed is possible at all times, especially in difficult times.

**Resumo**— O isolamento social, durante a pandemia, nos motivou a investigar quais os impactos que ele trouxe para a vida de pessoas idosas. O presente artigo tem por propósito refletir as situações ainda não vivenciadas por pessoas idosas. O objetivo da pesquisa é procurar entender os sentidos e experiências vividas por mais de 120 dias de isolamento social e ter um maior entendimento de ser do grupo de risco durante uma pandemia, através de cartas escritas e relatos de experiências que vêm do projeto denominado “Ciclo de Reuniões”, através da oficina “Do fundo do Baú”, que faz parte da atividade Trabalho Social com Idosos (TSI), vinculado ao Programa Assistência, do Serviço Social do Comércio – SESC, com o grupo denominado Plenitude. Trata-se de uma pesquisa exploratória, com abordagem qualitativa, a partir da análise de suas cartas. Desta forma, podemos concluir que a necessidade e capacidade do ser humano de se reinventar para se adaptar às novas condições impostas é possível a todo tempo, principalmente em tempos difíceis.

**Palavras-Chave**— Carta. Isolamento. Pessoas Idosas.

### I. INTRODUÇÃO

Esse artigo apresenta reflexões, a partir do interesse dos autores, relacionadas às questões geradoras

que cercam os impactos vividos por pessoas idosas durante a pandemia da Covid-19. Nesse sentido, buscamos uma das mais antigas e usadas formas de comunicação entre as

peças para compreender, através de seus escritos, como estão superando esse período tão difícil.

Escrever cartas foi o meio que encontramos para nos comunicar, visto que ainda é grande o número de idosos que não têm celulares e acesso à internet, para estar conectado às redes e aplicativos sociais ou têm o aparelho, porém não têm habilidades para acessar as redes sociais e poucas pessoas dispostas a ajudar. As cartas escritas e relatos de experiências vêm do projeto denominado “Ciclo de Reuniões”, através da oficina “Do fundo do Baú”, que faz parte da atividade Trabalho Social com Idosos (TSI), vinculado ao Programa Assistência, do Serviço Social do Comércio – SESC.

Acreditamos que a carta é uma opção “viável” mesmo para os poucos analfabetos do grupo, pois durante a divulgação da proposta, para os que não sabiam ler e escrever, foi dada como alternativa a intervenção de familiares de sua confiança para transcrever, na íntegra, a história e os sentimentos dos idosos para o papel.

A impossibilidade de nos encontrarmos pessoalmente para as rodas de conversa e leitura de nossas cartas e textos exigiu que nos readaptássemos e nos reinventássemos para que o projeto não parasse por completo. Foi pensado então em alternativas para resgate dessas cartas, incluindo um lugar fixo no centro da cidade, onde as cartas poderiam ser deixadas ou seriam resgatadas pela responsável nas portas das casas dos participantes seguindo as devidas orientações vindas do Ministério da Saúde.

O nosso lema era “viver um dia de cada vez”, mesmo que esse dia seja frente ao futuro e que ainda nos traga angústia a cada dia vivido. Ao passar dos meses durante o isolamento, as perguntas surgiam: Quando a quarentena irá acabar? Quando retornaremos à normalidade da vida? Será que vou contrair esse vírus? Será que vou transmitir aos idosos da minha família? Será que vou morrer pelo fato de ser uma pessoa idosa? Como ficarão as minhas finanças? Situações que acabam gerando um estado de alerta constante.

É nesse sentido que ganha força a escrita de Morin quando afirma que,

Não sabemos quais as consequências políticas, econômicas, nacionais e planetárias das restrições causadas pelos confinamentos. Não sabemos se devemos esperar o pior, o melhor, ou uma mistura dos dois: caminhamos na direção **novas incertezas**. (2020, p.01)

Diante de todas essas reflexões, podemos perceber esse incômodo angustiante, o que observa nas palavras dos mesmos

Eu sempre me considerei pela minha história de vida, uma pessoa forte; as vezes até fria, mas hoje desmoronei, caí mesmo, chorei pensando, quando isso vai acabar? e quando voltamos para o Sesc que não encontramos nossos amigos será que não sobreviveram a covid-19, qual será nosso sentimento nessa hora, nossa reação, só Deus para nos amparar (DOR, 76 anos).

[...]Somos uma família de 10 pessoas, entre marido, mulher, filhos, netos e genros; não ficou um que não tenha sido infectado pelo coronavírus. a partir daí travamos uma batalha em favor da vida. O que não nos faltou foi a fé em Deus. Todos os dias as 18h, quem conseguia levantar se juntava e se punha a rezar e agradecer a Deus a mais um dia de vida. Contudo fomos: um dia de cada vez, até a vitória [...] (FÉ, 62 anos).

[...]Estou achando muito ruim esse período difícil. Tá demorando muito passar! O meu medo é perder alguém da minha família, outro medo é de adoecer e não poder ver meus filhos. Minha dificuldade é ficar só em casa sem sair para lugar nenhum. Contudo estou aprendendo a dar mais valor à liberdade. (TRISTEZA, 63 anos).

Nesse período é necessário escutarmos e reconhecermos que sentimentos estão emergindo. Após essa análise e fazendo essa reflexão é hora de enfrentarmos a situação em que nos encontramos. É possível perceber nas falas essa consciência, “[...] derrepente tivemos que parar tudo e ficarmos isolados em nossas casas, para que ficássemos protegidos de um vírus[...].” (MEDO, 72 anos).

Percebemos em diversas falas que a fé, por muitas vezes, foi colocada em dúvida, “Meu Deus! Como está

difícil, eu sei que devemos crer, confiar e aceitar a vontade do pai, mas tá difícil” (DOR, 76 anos).

Existe também uma mistura de sentimentos percebida em “Neste período senti um pouco de tudo, o seja, medo de não ter saído vivo dessa e de nunca mais rever meus amigos do Sesc[...]” (AMOR, 64 anos).

O valor dado à importância da família em suas vidas, foi fundamental para um reconhecimento no cuidar do outro nessa fase da vida. “[...] essa quarentena me fez refletir o quanto as pessoas são importantes para mim. Estou com muita saudade de todos. Nesse período tenho tido total apoio da minha família e do grupo do Sesc” (AMIZADE, 64 anos).

Desse modo, percebemos também no discurso de outros sujeitos a importância a valorização do vínculo familiar, uma vez que

O confinamento para mim é um tempo que eu pude refletir mais sobre o valor da vida longe de tudo e de todos. O coronavírus me fez pensar como viver longe dos familiares, dos amigos e da igreja é difícil. Ficando presa dentro de casa, sem poder dar um beijo, um abraço a quem se ama[...]. (PREOCUPAÇÃO, 75 anos).

[...] Estou refletindo melhor, e me fez ver o quanto é bom ter família, amigos e poder ter sua liberdade de poder ir e vir, sem medo de se contaminar ou passar essa doença para outra pessoa. Infelizmente só com essa Covid-19 para me mostrar tudo isso. (FORÇA, 63 anos).

[...] Com o decorrer dos dias o medo foi tomando conta dos meus sentimentos e eu me enxergando longe de meus familiares e amigos, pois uma imensurável tristeza não somente por essa conjuntura pessoal, mas também por saber que tantas vidas não estavam mais em nosso meio. (MEDO, 72 anos)

A solidão é um sentimento que surge nesse momento em reflexo ao isolamento social. As pessoas velhas saudáveis e com autonomia estão “protegidas” em suas casas, com sentimento de medo, insegurança e até mesmo mais vulneráveis a sofrer violência psicológica por

parte de seus familiares. “Passo o dia só, com minha máquina de costura a costurar, abordar, procurando criar alguma coisa que ocupe meu tempo.” (DOR, 76 anos).

Qual era a orientação antes dessa pandemia? Que a pessoa idosa devia interagir socialmente, integrar-se em grupos, construir amizades, buscar conhecimento. O ano é 2020, o mês é março e as orientações mudam completamente. Pessoas idosas são consideradas do grupo de risco de uma pandemia nunca vivida antes em nosso mundo. E o que eles fazem? Eles estão tentando se recriar e se reinventar a cada dia. O pensamento de um dia de cada vez é verificado na fala do sujeito, pois

Com esse isolamento necessário, estou buscando muitas ocupações, como ocupar a mente fazendo leitura de bons livros, incluindo minha bíblia, fazendo meus bordados e crochê, rede, etc...enfim, de tudo um pouco para não ficar ociosa, além de minhas ginásticas, dança com minha filha, que graças a Deus está comigo e sempre convidando para fazer alguma coisa diferente (FORÇA, 63 anos).

Os Gerontólogos e Geriatras, profissionais que discutem o processo do envelhecimento humano, uniram-se dentro de suas possibilidades para escutar esses idosos, levando informações e dando dicas de como viver nesse período sem que tivessem prejuízo da sua saúde mental. Lembrando-lhes sempre que essa fase difícil iria passar.

Hoje, o nosso “maior inimigo” é invisível e não respeita classe social, credo, escolaridade, poder aquisitivo, acesso ao sistema de saúde, não faz distinção entre países desenvolvidos ou em desenvolvimento, não se importa com posições políticas ou discursos inflamados sobre defender ou acusar quem adota esta ou aquela posição. Esse inimigo é cruel. Não sabemos quando vai acabar, não sabemos ainda quantos irão adoecer, quantos vão morrer, quantos vão sobreviver. O que sabemos é que pessoas velhas, não só são vulneráveis, como fazem parte do grupo de risco dessa pandemia e do maior número de mortos. Nesse sentido, pode-se afirmar que:

O mundo está enfrentando um inimigo invisível aos olhos que demonstra uma característica bem peculiar: ele mata com muito mais voracidade os velhos. Velhos, no sentido cronológico da

palavra, com mais anos vividos desde o nascimento. Ainda que os mais jovens também estejam morrendo e sendo vítimas deste que é o mal do século (ou dos séculos, já que não se tem até o momento, comprovação científica de qual seria a cura), o número de velhos mortos é ainda muito mais expressivo pelo mundo afora. (VERDI, 2020).

Há um sofrimento natural devido ao isolamento por parte de todos, principalmente pelos idosos, nesse momento. É assustador não poder abraçar, beijar e evitar contato físico com os idosos de nossas famílias. Alguns relatos apresentam que “Já se passaram quase 4 meses, que estou nesse confinamento de não poder sair de casa e sem poder receber ou visitar parentes, amigos, de não poder dar um abraço nos netos, filhos, nora, amigos, namorado” (FORÇA, 63 anos).

Outros relatam que “Um dos piores momentos desse período foi no dia em que as netas vieram até a minha porta e eu não podia mandar entrar e nem abraçar, então chorávamos todos” (REALIDADE, 63 anos).

Como fazer para que idosos entendam da necessidade de estar isolado socialmente e que essa atitude é o melhor a se fazer considerando que a prevenção é a melhor orientação de nossos órgãos de saúde? Se não está sendo fácil para os idosos que recebem apoio de seus familiares incluindo: filhos, netos, noras, genros, imagina para os idosos que moram só e que as vezes não têm nenhum familiar por perto. Outro relato apresenta que “O isolamento já completa 4 meses sem poder ir nem na casa dos filhos e nem no Sesc. Esse isolamento, tá me parecendo viver o tempo que era criança. Não pode isso, não pode aquilo”(LIBERDADE, 76 anos)

Ninguém nunca estará preparado para esse tipo de situação que se vive. Idosos ativos, autônomos, protagonistas, participativos, viajantes, de uma hora pra outra, “trancados” ou “protegidos” em suas residências e sem receber visitas de familiares e amigos. Como manter a nossa saúde mental equilibrada nesse período? Quais orientações estamos oferecendo às pessoas idosas?

As orientações recebidas de profissionais da saúde e órgãos competentes para os familiares de pessoas idosas se resumiam em pequenos cuidados como: ligar com frequência para seus idosos, fazer contato via mensagem, procurar ver se os medicamentos estão dia, verificar se estão se alimentando com qualidade e se a hidratação está

sendo feita, a limpeza da casa estava em dia, orientar em relação a evitar receber e fazer visitas, fazer as compras de supermercado para eles, saber se as orientações dos órgãos de saúde estão sendo feitas como: lavar as mãos de forma correta, higienizar com álcool em gel, entre outros.

Podemos observar a tristeza em não poder mais exercer a profissão “Não estou triste, mas sinto um vazio que não sei explicar. Parei de pegar roupas para costurar por conta da contaminação. Achei melhor evitar” (LIBERDADE, 76 anos). E também o sentimento de culpa, por precisar expor pessoas para não se expor, devido a condição de estar no grupo de risco. “Como que eu para me proteger, jogava meu filho para a frente da batalha, isso é justo? E ainda continua! Até quando? (APRENDIZADO, 72 anos). Neste sentido, verificamos também na fala do sujeito a preocupação do cuidado com o que cuida. Por conseguinte,

[...]Eu me isolei com meu filho, ele é quem saía para fazer as comprar o necessário para nos mantermos. Ele tomava todos os cuidados com ele e me superprotegia, até que um dia ele foi infectado. Me senti muito culpada porque ele protegia tanto a mim e descuidou de si próprio (ESPERANÇA, 70 anos).

Dentre as orientações dadas às pessoas idosas, sugeriu-se escolher um período do dia para ouvir as informações sobre a pandemia. Talvez as inúmeras informações repassadas poderiam trazer confusão e angústia. É possível perceber uma certa resistência ao excesso de informações “[...] não gosto de assistir jornal, só dá notícias tristes” (ANSIEDADE, 86 anos) também “[...] era *um* martírio, até hoje ainda não deixou de ser, assistir ao jornal ou qualquer programa de TV, que informe números de infectados e mortos desse terrível vírus. (REALIDADE, 63 anos)” além disso “Não estou gostando do que estou vendo através da imprensa, a falta de ‘juízo’ das pessoas que nem usam mais a máscara para proteger a sua própria saúde e a do semelhante”(CONFINAMENTO, 74 anos).

Entendemos que é importante também orientar que você precisa fazer o que você acredita que é possível fazer. Não existem regras nesse caso. É necessário que se tenha consciência de suas limitações e de suas possibilidades. Desse modo podemos constatar nas falas “Estou sempre procurando alguma coisa para preencher o tempo, cuidando das minhas plantas, costuro, bordo e cozinho, amo cozinhar”. (GRATIDÃO, 81 anos). Sem dúvida a necessidade de se manter ativo e capaz de reorganizar sua rotina com autonomia é inegavelmente muito importante,

Para não ficar parado totalmente, faço aquecimento dentro do quarto e posteriormente alguns alongamentos

para não deixar o corpo parado por inteiro. E assim vou levando até acabar essa longa espera, e tudo volte ao normal[...] (AMOR, 64 anos).

Uma equipe da Residência Multiprofissional em Saúde Mental elaborou um manual de estratégias para manutenção da saúde mental em tempos de *Pandemia* e de acordo com a contextualização do documento, acredita-se, pois, que

Cada pessoa, reage a esse momento de uma maneira diferente, como o indivíduo responde depende de sua formação, que fase da vida está (criança, adolescente, adulto, idoso), sua história de vida, características particulares, comunidade em que vive e que recursos estão disponíveis para esse momento cesso a internet, tv a cabo, recurso financeiro, entre outro (PITHAN, Ana Cláudia. Et. al. P.4, 2020).

Em relação a isso, podemos perceber que cada sujeito idoso, enfrenta a situação de maneira diferente. Alguns buscando alternativas de até mesmo aumentar sua renda financeira nesta crise. “Em casa estou fazendo as minhas obrigações e também costurando, pois peguei *uma* encomenda de máscaras e com isso ocupo meu tempo livre que agora já é pouco”. (ASSISTÊNCIA, 74 anos). Nessa outra fala, percebemos que a rotina diferente serviu como válvula de escape para a tristeza que sentia. “[...] passei a costurar o dia inteiro e às vezes até entrava pela noite, para superar a falta que sentia de todos. Chorei muito escondida e assim me aliava a tristeza.” (REALIDADE, 63 anos).

Foi possível observar também que pessoas idosas são muito criativas e sábias em relação as suas decisões. Pois,

[...] Comecei a me reinventar, comecei a fazer coisas simples, que não fazia comumente, como faxinar a casa todos os dias, a lavar roupas (tinha preguiça até de ligar a máquina de lavar!) e lavar o banheiro. Minhas aulas de inglês também foram suspensas, comecei a revisar as lições do ano passado, escutando os CD’S das lições. E quando pensei que tinham esgotado minhas opções, retomei meus quadros e meus livros de pintura (DÚVIDA, 70 anos).

Outros reagem de forma diferente, deixando que a angústia e o medo sejam superiores às possibilidades de superação de um período que não irá durar para sempre. “[...] são 4 meses que parece um pesadelo, parece que tudo ao nosso redor não vai passar, pois *cada* dia que passa são mais pessoas adoecendo e perdendo suas vidas.” (ANSIEDADE, 86 anos), ou ainda

Sonho em sair de casa e estar na rua, mas logo vem a angústia e me faço várias perguntas: depois desses 4 meses sem sair de casa, será que ainda vou saber caminhar na rua? Será que ao sair vou ser contaminada? Vou conseguir

continuar minha vida de onde ela parou? Vou sorrir novamente como antes? Vou chorar no momento em que reencontrar meus amigos no Sesc? E no momento em que puder abraçar as pessoas da minha família, acho que vai ser o melhor momento, depois de tudo o que está acontecendo nesse planeta. (REALIDADE, 63 anos).

Duas situações se afloram em mim nesse momento de confinamento: medo e aprendizado. Sempre me perguntando, porque ter medo do meu semelhante, das pessoas que tanto amo? Não poder chegar perto, isso seria impossível, olhar de longe, sofrer e fingir que está tudo bem só para não os preocupar. (APRENDIZADO, 72 anos).

Mas, e a saúde mental? Por saber que fazem parte do grupo de risco e que a grande maioria das mortes pelo coronavírus são de idosos, fazem com que cresça a ansiedade, a sensação de impotência, medo, entre outras situações. Orientações estão *sendo* dadas para que tenham uma rotina durante essa quarentena como tarefas domésticas, escutar música, ler um bom livro, atividades manuais, cuidar de plantas e quintal, fazer uma receita culinária, escrever ou assistir um filme. É possível perceber que existe uma preocupação por parte dos sujeitos em seguir as recomendações dadas pelos profissionais da saúde. Vejamos como isso aparece premente nas falas seguintes:

Quanto as minhas limitações, não sofri muito, pois segui o mesmo ritmo de sempre: bordando, cuidando de minhas plantas, lavando roupa, lavando louça. Coisas foram me acrescentando como assistir novelas, filmes e programas religiosos. (CORAGEM, 86 anos).

[...] no meio de tantas tristezas, tantas lágrimas, decidi me mudar. Aluguei uma casa e hoje estou no paraíso, hoje estou no paraíso, hoje estou realmente vivendo aquilo que mais prezo que é a minha liberdade[...] (VITÓRIA, 70 anos).

Nunca houve tanta necessidade de trabalho voluntário para auxiliarem esses idosos, tanto para realizar atividades fora de casa para eles, quanto para conversar e amenizar o sentimento de solidão. Para lidar com o momento com mais leveza, também foi *urgente* transformar a prática de cumprimentos à distância em um momento de interação. Diante disso, as falas nos revelam claramente esses sentidos:

Fui confortada e ajudada, mesmo com o distanciamento, por meio da tecnologia, por vizinhos e amigos de todos os grupos e de todos os lugares, até mesmo de outros estados, com orações e mensagens encorajando-me a lutar. (SAUDADE, 80 anos).

Pessoas não foram feitas para o isolamento social, sentir-se só é muito prejudicial para saúde. O momento foi procurar alternativas e buscar “conexões” para evitar a solidão entre as pessoas idosas. A esse respeito, as falas nos levam a essas reflexões:

Olha, meus mais de 2 meses de quarentena foi como uma injeção, pois tratou não somente meu coração, mas também, parte de meus sentimentos, pois aprendi que apesar de já ter esse conhecimento que a família é a nossa principal companhia. Me senti como se fizesse muito tempo sem tantos carinhos, cuidados, solidariedade e principalmente amor. (CORAGEM, 86 anos).

Durante esse período foi impossível não relacionar a covid-19 à finitude. De acordo com Foucault, no seu livro: ‘As palavras e as coisas’, “A finitude do homem se anuncia -e de uma forma imperiosa – na positividade do saber, sabe-se que o homem é finito” [...] Nesse sentido, ademais, ele afirma

No fundamento de todas as positivities empíricas e do que se pode indicar como limitações concretas à existência do homem, descobre-se uma finitude – que em certo sentido é a mesma: ela é marcada pela espacialidade do corpo, pela abertura do desejo e pelo tempo da linguagem; e, contudo, ela é radicalmente outra: nela o limite não se manifesta como determinação imposta ao homem do exterior (por ter uma natureza ou uma história), mas como finitude fundamental que só repousa sobre o seu próprio fato e se abre para a positividade de todo limite concreto. (2000, p.337)

Nas cartas da pandemia, pudemos observar que os sentimentos de dor pela partida de familiares e amigos, a desesperança, solidão, *sofrimento* e tristeza, misturavam-se com os de esperança, superação, dedicação e gratidão por um tempo de adaptação e reinvenção do existir.

Falar de morte nos últimos tempos tornou-se muito comum. Mas sempre foi assim? A pandemia da Covid-19 trouxe ao mundo uma necessidade *emergencial* sobre se pensar e falar a respeito de como se deseja o próprio fim. Falar de morte é algo difícil, ainda que seja esta a única certeza que todo ser humano carrega consigo, desde o nascimento com vida.

Desta *forma*, socialmente se evita abordar o tema, porque na verdade ninguém está preparado para fazer essas reflexões. Afinal de contas, viver ainda é a melhor solução mesmo em tempos difíceis. Mas se pararmos para refletir, nunca foi tão necessário se falar de morte, sobre como se deseja morrer, sobre como se pensa o próprio fim.

Nesse sentido, afirma Morin,

[...]Mesmo que possamos retardar a morte por

envelhecimento, jamais poderemos eliminar os acidentes mortais nos quais nossos corpos serão esmagados, não poderemos jamais nos livrar das bactérias e dos vírus que sem cessar se transformam para resistir aos medicamentos, antibióticos, antivirais e vacinas. (2000, p.02).

Os últimos dias vividos pela humanidade mundo afora, em virtude da pandemia do Coronavírus, colocaram em xeque a continuidade da *vida* com dignidade. Assistimos perplexos, diariamente, os inúmeros casos de pessoas que por conta da pandemia se viram longe do que esperavam e do que tinham planejado, projetado e perseguido para si. Desse modo, é possível observar a dor da perda na fala dos sujeitos “Além da perda dos amigos, o que mais me dói e não podemos nos despedir, isso faz com que não acreditemos no que está acontecendo” (DOR, 76 anos) e “O medo não deixa de ser uma reação circunstancial que faz parte dos momentos de solidão, saudade, confinamento e da morte que tem nos tirado amigos (as) e faz com que as lágrimas brotem (CONFINAMENTO, 74 anos).

Com toda certeza as pessoas não se imaginaram, nem no seu pior pesadelo, ser um número, de um corpo, dentro de um caminhão que carregava centenas deles para um enterro coletivo e sem despedidas. A esse respeito, a dor sentida em não poder velar um ente querido, traz *um* enorme sentimento de tristeza, percebida nas palavras de quem viveu essa perda

O meu período de isolamento social, foi muito difícil, eu e minha irmã fomos infectadas pela covid-19, ela não resistiu e partiu sem que eu pudesse me despedir. A minha maior dificuldade é conviver com a saudade, me sinto muito triste, não consigo deixar de chorar. (SAUDADE, 80 anos).

## II. CONSIDERAÇÕES FINAIS

Diante disso, percebe-se que neste processo de enfrentamento a uma pandemia, fomos convidados a nos reinventar para poder continuar. Hoje, temos horários específicos para a ida de idosos aos supermercados. O que nos parecia tão simples, hoje já não é mais. As entradas em

supermercadosnunca foram tão diferentes.Colaboradores devidamente equipados com máscara e luvas e munidos de álcool em gel,abordam a todos que ali chegam. Como máquinas, fazendo um trabalho quase mecânico, borrifam álcool em gel em nossas mãos, passam álcool nos nossos carrinhos e nos orientam como devemos nos comportar dentro do estabelecimento. Nossa reação de medo, espanto e ao mesmo tempo agradecimento é transmitido apenas com o olhar que diz tudo naquele momento, pois as palavras faltam.

Derepente nos vimos isolados ou “protegidos” em casa, fazendo e utilizando recursos que jamais imaginávamos precisar utilizar. Hoje, pedimos nossos *suprimentos* via whatsapp, sem precisar sair de casa, confiando no bom senso do estabelecimento na melhor escolha. Se quisermos, hoje também não precisamos ir aos supermercados, as compras podem chegar até nós por serviço de delivery.

Segundo Morin,

[...] (O Confinamento) Se prolongará ou se intensificará o despertar da solidariedade provocada durante o confinamento, não somente pelos médicos e médicas, pelos enfermeiros e enfermeiras, mas também pelos garis, pelos encarregados de manutenção, entregadores, caixas, sem os quais não poderíamos sobreviver.(2000,p.03)

São médicos, enfermeiros, farmacêuticos e psicólogos, profissionais de educação física, Gerontólogos, assistentes sociais, entre outros, realizando atendimentos online. Os músicos fazendo shows virtuais, as famosas “lives”, a todo instante para distrair e deixar os dias e noites mais alegres e com isso, em contra partida, arrecadando alimentos e itens de higiene extremamente necessários no momento atual, além de *EPI's* para profissionais da saúde como aventais e máscaras. Em relação às máscaras, esse acessório hoje é necessário e de uso obrigatório, estamos aprendendo a utilizá-las e com isso os sorrisos ficam debaixo de um pano branco ou estampado. A comunicação agora é feita pelo olhar e esse às vezes pode ser revelador ao encontrar pessoas, mesmo com 2 metros de distância. Olhares que se cruzam e às vezes revelam medos e angústia.

Nesses tempos, tivemos que nos acostumar e até mesmo aprender a fazer vídeo chamadas para falar e assim ficar mais próximos de seus familiares,falar com os amigos

por skype, aulas por vídeo conferência, aulas prontas via whatsapp para nossos filhos, preparadas pelos seus professores, pessoas se reunindo para recitar poesias. Uma idosa relatou que “A quarentena me trouxe um aprendizado bastante útil, pois agora sei entrar em aulas virtuais (online),assisto missa através da internet, falo por chamada de vídeo com minha família”(CORAGEM, 86 anos).

Um celular, um notebook e acesso à internet nunca foram tão necessários. Mas e os velhos? Têm acesso a essas tecnologias? Os que não possuem e moram só, como estão se comunicando?

O que a pandemia vem nos trazendo de aprendizado? É possível fazer reflexões do nosso envelhecer no contexto atual? Ainda é possível aprender algo novo, mesmo com tantas incertezas do que realmente importa nesse momento? foi possível estreitar relações e vínculos afetivos com a *família* em momentos de medo? Diante dessas questões, podemos ver essa preocupação através de reflexões feitas pelos sujeitos “Do alto dos meus 72 anos, continuo aprendendo, a vida é um contínuo aprendizado. Nesse período, aprendi a aceitar minhas rugas, meus cabelos crespos e esbranquiçados e também meus limites” (APRENDIZADO, 72 anos). Poder se perceber de forma genuína, olhar-se, obter sensações relatadas com certa satisfação é um exercício que tem sido praticado e vivenciado pelos sujeitos. A esse respeito constata-se através das falas:

Tenho pra mim, que a humanidade estava precisando de um “freio”, para rever seus valores e pensar mais nos outros, próximos ou não. Pelo menos, nos meus altos 70 anos, aprendi muito, principalmente com valores internos em relação à minha família. (DÚVIDA, 70 anos).

O confinamento uniu as famílias onde há muito tempo os pais não tinham tempo para ouvir os filhos e vice-versa e assim se conhecerem mais, estreitando o relacionamento, buscando o entendimento, união, respeito e principalmente a oração, buscando e vivenciando o amor a Deus. (CONFINAMENTO, 74 anos).



O que todos sabemos é que este período complicado não irá durar para sempre, os sobreviventes, após muitas reflexões de tudo o que foi vivido, vão seguir suas vidas. Ainda não sabemos o tempo que levará para voltarmos à normalidade, mas acreditamos que ela virá. Esperamos que toda essa crise vivenciada no mundo, nos afete e que possamos, todos, crescer no individual e coletivo, valorizando as coisas que realmente importam nesta vida. As pessoas idosas, sujeitos do grupo de risco nesta pandemia, sentiram e vivenciaram na “pele” as consequências de viver no isolamento social e todas as suas consequências. A esse respeito, é perceptível notar na escrita dos sujeitos *através* de relatos das experiências vividas todas essas questões. “Estou ansiosa para que termine essa pandemia para que possamos voltar para as atividades novamente” (VONTADE, 66 anos).

O desejo do fim é latente “Não está sendo fácil viver nesse mundo tão diferente. Procuo me reorganizar no que sou agora para o que era antes”. (*CONFINAMENTO*, 74 anos). “Quando tudo passar e ter uma vacina, mesmo assim não ser normal. Será difícil. Porque houveram muitas perdas pessoais e econômicas. (PERDAS, 84 anos).

De acordo com Ramos,

A vida não é algo acabado e pronto, por isso, ganha-se, mas perde-se, a cada instante, o que se ganha, construções e destruições a perfazem, formas e deformações a constituem. Tudo parece se criar e morrer, em um movimento contínuo, sem se perpetuar em seu movimento em direção a si mesmo e, sequer, em direção a qualquer ponto de partida ou de chegada (2012, p.225).

Com base nisso é possível dizer que ao recebermos as cartas e analisarmos os conteúdos, foi perceptível constatar diversas reações e comportamentos vivenciados pelos sujeitos durante essa pandemia, entre elas as que nos chamaram mais atenção foi o medo de adoecer e de ficar desamparado, medo de morrer sem poder se despedir da família, medo de perder alguém da família, a dor profunda de quem perdeu um familiar, a preocupação excessiva com a saúde da família, alguns conflitos eventuais e intergeracionais na família conforme a longa convivência durante o isolamento, falta de concentração para realização de tarefas habituais, alterações no sono, a falta ou excesso de apetite, tristeza, irritabilidade, insegurança, a falta que as atividades físicas fazem na rotina e o que mais

incomodou as pessoas idosas foi ter sua liberdade, direito de ir e vire autonomia prejudicados com o confinamento.

Porém, os aspectos positivos na fala dos sujeitos foram bastante relevantes como a necessidade e capacidade do ser humano se reinventar para se adaptar às novas condições impostas, a experimentação dos novos aprendizados, da fé em acreditar que toda essa situação terá um fim, descobrir que você não precisa ter o controle de tudo, que nessa fase da vida “velhice”, o viver um dia de cada vez, fazendo o que é possível fazer, ainda pode ser uma opção viável em tempos difíceis.

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## What is it, Old Age? O Que É Isso, A Velhice?

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**Keywords**— Aging, Old age, Old.

**Abstract**— When we are made to think about old age nowadays it motivates us to believe that we are contributing to break some social prejudices. This article aims to reflect the question of old age and turns to the conception of some references and reports experienced by a group of old people, as an object of study of gerontology, defining some approaches that guide the discussions on social relations, involving subjects. It was found throughout the study that there was a "silence" around the theme of old age, around the word "old", the pronunciation of the terms for that moment in life and the subject who lived that phase, was still veiled. The objective of the research is to have a greater understanding of this stage of life, old age, nowadays, seeking to hear and understand the subject, in particular how they are experiencing their aging, from their speeches and reports of experiences that come from the project called "Cycle of Meetings", through the workshop "Exchanging Ideas", which is part of the Social Work with the Elderly (TSI) activity, linked to the Assistance Program, of the Social Service of Commerce - Sesc, with the group called Grupo Plenitude. It is an exploratory research, with a qualitative approach, based on the analysis of the speeches of 25 subjects. Thus, we can conclude that it is possible for old people to discuss and reflect on their old age, visualizing their needs, seeking to overcome the various challenges and open themselves to new conquests, through their life project, envisioning autonomy until the end of their existence.

**Resumo**— Quando somos postos a pensar a respeito da velhice nos dias atuais nos motiva em acreditar estar contribuindo para quebrar alguns preconceitos sociais. O presente artigo tem por objetivo refletir a questão da velhice e se volta a concepção de alguns referenciais e relatos vividos de um grupo de pessoas velhas, como objeto de estudo da gerontologia, definindo algumas abordagens que guiam as discussões sobre as relações sociais, envolvendo sujeitos. Verificou-se ao longo do estudo que existia um "silêncio" em torno do tema velhice, a cerca da palavra "velho", a pronúncia dos termos para esse momento da vida e o sujeito que vivia essa fase, ainda era velado. O objetivo da pesquisa é ter um maior entendimento desta fase da vida, a velhice, nos dias atuais, buscando ouvir e compreender o sujeito, em particular como estão vivendo o seu envelhecer, a partir das suas falas e relatos de experiências que vêm do projeto denominado "Ciclo de Reuniões", através da oficina "Trocando Ideias", que faz parte da atividade Trabalho Social com Idosos (TSI), vinculado ao Programa Assistência, do Serviço Social do Comércio – Sesc, com o grupo denominado Grupo Plenitude. Trata-se de uma pesquisa exploratória, com abordagem qualitativa, a partir da análise das falas de 25 sujeitos. Desta forma, podemos concluir que é possível que pessoas velhas possam discutir e refletir sobre sua velhice visualizando suas necessidades, buscando superar os

*diversos desafios e abrir-se a novas conquistas, através do seu projeto de vida, vislumbrando autonomia até o final de sua existência.*

**Palavras-Chave**— **Envelhecimento. Velhice. Velho.**

## I. INTRODUÇÃO

Esse artigo discute e apresenta, a partir da experiência e interesses dos autores, o envelhecimento humano e questões que cercam a velhice. Os relatos de experiência que são apresentados no texto vêm do projeto denominado “Ciclo de Reuniões”, através da oficina “Trocando Ideias”, que faz parte da atividade Trabalho Social com Idosos (TSI), vinculado ao Programa Assistência, com o grupo denominado Grupo Plenitude. As ações dessa atividade acontecem dois dias da semana, às terças e quintas, com uma ampla oferta de serviços socioeducativos, para 200 inscritos, operadas por uma Assistente Técnica com formação em Gerontologia e estagiários, na Unidade Operacional do Serviço Social do Comércio - Sesc, em Castanhal, no estado do Pará. A mediadora do projeto desempenha o papel de instigar a reflexão, a construção e a troca de conhecimentos entre os participantes idosos, orientados por temas diversos relacionados ao envelhecimento humano, com utilização de metodologias ativas, vídeos comentados, leituras reflexivas, montagem de cartazes, estimulação da escrita de textos, leituras coletivas e outros. Alguns dos relatos têm como base observações, registros de narrativas, relatórios de programações e diários de campo no decorrer do exercício de 2019/2020 e optamos por adotar o procedimento de usar nomes fictícios para identificar alguns dos relatos. Nas atividades desenvolvidas considerase os interesses do grupo, o reconhecimento de seus direitos enquanto cidadãos, estimula-se a reflexão sobre as possibilidades de construção de novos papéis sociais e políticos, com o objetivo de estimular o desenvolvimento individual e coletivo da pessoa idosa na sociedade, promover sua autoestima e integração em diferentes ambientes e reconstruir sua autonomia.

Como afirma Sommerhalder, envelhecer nos tempos modernos pode significar um presente da alta tecnologia, de corrida contra o tempo, de produção e renovação de conhecimentos (2000, p. 134).

## II. CONTEXTO HISTÓRICO DA VELHICE

No que se refere ao tempo, uma das características do envelhecimento e da velhice é o encurtamento do futuro e esse processo sempre tem acompanhado a humanidade como uma etapa inevitável de declínio, decadência e antecessora da finitude. A palavra velhice é carregada de significados como decrepitude, caduque, fragilidade, teimosia e ao contrário do jovem, a

pessoa velha tem uma longa vida às suas costas e esperanças muitas vezes limitadas com atenção voltada no passado e uma decorrente desesperança nos projetos existenciais.

A imagem que se tem da velhice mediante diversas fontes históricas, varia de cultura em cultura, de tempo em tempo e de lugar em lugar. Esta imagem reafirma que não existe uma concepção única ou definitiva da velhice, mas sim concepções incertas, opostas e variadas através da história. (LEMONS et al. 2017)

A este respeito, temos pessoas velhas respeitadas por suas famílias, com a possibilidade de viver um “envelhecer digno” e por outro lado temos velhos negligenciados, com seus direitos violados. Por um lado, existe até mesmo uma superproteção ou excesso no cuidar, por outro total descaso e abandono. Ao longo da história, nos primórdios, ora colocam o idoso em um lugar imperioso, ora em um lugar de decadente. Segundo Kamkhagi (2008, p. 23 a 37), é possível fazer um breve levantamento histórico, constata-se que “os velhos eram vistos como feiticeiros e bruxos”, em inúmeras tribos prevalecia a imagem do “velho sábio (detentor de conhecimento)” ou “velho incapacitado (doente, medroso)”.

Sociedades pré-históricas, como o povo massageta, através de rituais tinham por hábito “imolar o idoso”, depois do corpo imolado, cozinhavam e comiam o corpo velho. O povo mongol, respeitava apenas os velhos saudáveis, o restante era desprezado e por muitas vezes abandonados. Para o povo Judeu, o idoso era visto como a coroa do seu povo. A velhice era vista como recompensa de uma obediência a Deus, como uma virtude. Segundo a sociedade Hebraica, uma família que não possuía um ancião, não era abençoada.

Na cultura Grega, o velho representa um ser impossibilitado de corresponder aos ideais de beleza e juventude, por esse motivo era completamente desvalorizado. Na sociedade romana, os anciões tinham uma posição privilegiada. O direito romano concedia a autoridade de “pater famílias” aos anciões. Quanto mais poderes lhes eram concedidos, mais a ira de novas gerações se voltava contra os velhos. Segundo a visão dos “povos bárbaros” uma pessoa deveria viver apenas até a

idade em que estivesse apta a lutar, depois disso nada valia aos olhos da sociedade.

Na chamada sociedade feudal, tornou-se organizada, contudo, o velho tinha ainda um papel muito apagado, o administrador do feudo deveria ser forte, rápido e estar apto a defender seu espaço com uma espada. Nas culturas Incas e Astecas, a população anciã era tratada com muita consideração. A atenção a esta população era vista como responsabilidade pública.

Em sociedades antigas o ancião era visto com uma aura de privilégio sobrenatural que lhe concedia uma vida longa e como resultado, este ocupava um lugar primordial, no qual a longevidade se associava com a sabedoria e a experiência. Assim era nas sociedades orientais, principalmente na China e no Japão.

Nas antigas culturas e civilizações, a pessoa idosa era idolatrada e respeitada. Beauvoir aponta como os idosos chineses são respeitados “Toda a casa devia obediência ao homem mais idoso. Não havia contestação prática de suas prerrogativas morais, pois a cultura intensiva que se pratica na China exige mais experiência do que força”(BEAUVIOR, 1990, p. 112).

Goldfarb comenta porque a velhice já foi símbolo de status social

[...] nas sociedades tradicionais a figura do velho representava a sabedoria, a paciência, e transmitia os valores da ancestralidade: era ele quem detinha a memória coletiva; quem, através da evocação e da transmissão oral, construía uma narrativa com a qual se incorporava (fazia-se corpo) cada indivíduo na história do grupo(GOLDFARB, 1997, p. 11).

Estudos realizados em sociedades não ocidentais apresentam imagens positivas da velhice e do envelhecimento, ensinando que a representação de velhice enraizada nas ideias de deterioração e perda não é universal. À medida que o envelhecimento é documentado em outros povos, constata-se que ele é um fenômeno profundamente influenciado pela cultura (UCHÔA, 2003).

No Brasil, a velhice já foi considerada um status social. O número de idosos era menor devido às condições que desfavoreciam a longevidade, eram mais valorizados pelos mais jovens, significavam símbolos de respeito, experiência de vida. Porém, com o passar do tempo isso foi se modificando e, segundo Santana e Sena isso ocorre

Com o crescente envelhecimento da população, começa a se formar, gradativamente, uma nova imagem sobre o envelhecer, atribuindo ao mesmo, novos significados e valores que se contrapõem àqueles criados e reproduzidos socialmente durante muito tempo (SANTANA e SENA, 2003, p. 45)

O que se percebe são ciclos que ocorrem ao longo da história. Períodos em que os idosos são valorizados, são seguidos por crises entre jovens e velhos e posterior desvalorização do velho. Não estamos na sociedade pré-histórica, não se comem mais corpos de velhos, porém a todo instante velhos são violentados fisicamente, são mortos por próprios filhos, ameaçados psicologicamente, abandonados à própria sorte, silenciados por uma sociedade preconceituosa que não dá a ele voz e nem vez, invisíveis a uma sociedade que ainda nem de longe está preparada para recebê-los.

A velhice, ao longo da história da humanidade é tratada de maneira diferente de acordo com períodos e estrutura social, cultural, econômica e política de cada sociedade. Nesse sentido, a pessoa velha sente-se incluída na sociedade? É fundamental trazer o fato de que a sociedade a que pertencem esses idosos, impõe uma norma de relacionar-se com a vida, que é definida socialmente.

Para Beauvoir, “a velhice não poderia ser compreendida senão em sua totalidade; ela não é somente um fato biológico, mas também um fato cultural” (1990, p. 20). Segundo Simões(1998, p.27), “A velhice não é um processo único, mas a soma de vários outros, distintos entre si”.

### III. VELHICE: ALGUMAS CONCEITUAÇÕES

A partir destas definições, percebe-se que a velhice, embora caracterizada pela existência das alterações físicas, tem uma essência que transcende este aspecto, devendo ser considerados seus fatores sociais, culturais, psicológicos, econômicos, entre outros. Dessa forma, as pessoas velhas devem ser vistas como sujeitos capazes de construir sua própria história, acumulando vivências e experiências das várias etapas da vida. Em relação a essas etapas procuramos entender também um pouco das faces da velhice nos séculos passados e nos dias atuais.

Envelhecer é um processo natural de todos os seres vivos. Entendemos o envelhecimento humano como um processo natural da vida, a velhice como uma fase da

vida e o velho como sujeito desse processo. O mundo está envelhecendo, porém é perceptível a grande dificuldade em se determinar o conceito de velhice. Atualmente, percebe-se uma proliferação dos termos utilizados para se referir às pessoas que já viveram mais tempo ou à fase da vida anteriormente chamada apenas de velhice. Entre os termos mais comuns estão: terceira idade, melhor idade, adulto maduro, idoso, velho, meia-idade, maturidade, idade maior e idade madura (NERI & FREIRE, 2000)

Considera-se, portanto, que seja necessário aquilibrar como a velhice é entendida para alguns autores. Na compreensão de Neri (2001, p. 69) “a velhice é a última fase do ciclo vital e é delimitada por eventos de natureza múltipla, incluindo, por exemplo, perdas psicomotoras, afastamento social, restrição em papéis sociais e especializações cognitivas”.

Para Marcelo Salgado (1988, p.30), a velhice deve ser definida como o tempo de vida humana em que o organismo sofre consideráveis mutações de declínio na sua força e aparência, as quais, porém, não incapacitam ou comprometem o processo vital. Beauvoir (1970, p.17) coloca ainda que “a velhice não é um fato estático; é o término e o prolongamento de um processo, processo este denominado de envelhecimento”.

Acredita-se que chegar à fase da velhice é um processo inerente ao ser humano que aspira viver muitos anos. É um fenômeno dinâmico e progressivo que envolve diferentes fatores. Segundo Mazzucco (1995, p.11), “a velhice é então definida como parte do desenvolvimento do homem. É o resultado de sucessivas passagens ocorridas no indivíduo, tanto física e psicologicamente, quanto cultural ou socialmente”.

A sociedade capitalista somente reconhece o idoso como ser de direitos pela dimensão cronológica. Porém, o estigma da velhice não se refere apenas a quantos anos de idade ele possui, pois esses traços estigmatizadores estão ligados a outros valores depreciativos de tudo o que se distancia do estabelecido e aceito como modelo padrão, a exemplo da pobreza, da raça, da obesidade, do desemprego, da doença, entre outros. Dessa maneira, Beauvoir (1970, p.16) coloca que “o mundo fecha os olhos aos velhos, assim como os delinquentes, as crianças abandonadas, aos aleijados, aos deficientes, todos estigmatizados, nivelados em um mesmo plano”.

A sensação de não ser mais “útil” a uma sociedade capitalista, faz com que muitos idosos se sintam excluídos de um processo de construção e desenvolvimento. É possível ouvir, entre relatos de pessoas idosas, que ainda se sentem capazes de produzir. Entre esses relatos ouvimos *o corpo pode até não ser tão ágil e forte, porém sou criativo, meu cérebro funciona*

*muito bem e me sinto muito capaz* (Poeta, 66anos) <sup>3</sup>. Neste sentido,

Pode-se considerar que a perda de status dos idosos está relacionada com o surgimento do capitalismo, onde a produção de bens ganha valor. Nesse sistema valemos mais pelo que produzimos do que pelo que somos, ou seja, a sociedade tende a rejeitar o indivíduo na medida em que ele perde a condição de produzir força de trabalho. Dessa concepção resulta a tendência de que os idosos e, economicamente inativos, sejam considerados socialmente mortos, banidos da esfera do poder (FRAIMAN, 1995 p. 143).

#### IV. VELHICE: CONSTRUINDO CONCEITOS

Esta senhora, a velhice, vem chegando sem avisar e nos convida sem pudor e lentamente a experimentá-la e vivê-la. Devemos nos preocupar ou encarar de frente a sua chegada? E quando se inaugura em nós a velhice? Quem é esse que chamamos de velho? Como os velhos se veem e como os outros os veem? Durante esses 20 anos de convívio com pessoas velhas, tivemos a oportunidade de fazer essa pergunta a eles: quando percebeu estar vivendo sua velhice? Entre tantas respostas estão *quando foi sugerido e prescrito por médicos que entrasse em grupos de idosos para fazer exercícios adaptados para minha faixa etária; quando cronologicamente completei 60 anos e todos ao meu redor diziam: agora conforme a lei e segundo a OMS, você já é uma pessoa idosa; quando “chegou” minha aposentadoria e perdi esse vínculo profissional (sair da lista dos “ativos” e entrar na lista dos “inativos”); quando me tornei avó ou avô, quando entrei em um coletivo, um adulto levantou-se e disse: sente senhora, afinal já é uma idosa, tem seus direitos; quando percebi as minhas diversas limitações*, entre outras diversas respostas.

Temos algumas orientações de organismos internacionais que procuram balizar um momento específico para se considerar a fase da velhice. Para a Organização Mundial de Saúde – OMS, por exemplo, 65 anos é o limite inicial dessa fase, enquanto a Organização das Nações Unidas - ONU considera os 60 anos o marco dessa fronteira. Considera-se, no entanto, que a velhice não

inicia em uma idade cronológica, nem ocorre de forma igual para todas as pessoas. Fruto de nossos hábitos e costumes, o envelhecimento é um processo individual e também se difere de época para época. Nos anos 40, por exemplo, era considerada velha uma pessoa de pouco mais de 50 anos de idade, já que a expectativa de vida da população brasileira era de 45 anos. Hoje, em 2020, essa expectativa de vida subiu para 76,5 anos, segundo o Instituto Brasileiro de Geografia e Estatística (IBGE).

Simone de Beauvoir alertava “Velho não é o outro” Na verdade, a velhice está inscrita em cada um de nós. Só assumindo consciente e plenamente, em todas as fases da vida, que nós também somos ou seremos velhos, podemos ajudar a derrubar os medos, os estereótipos e os preconceitos existentes sobre a velhice. (1990, p.348)

Temos desenvolvido através de nossas práticas na área da gerontologia, ações com grupos de idosos com momentos presenciais de escutas em grupo e consultas sociais, incluindo reuniões, rodas de conversa, palestras e dinâmicas grupais. Nessas ações, é possível evidenciar pessoas idosas com demandas diferentes e é notório em suas falas perceber que a grande maioria é engajada politicamente, fisicamente ativos, com muita autonomia, alguns ativos profissionalmente, com amizades e uma vida social repleta de festas de aniversário, passeios, excursões e participações em grupos de interesse.

Quando se trabalha com um grupo heterogêneo culturalmente falando e com realidades muito próprias que tiveram ou não oportunidades, graus de escolaridades, educação e religiões diferentes, é uma percepção preconceituosa da sociedade carregada de estigmas do que é ser velho, se torna visível a dificuldade em desenvolver um trabalho da percepção de sua velhice. Existem porém, diversas instituições com equipes preparadas e que oferecem serviços para esse segmento, hoje em nossos países, e que tornam-se referências para os mais velhos, sejam elas públicas ou privadas, sejam projetos, programas, associações, ONG's, que procuram dialogar e escutar as pessoas idosas sobre o seu envelhecer, procurando propor aspectos que visam colaborar com a qualidade de vida no processo de envelhecimento humano.

A heterogeneidade e as diversidades da velhice traduzem a diferença entre as pessoas e suas histórias de vida. É sabido que os velhos não são iguais e tendem a ser muito diferentes entre si. A partir de nossa realidade convivemos com pessoas idosas que se consideram velhas, outras que negam sua velhice se autodenominando jovens, analfabetas, semianalfabetas, com ensino fundamental ou ensino médio, com nível superior e bilíngue, católicos e evangélicos de várias denominações, espíritas e budistas, umbandistas e ateus, empregadas domésticas e empresárias, pensionistas e aposentados,

mantidos pela família e autônomos, solteiros e casados, divorciados e viúvos, com ou sem filhos, com ou sem netos e bisnetos, que moram só ou com seus filhos, muitos saudáveis e outros com muitas patologias, entre elas Parkinson e Alzheimer, convivendo harmoniosamente, buscando entender esse processo de envelhecer que é natural, porém de uma complexidade absurda.

O sujeito deve valorizar a si mesmo e obter o reconhecimento do grupo social. A identidade se consolida na percepção que tem o sujeito de seu poder sobre si, sobre os outros e sobre os acontecimentos. Logo, o sentimento de ser rejeitado, desvalorizado pelo grupo social pode atingir a imagem de si, em resumo, a identidade pessoal. Tudo se passa como se fossem as duas faces da mesma moeda: realidade objetiva e realidade subjetiva (Berger e Luckman, 1973).

No ano de 2000, quando iniciamos o interesse pelo estudo do envelhecimento humano, mesmo com muitos estudos e pesquisas na área, ainda assim, existia um “silêncio” em torno do tema velhice, em torno da palavra “velho”, a pronúncia dos termos para fase da vida e o sujeito que vivia essa fase, ainda era velado. Os termos 3ª idade, melhor idade, idosos jovens, nesse período e ainda nos dias atuais, parecem soar melhor. O nosso papel sempre foi, através de nossa fala, concepções e através de leituras dos nossos referenciais, “quebrar esse silêncio”. Para Simone de Beauvoir, devemos ouvir a voz dos velhos e ajudar a romper com a conspiração do silêncio que cerca a velhice. Para Ramos, o saber escutar a voz do outro é saber abrir-se, dispor-se a interpelação, ao clamor inquietante e que faz perigara vida de quem se empenha e exige justiça. (2012, p.207).

Quando se pergunta, qual fase você está vivendo? A segurança de se responder “a velhice” é absurdamente difícil, independente do trabalho que é desenvolvido e geralmente a resposta vem: vivendo “a melhor idade” da minha vida. Ana Carolina de Oliveira em seu livro “O desejo envelhece?” reflete sobre a expressão “melhor idade”, que vem sendo utilizada como substituição da palavra velhice, mas que se trata de um conceito equivocado, pois supervaloriza o idoso, exacerbando os ganhos e negando as perdas. (OLIVEIRA, 2012, p. 23).

Atualmente existem inúmeros termos para designar o período de quem vive mais tempo. Os outros termos das fases da vida como: infância, adolescência, juventude, adultez são bem aceitos e não trazem quase nenhuma carga de preconceito. O que há de errado no termo “velhice” para denominar a última fase da vida? Embora a velhice seja nada além do que um construto social, o preconceito continua florescendo. A idade é uma categoria embutida dentro dela mesma, é discutível e obsoleta. Enquanto todos os outros estágios da

vida são planejados e construídos social e culturalmente e não existem conflitos para eliminar a infância, a adolescência e a idade adulta do panorama do desenvolvimento humano, a velhice é colocada à margem (ANDREWS, 1999), pois ao mesmo tempo em que as pessoas querem viver muito, não querem ficar velhas nem se parecer com velhos.

Todas as vezes que uso essa frase para pessoas idosas, elas tomam um "baque", quando param e pensam que realmente é a última fase da vida. Ou existe outra após a velhice? Velho assusta! O envelhecimento assusta! No entanto, uma vez que é a fase final do organismo humano, faz com que as pessoas associem a sua chegada ao sinônimo de morte. Estar ou viver nessa fase não significa "parar no tempo" ou ter que esperar "a morte chegar", por esse motivo essa fase deve ser vivida de forma intensa, procurando estar ativo e integrado ativamente com movimentos e ações na sociedade, buscando conhecimento sempre (essa busca nunca se deve parar), novas amizades, relações intergeracionais, projeto de vida, com protagonismo, enfim, viver essa fase com perspectivas e possibilidades.

Neste sentido, fica a indagação, porque para muitos, esse período é o "melhor" de suas vidas? Essa pergunta também tivemos a oportunidade de fazer para as pessoas idosas do "Grupo Plenitude" as respostas estão: *tive infância e adolescência sofrida demais, trabalhei a vida inteira para ajudar meus pais, não pude estudar, minha vida foi cuidar de filhos e marido, os filhos cresceram e marido se foi, estou viúva, nunca tive dinheiro para nada, sempre fui do lar e nunca tive oportunidades.* No final de cada fala todas as respostas finalizavam com, *agora é que estou vivendo a vida.*

Sabe-se, portanto, que a sociedade busca mudar conceitos, principalmente em relação a velhice e ao processo de envelhecer. É sabido também que para alguns velhos, essa fase é sinônimo de sabedoria, experiência, reconhecimento e respeito principalmente no âmbito familiar. Para outros velhos (sujeito do processo de envelhecimento) essa fase significa incapacidades, enfraquecimento, perdas, redução da capacidade financeira, interrupção das atividades relativas ao trabalho (aposentadoria), como ser assexual.

Para Mannoni "a velhice nada tem a ver com a idade cronológica. É um estado de espírito. Existem velhos de 20 anos, jovens de 90" (1995, p. 16-17). Messy (1999) comentou que podemos ser velhos, nos vemos velhos, sem nos sentirmos jamais como velhos.

Porém, o que há de errado como o espírito velho? É muito comum, entre as pessoas idosas uma negação da sua velhice quando através de sua fala podemos observar: *sei que sou velho, mas minha alma é de um jovem, ou*

*ainda meu corpo é de velho, mas meu pensamento é de um jovem de 15 anos, não existe ninguém velho, velho é o mundo, não me sinto velho, só estou um pouco gasto.* Para Messy (1999), "pode-se envelhecer, tornar-se mais idoso no sentido cronológico, sem passar pela velhice; ela não seria inevitável ao termo da vida; pode se morrer aos 90 anos sem atravessar essa etapa".

Na velhice, como todo processo, cabe ajustes e acertos, mas sempre podemos reconstruir e ressignificar. Precisamos ser protagonistas de nossas próprias vidas. Cada dia mais, nos deparamos com uma sociedade velhofóbica, que cultua o "corpo jovem", ágil, produtivo e dinâmico. Mas percebe-se que para quem envelhece, esses aspectos da juventude já não têm tanta importância. Acreditamos que o velho é detentor de conhecimento, experiência e visão ampla do mundo, tendo condições de contribuir com sua experiência e conhecimentos acumulados ao longo dos anos para atividades e ações produtivas.

A imagem da velhice vem sendo considerada como algo ruim, porque representa a negação de valores até então cultuados e valorizados, como a beleza externa, a produtividade e o poder, valores considerados próprios da juventude, e, por isso, almeçados por muitos.

Entendemos que não existe "a velhice" e sim "as velhices". De acordo com Siqueira e Goldstein, "os velhos não só não são todos iguais, como também tendem a ser muito diferentes entre si. (2000, p.113) Ninguém envelhece igual. Quando falamos de pessoas, as experiências são individuais. Às vezes você constrói um longo caminho, mas de repente e surpreendentemente a vida pode dar uma reviravolta e o desfecho poderá ser outro, até mesmo de quem acreditava ter se preparado para o seu envelhecer ou sua velhice. São as nossas escolhas que garantirão a nossa autonomia futura.

O que precisamos garantir para termos um final de vida digno? Não existe uma receita pronta ou uma fórmula milagrosa, também não é nosso objetivo por aqui dizer como ter um envelhecimento bem-sucedido. Existem alguns fatores como: socioeconômicos, escolaridade e gênero que influenciam nesse processo.

Há de se perguntar: É possível, fazer o quê quando se é velho, numa sociedade que prestigia a juventude?

Enquanto profissional da gerontologia e professora, tenho estado a pessoas velhas, consequentemente escutamos diversos relatos e um desabafo de um aluno me chamou atenção quando dizia: *É! Não é fácil ser velho! Vamos perdendo a autonomia e cada vez mais, sendo dominados por nossos cuidadores.* (Curió, 63). Dessa forma, refletir acerca do significado do envelhecimento e velhice por meio dos

relatos dos idosos, provavelmente se faz urgente e necessário para assim darmos vez e voz às pessoas velhas e mais do que nunca estar atentos e prontos para escutá-los. A escuta deve ser respeitosa e deve ser incorporada nas ações dos profissionais que trabalham com esse segmento.

É comum depararmos-nos, em nosso país, com queixas de ceticismo e desesperança, quando acompanhamos ou cuidamos de pessoas idosas, que lamuriam a falta de perspectiva dessa etapa da vida. Nos é revelado das saudades de sua juventude, de sua falta de motivação para continuar vivendo, de sua “certeza” de que não tem mais nenhum papel a cumprir. Ao mesmo tempo, observamos outros idosos, aparentemente alegres e satisfeitos, que nos deixam a impressão de estarem vivendo de forma plena sua velhice. A idade não explica tais diferenças, pois ela, por si só, não discrimina entre os bem e os malsucedidos.

E o que querem os velhos? Essa pergunta fazemos quase que diariamente. As respostas são surpreendentes. Entre elas estão: *queremos ser respeitados, direito de ir e vir, ter autonomia, tomar nossas próprias decisões, fazer o que tenho vontade, ser livre, estar entre amigos, viajar, namorar, estudar, dançar, ser feliz, realizar meus sonhos*, entre outras. Sim, eles podem. Estão vivos! Muito comum entre as respostas também temos *agora que estou vivendo*.

Entendemos que as pessoas idosas são capazes de fazer suas próprias escolhas. Sugerimos então, vivê-las intensamente. Aos que desejam viver essa última fase da vida com suas dores e delícias, sugere-se fazer um projeto de vida, buscando conhecimento, incluindo-se em grupos de interesse, conectando-se com as questões da sociedade atual, apropriando-se de leis, despidendo-se de preconceitos.

Concordamos com Freire, no seu capítulo: *Envelhecer nos tempos modernos*, no livro “E por falar em boa velhice” quando diz que estudos na área da gerontologia têm sido realizados a fim de identificar e compreender as mudanças necessárias, tanto no que se pensa sobre o envelhecimento quanto na maneira como tratamos os idosos (2000, p. 131). A esse respeito, infelizmente ainda temos muitos profissionais que veem a velhice e o velho com preconceito e com projetos e propostas feitas “para eles” e não “com eles” sem realmente fazer uma escuta respeitosa e muitas vezes até subestimando a inteligência dos idosos.

Se faz necessário que os profissionais da área da gerontologia, estejam atentos aos aspectos referentes à prevenção, assim como para detectar os possíveis problemas nos aspectos biopsicossociais da velhice. Tais ações e planejamentos serão possíveis pela compreensão que a velhice não é uma concepção absoluta, na medida

em que o significado real das mudanças decorrentes do processo de envelhecimento é singular, como o modo de pensar, de agir e de questionar, passando pela interpretação de cada pessoa e como isto afeta a sua vida.

Acredita-se que o envelhecimento é um processo que está rodeado de muitas concepções falsas, temores, crenças e mitos. Os estereótipos negativos também são muito explorados. Alguns desses mitos relacionados a velhice, ainda cercam toda uma sociedade, entre eles estão: o velho não produz, a velhice é uma fase totalmente negativa, velho é feio, velho fede, velhice é doença, todo velho é surdo, velho é desmemoriado, todo velho é ranzinza, velho é igual criança, velho só serve para atrapalhar o trânsito, velho não aprende e ainda todo velho é teimoso e por esses e outros motivos o medo de encarar viver nessa fase da vida seja tão doloroso. Esses comportamentos e características não são exclusivos de pessoas idosas. A beleza por exemplo, assim como a velhice é um conceito efêmero e que muda de século para século. O conceito de belo hoje é muito diferente do século passado. Porque nas novelas, teatro, literatura, os jovens são sempre os “mocinhos”? Porque a fada sempre é uma bela jovem? E por qual motivo a bruxa no conto infantil é uma bruxa horrenda? Por qual motivo o “homem do saco” sempre será “o homem velho do saco”? Essas formas de discriminação já estão sendo vistas com outros olhares e gradativamente sendo combatidas com iniciativas diversas, ainda assim muito se tem a fazer. Vale ressaltar também que a imagem passada pelos meios de comunicação ainda afeta a autoestima dos idosos. Faz-se necessário uma conscientização da importância desses meios na constituição da velhice. Assim podemos quem sabe iniciar uma tentativa de mudar a visão que nossa sociedade possui do que é ser velho nos dias atuais.

Hoje, para uma parcela economicamente ativa da população idosa, existe um movimento de valorização, pois esta população está impulsionando mercados como o de turismo e serviços.

Os meios de comunicação, da forma como estão hoje inseridos em nossa vida, também têm um papel importante na construção desta terceira idade. A televisão e o cinema, particularmente, possuem um grande potencial para influenciar nos conceitos acerca da velhice. As parcelas da população mais influenciáveis são as crianças e jovens. Estes meios funcionam como um espelho da sociedade e contribuem para estabelecer ou validar modelos de comportamento. Porém o número de pessoas idosas que aparecem nos programas ou filmes não corresponde à realidade encontrada na sociedade. Neste caso a mensagem que pode estar sendo passada é de que o velho não é importante.



Segundo Ângela Mucida, “a velhice não é um amontoado de doenças. O surgimento de doenças não é determinante para se definir se um corpo é ou não velho.”(MURCIDA, 2006. p. 23). Há muitos meios de se prevenir doenças e preservar a saúde física e mental, é sabido que existem sim doenças que se manifestam na velhice, porém algumas são adquiridas na infância, se manifestam e se agravam ao longo da vida. A maioria das pessoas idosas não tem limitações, nem sua vida é negativa e dependente. Se continuarmos tendo uma sociedade que valoriza unicamente o vigor físico, com toda certeza o velho ficará em desvantagem. O importante em uma sociedade democrática é o respeito a este segmento, a sua história, sua experiência, conhecimento de vida, tudo isso em equilíbrio e intergeracionalmente falando em equilíbrio e a capacidade de inovação, criatividade, iniciativa e vitalidade dos jovens e adultos. A velhice não é uma etapa totalmente negativa como pensa a maioria das pessoas que “convivem” com velhos.

Mesmo nos dias atuais, o envelhecimento aparece associado a doenças e perdas, e é na maioria das vezes entendido como apenas um problema médico. Para Neri e Freire (2000), o envelhecimento ainda está ligado à deterioração do corpo, ao declínio e à incapacidade. “Na base da rejeição ou da exaltação acrítica da velhice, existe uma forte associação entre esse evento do ciclo vital com a morte, a doença, o afastamento e a dependência” (Neri & Freire, 2000, p. 8).

Existe um declínio natural desse processo de envelhecimento. Doenças naturais podem aparecer, mas doenças aparecem em qualquer fase da vida. O que fazer no tempo que temos? Viver a velhice enquanto estamos vivos. Porém, outros não suportam mais viver a velhice, como foi o caso do ator Flávio Migliaccio, que cometeu suicídio aos 85 anos e deixando um bilhete em que parte dele dizia: “*Me desculpem, mas não deu mais. A velhice neste país é o caos, como tudo aqui*”. Na Carta aberta de seu filho Flávio Migliaccio, nas redes sociais, contou que seu pai se incomodava com a velhice. “Ele sempre me dizia que não aguentava mais viver num mundo como esse e sentir seu corpo deteriorar-se rápida e irreversivelmente pela idade avançada. Pouco escutava e enxergava. *‘Daqui para frente só vai piorar’*, ele me dizia enquanto eu buscava todos os argumentos possíveis para lhe mostrar que ainda havia muita coisa boa reservada para ele”

A velhice começou a ser tratada como uma etapa da vida caracterizada pela decadência física e ausência de papéis sociais a partir da segunda metade do século XIX. O avanço da idade dar-se-ia como um processo contínuo de perdas e de dependência, que daria uma identidade de falta de condições aos idosos e seria responsável por um

conjunto de imagens negativas associadas à velhice (DEBERT, 1999).

## V. CONSIDERAÇÕES FINAIS

Diante disso, acreditamos na relevância dese ter um projeto de vida, um processo pelo qual o indivíduo veja a sua perspectiva para o futuro, na possibilidade de um bem-estar global. Um projeto de vida adequando-se a realidade atual, no ponto de vista de suas condições pessoais, orgânicas e econômicas. A este respeito, participar de grupos de idosos, talvez seja um espaço no qual os participantes sintam-se respeitados enquanto cidadãos, plenos de direitos e livres para expressar suas dores, dificuldades e carências.

Durante a formação de diversas rodas de conversas, com pessoas idosas, colocando em pauta diversos assuntos referentes ao envelhecer, entre elas uma em especial nos chamou muita atenção. O tema: projeto de vida, que teve uma pergunta chave para iniciar a conversa. O que você tem feito por você? Essa pergunta, os levavam a refletir que pouco fizeram ou faziam algo por eles mesmos. Entre as respostas pudemos observar que se alimentar bem, pagar um plano de saúde e fazer exercícios diários já eram suficientes. Outros desconfortáveis com a pergunta, descobriam naquele momento, que pouco tinham feitos por eles, e que os outros, os seus, sempre foram a prioridade e que fazendo pelo outro já estavam de uma certa forma fazendo o bem para si. Outros na oportunidade faziam muitos projetos para o futuro como: aprender uma nova língua, viajar, casar, voltar a estudar, aprender a dirigir, comprar sua casa própria, enfim. Nessas atividades grupais, é possível que pessoas idosas possam refletir de suas necessidades, superação dos novos desafios e possibilidade de novas conquistas.

Compartilhar o vivido no passado e trazer para o presente possibilita ao idoso compreender antigas experiências e modificar formas atuais de sentir e lidar com o dia a dia. “lembrar não é reviver, mas refazer. É reflexão, compreensão do agora a partir de outrora”. (Bosi, 1999 p. 20-21).

Nesse sentido, infelizmente vivemos em um período de muitas incertezas e cada vez mais frequente a chegada até nós de pessoas idosas diagnosticadas com depressão, ansiedade e síndrome do pânico. Todas elas vêm encaminhadas de seus psicólogos, psiquiatras e familiares que buscam uma melhoria da qualidade de vida dessas pessoas. O que eles buscam? A esse respeito, entendemos que buscam um lugar onde possam ser compreendidos sem julgamentos, que possam ser ouvidos, que possam relatar suas angústias e buscar possíveis soluções, e uma enorme força para superar sua dor, através de integração e socialização, atividades físicas,

identificação em algo prazeroso, tentativa do resgate de autoestima e autocuidado ou simplesmente uma conversa, atenção ou convivência respeitosa.

Ser velho e ter um lugar no mundo é possível a qualquer tempo e a qualquer momento. É fácil? Através dos relatos que temos obtido de escutas respeitadas e vivências diárias, posso lhe afirmar que não é. Porém, a prática do empoderamento precisa ser exercitada para que se viver a velhice seja no mínimo um período de dignidade. A tão incessante busca pela autonomia até o final nesta fase da vida, não procede de uma simples adequação, mas de uma adaptação permanente. Acreditamos que a velhice é complexa, cheia de nuances, como tantas outras fases de nossa vida.

Com base nisso, é possível dizer que a percepção da velhice já se modificou ao longo do tempo e na sociedade atual convive-se com os diferentes tempos. Definem o momento em que as pessoas são consideradas velhas. Desta forma, a velhice é uma fase da vida de construção cultural e social sempre sustentada pelo preconceito de toda uma sociedade que em sua maioria, quer ter vida longa, porém nega sua velhice e tão pouco querem ser velhos.

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# Quality analysis in the service sector of an electricity generating company according to Servqual's model

## Análisis de calidad en el sector servicios de una generación eléctrica empresa según el modelo Servqual

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**Keywords**— *Service quality, Servqual, Service management, Technological innovations, Multivariate analysis.*

**Abstract**— *Measuring the quality of service levels in self-service, rural and urban emergency services, as well as the wait time for a possible customer until connection offered by an electricity company continues as an objective, based on the perspective proposed by Parasuraman et al. (1985). In order to detect the sources of problems in service quality and seek improvement, this model is based on the principle of comparison between the perceived service and the expected service, considering that the expectations of customers is strongly influenced by their personal needs. The survey had participation from 2450 customers distributed in the 98 neighborhoods of the municipality, which were already familiar with the services provided, since, in the state of Paraná, this company is currently the only electricity utility to serve the population. To analyze the survey, dimensions related to Access, Efficiency, Receptivity, Ease of understanding, Flexibility, Customization, Privacy, Wait time for service, Trust and Security were considered. The perceived quality evaluation for these services was considered average for practically all dimensions. This study also presents a comparison between the ten dimensions evaluated and the method of the main components of factor analysis, responsible for extracting five new dimensions: Trust in the company, Flexibility in providing service, Ease of self-service, Security and Speed. And even though these new dimensions have significantly reduced the initial number of variables analyzed, there was no loss in relation to the importance of the services provided by the company.*

**Resumen**— *Medir los niveles de calidad de servicio en autoservicio, atención de emergencia rural y urbana, así como el tiempo de espera de un posible cliente hasta que la conexión ofrecida por una empresa eléctrica sigue el objetivo del estudio basado en la perspectiva propuesta por Parasuraman et Alabama. (1985). Para detectar las fuentes de problemas en la calidad del servicio y buscar la mejora, este modelo se basa en el principio de comparación entre el servicio percibido y el esperado, considerando que las expectativas de los clientes están fuertemente influenciadas por sus necesidades personales. La encuesta contó con la participación de 2.450 consumidores, distribuidos en 98 barrios del municipio, que ya conocían los servicios prestados, ya que, en el estado de Paraná, esta empresa es actualmente la única concesionaria eléctrica para atender a la población. Para el análisis de la investigación se consideraron las dimensiones relacionadas con Acceso, Eficiencia, Receptividad, Facilidad de comprensión, Flexibilidad, Personalización, Privacidad, Tiempo de espera para el*

*servicio, Confianza y Seguridad.*

*La valoración de la calidad percibida de estos servicios se consideró media para prácticamente todas las dimensiones. Este estudio también presenta una comparativa entre las diez dimensiones evaluadas y el método de los principales componentes del análisis factorial, responsable de extraer cinco nuevas dimensiones: Confianza en la empresa, Flexibilidad en la prestación del servicio, Facilidad de autoservicio, Seguridad y Velocidad. Y aunque estas nuevas dimensiones han reducido significativamente el número inicial de variables analizadas, no hubo pérdida en relación a la importancia de los servicios prestados por la empresa.*

**Keywords—** *Calidad de servicio, Servqual, Gestión De Servicios, Innovaciones tecnológicas, Analisis multivariable.*

## I. INTRODUCTION

The advance of local and international competition, resulting from the globalization of the economy and coupled with the instability of the socio-economic environment, has been growing at an accelerated rate in recent decades. These changes impel practically all organizations (public or private, large or small, that aim or not to profit) to search frantically to obtain and maintain an important competitive advantage by Manzi (2019).

As the competitiveness between the companies becomes more fierce, analysis of the factors that contribute to the maintenance and conquest of markets becomes essential (CALICCHIO; MARCONDES, 2016). Therefore, measurement and analysis of the service provided to consumers and potential customers is essential, since perception and concern on behalf of customers about the quality of service is what ensures the company's success in the market where it operates.

Service quality is, therefore, a factor of strategic relevance for the company and should be measured and analyzed, especially considering its growing relevance in an increasingly competitive context (SANJEEV BORDOLOI, 2019).

For companies, monitoring the evolution of the market has resulted in a growing concern with the quality of the service (the risk of loss of competitiveness is recognized, with consequences that are never negligible, resulting from the neglect of this aspect). At the same time, companies seek to rationalize investment in quality control and/or improvement activities, in order to ensure a favorable cost/benefit ratio.

In this context, the translation of the basic concepts of Total Quality in developing technical and human skills constitutes one of the main actions adopted by organizations in the search for sustainable competitive advantages. Recognition of the fact that the role of each individual is to receive the work of others, add value to it and provide it to the next person in the process (FERNANDES; LOURENÇO; SILVA, 2014) and, thus, enable the delivery of the product in accordance with the demands of the final consumer, increases the need to

promote and develop human resource skills and values. This need is common to organizations in general, including those in the area of electricity (KHARUB; MOR; SHARMA, 2019). The electricity service sector is constantly undergoing major changes, always focused on customer satisfaction (DROSOS *et al.*, 2020). This phenomenon favors increased competitiveness and the constant search for new guidelines so that companies can achieve success in their journeys. To be successful in the new economy, a history needs to be created, it has to be a place where the customer likes to be, to choose and to buy from.

In the last few years, companies in the electricity sector have been trying to understand their own customers in order to be able to serve them better and, consequently, build customer loyalty over time. This loyalty comes from perfecting the services provided to customers and, mainly, through the forms of access available to customers for these services (LINDEN, 2016). These innovations in forms of distribution go through various types of solutions, some that significantly reduce the direct costs of operating services, and others, more remote, that can reach customers wherever they are (ENGLAND, 2015; LEE, T. B., 2018).

Knowing what customers, enlightened consumers, value in quality service provided that meets their minimum quality standards, and knowing their tolerance levels for the services provided is paramount so that services are increasingly provided under their point of view to add value to the customer (FARAH *et al.*, 2006).

In this new scenario of increasingly sophisticated services, a closer approach to each customer is essential through a careful analysis of their individual behavior and peculiarities. And the result of this deeper investigation serves to guide segmented and personalized actions, according to what customers think and value in having electricity services provided (LI *et al.*, 2020).

Measuring the quality of service levels in self-service, rural and urban emergency services, as well as the wait time for a possible customer until connection offered by an electricity company continues as an objective, based

on the perspective proposed by Parasuraman et al. (1985), *Service Quality Gap Analysis*, one of the first methods to take the expectations of customers in relation to a given service into account. In order to detect the sources of problems in service quality and seek improvement, this model is based on the principle of comparison between the perceived service and the expected service, considering that the expectations of customers is strongly influenced by their personal needs.

## II. MATERIAL AND METHODS

Aiming at the search for savings, time, data reliability and operability (BARBETTA, 2014) this work opted for inferences about the population of a city in the countryside of the State of Paraná, using probabilistic sampling. According to Ross (2019), this technique allows the maximum acceptable sampling error to be determined.

The sampling plan of this survey was *simple random sampling*, with allocation of the sample size

proportional to the size of the population (FÁVERO; BELFIORE, 2017; MINGOTI, 2007) resulting in a sample corresponding to 3.047% of the total user population of the services provided by the energy company, in other words, 2450 respondents. The fieldwork for data collection was carried out between February 17 and March 26, 2020 and included face-to-face methods.

To determine the indicators for evaluation the quality of service provided by the energy company, the dimensions were checked according to the construction of a specific questionnaire adapted to the language of the services provided by the company.

Initially, two specific questions were prepared for each dimension, but as the idea would be to contemplate only ten dimensions in the survey instrument applied to users of the services provided by the company, it was necessary to assign three specific questions to the privacy dimension and three specific questions to the wait time for service dimension, since the questionnaire was organized containing twenty-two questions, as shown in Table 1.

Table 1 - The main dimensions proposed by Parasuraman et al. (1985)

Dimension	Questionnaire stimuli
Access	1. Ability to locate self-service stations. 2. Ease of accessing self-service.
Efficiency	3. Certainty of trust in self-service. 4. Simplicity of use.
Receptivity	5. Quick service response. 6. Ease of getting information.
Ease of understanding	7. Ability to interpret easily. 8. Adaptation to customer preferences.
Flexibility	9. Recognizes and adapts to your usage history. 10. Offer consumer manual to meet customer needs.
Customization	11. Quality in billing. 12. Ability to simulate rates and allow the total price to be determined.
Privacy	13. Ability to compare the service provider's products and services. 14. Provides personal information protection. 15. Clarification meetings with customers.
Wait time for service	16. Average emergency service time - urban. 17. Average emergency service time - rural. 18. Average time of possible customer until connection.

Trust	19. Ability to solve your needs. 20. Service accuracy.
Security	21. Trust in connecting with the website. 22. Simplicity and security in clarifying doubts about the services provided by the company.

Source: Prepared by the authors (2020).

The questions were designed with the aim of portraying the concept of each dimension proposed by Parasuraman et al. (1985) as much as possible using a language appropriate to the services provided by the energy company, object of this work.

For eight dimensions, two questions were developed and for two dimensions, three questions were developed. For the access dimension, two stimuli were used, one referring to the ability to locate self-service stations and another that observes the ease of accessing self-service (LEE, T. B., 2018; LEMON; VERHOEF, 2016). The two incentives related to the efficiency dimension included the confidence that customers have in accessing self-service and the ease (whether it is simple or not) in using it. For the receptivity dimension, two stimuli were used, one related to the quick response in the service and the other related to the ease of getting information. The stimuli related to the ease of understanding dimension sought to portray the ability to easily understand and adapt to customer preferences. For the flexibility dimension, questions were used regarding the recognition and adaptation to the history of use and the options for searching for information through a consumer manual (SON; HA; KHUYEN, 2018). The questions related to the customization dimension were designed to evaluate the quality of billing and the provider's ability to allow comparisons between products and services and provide customers with rate simulations to determine the total price. For the privacy dimension, three stimuli were used: one related to the ability to compare products and services, another for the protection of personal information and another for the clarification meetings with customers (LEE, J. et al., 2013). The Wait time for service dimension was also addressed with three issues related to the average time in urban emergency service, the average time in rural emergency service and the average wait time of a potential customer until connection. In order to evaluate the trust dimension, stimuli were used regarding the ability to solve customers' needs and the accuracy of the services provided by the company's electricians. Finally, for the security dimension, two questions were prepared that dealt with trust in connecting to the company's website and simplicity and security in clarifying doubts regarding the services

provided (KHADEMLOO; MOOSAZADEH; KHOSRAVI, 2019).

After structuring the 22 questions, the data collection instrument was designed according to four aspects:

*Introduction.* This aspect was characterized by presenting what the questionnaire intended to evaluate, as well as the name of the respondent, the neighborhood to which they belonged and the date of the interview. This first step also includes an explanation of the rules for the correct completion of the questionnaire, in a clear and precise manner.

*Frequency of use of services provided by the company.* In this second aspect, we sought to identify the degree of proximity of the customer to the services available by the service provider company and their degree of use. It is worth mentioning that option 6 (do not use) was included, which would serve as a filter, since the preamble already stated the condition that the respondent had used the services at least once (PARASURAMAN; BERRY; ZEITHAML, 1991). According to Bitner et al. (2008), this proximity to the evaluated services is indispensable for the customer to be more certain about the positive and negative aspects resulting from the transaction.

*Customer evaluation of the dimensions of the quality of services provided by the company.* This aspect can be characterized as the culmination of the survey, as it was there that the respondent was able to measure the performance levels of the services offered by the company according to their expectations, which were verified under two approaches (LEMON; VERHOEF, 2016; MAHMOUD; HINSON; ANIM, 2018). The first approach considered the minimum level of service performance, in other words, the service considered adequate by the customer. The second approach considered the level of performance actually desired. As the questionnaire was prepared containing twenty-two questions and in the format of three columns, these two stimuli also started from the focus given to the dimensions of Servqual's model, already reported in more detail. As the columns used the nine-point *Likert* scale, varying from "low" to "high", the third column that focused on the perception of

the service provided had to contain the option “don’t know”, predicted by Parasuraman et al. (1985) for cases in which the customer did not want or could not comment on the performance of the service provided in that specific stimulus.

*Personal data.* In this last aspect, the profile of the respondents was established through identification of demographic variables (KOTLER, 1998; KOTLER; AMSTRONG, 2008) such as sex, education level, income range and age.

### III. RESULTS AND DISCUSSIONS

After a final cleanse, the data collection instrument was reproduced and distributed to potential users of the services provided by the energy company.

In the data tabulation, each column gave rise to a 2350x22 dimension matrix (two thousand three hundred and fifty lines per twenty five columns). The matrices will be referred to from then on by the MA (minimum acceptable) matrix, MD (maximum desirable) matrix and NP (perceived level) matrix, reflecting the expectations of users in relation to the levels considered. In order to relate

the service quality measures proposed by Parasuraman (ZEITHAML; BERRY; PARASURAMAN, 1996), the difference between the NP and MA and NP and MD columns was made and the quality perceived by the user was obtained through the column of the perceived service and the appropriate service (NP-MA), characterized as MAS, or even, measure of adequacy of the service (PARASURAMAN, 2002; PARASURAMAN; BERRY; ZEITHAML, 1991; ZEITHAML; BERRY; PARASURAMAN, 1996). On the other hand, the desired quality was obtained through the column of the perceived service and the desired service (NP-MD), characterized as MSS, or even, a measure of service superiority. As the matrix referring to the perceived level (NP) is in the do not know option, and this would also affect the subtraction between the matrices, so it was decided to first determine the average among the respondents who assigned scores to the services and then make the replacement through this column, since of the 51700 responses obtained by the sample, 27%, or 13959 did not evaluate the services provided by the company, while 37741, or 73% evaluated these same services. To have a better view of the number of unanswered questions, as shown in Figure 1.

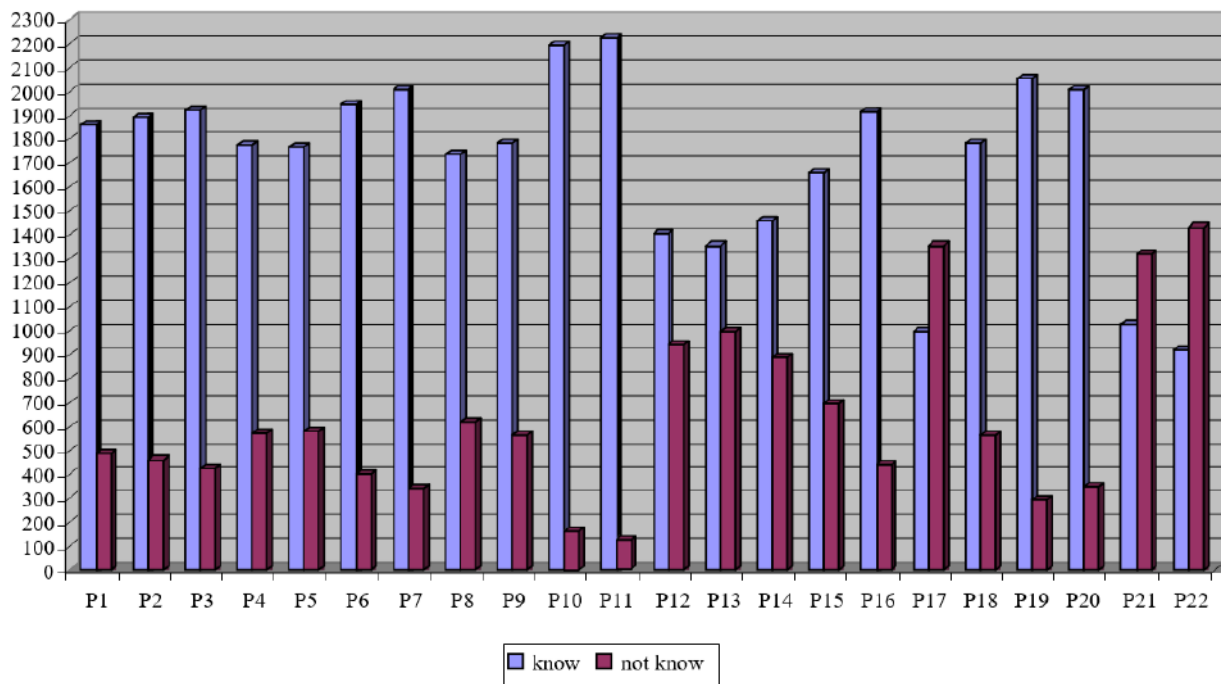


Fig.1: List of accepted and unaccepted responses

Source: Prepared by the authors (2020).

It is important to note that the respondents were very knowledgeable about the services provided by the company in relation to explanatory manuals provided and the quality provided in billing. On the other hand, services

provided online proved to be quite ineffective, in other words customers are unaware of the advantages of accessing the company’s website and obtaining useful information.

To analyze the frequency of use of the services provided by the company and the demographic data obtained in the application of the questionnaires, a Matlab R12 17.0 software program was also developed, which, in addition to providing the percentage of each item considered, also presented the graphical analysis representation of all aspects considered, facilitating interpretation and minimizing the analysis time of the service.

Thus, according to the completion of the second aspect related to the frequency of use of services provided by the company, it was observed that the highest rate of use of services was with the variable “less than once a month”, which reached 40% of the frequency and “don’t use” with 30%. Together, they made up a total of 70% of respondents, as shown in Figure 2. Such percentages indicate that there is no great need to use the services provided by the company in shorter periods, since the respondents pointed out that there are no constant power outages or any other problem that requires technical assistance from electricians.

The analysis also suggests that only 1% of respondents marked the option “once a week” and 2% marked the “once every fifteen days” option. It is

important to highlight that a total of 14% mentioned using the company’s “daily” services, which means they are using online and self-service services to keep themselves more informed, as shown in Figure 2.

Regarding the fourth aspect of the information obtained in the questionnaire area, where the respondent’s identification information is found, in other words, the information capable of allowing its characterization according to demographic data. First, the result of the frequency of use by gender of the interviewee is observed. The results show that the number of male respondents, 41%, was lower than that of women, 59%.

The reason women are the biggest users of services is due to the fact that they are closer to the problems related to the service and maintenance of their homes, since they are more dedicated to domestic work than to external work. The educational level variable was divided into five groups: first grade, second grade, higher education, incomplete higher education and post-graduation. The highest concentration of respondents (46%) is in the high school segment and that, of the total of 2350 respondents, 32% have only finished elementary school.

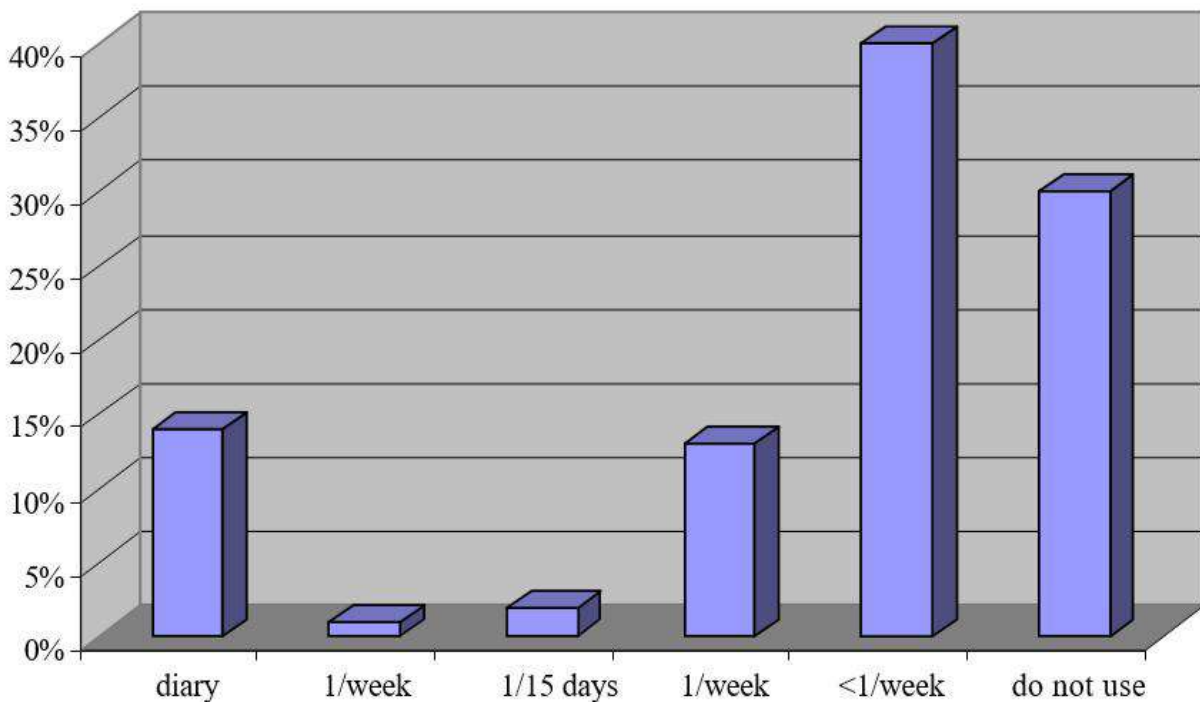


Fig.2: Frequency of use in services

Source: Prepared by the authors (2020).

Likewise, the percentage of respondents in the postgraduate segment is not important, as it accounts for only 2% of the segment’s total. Customers in the

incomplete higher and complete higher education segments total just 20%, which leads to the belief that customers with a higher level of education are also less



frequent users of self-service and online services. The results shown reflect the country's education: few manage to enter higher education and complete it according to their expectations. Even less is the number of people who are specialized in an area. Another major problem identified is related to the respondents' income, which were divided into six groups: (1) up to R\$ 1500.00, (2) between R\$ 1501.00 and R\$ 2500.00, (3) between R\$ 2501.00 and R\$ 3500.00, (4) between R\$ 3501.00 and R\$ 5000.00, (5) between R\$ 5001.00 and R\$ 10000 and (6) over R\$ 10,000. It was found, in this section, that a large number of people concentrated in the lower income brackets, in other words, of the total of 2350 respondents, 1974 receive monthly salaries below R\$ 1500.00, and among those interviewed 0% receive income above ten thousand reais and 0.04% earn between five and ten thousand reais.

But even in the lowest income bracket, below R\$ 1500.00, the frequency of use of the company's services is relatively high, as the interviewees stated that they use the services at least once a week or even every fifteen days. It should also be noted that many respondents, despite having an income below R\$ 1500.00, made a point of showing the exact amount they receive monthly: of the 1974 respondents who are in this group, 1300 receive something just around R\$ 1000.00.

The analysis of the last demographic data, age, shows that this variable was distributed in five age groups, with intervals of ten years. The first group includes people up to 20 years old and the last group includes all people over 50 years old.

There is a concentration of the sample in the age group between 31 and 40 years old, with 31% of respondents, followed by the group between 21 and 30 years old, with 26%. The age group above 50 years old had the second smallest representation of the sample, behind only the group up to 20 years old. Although the survey was carried out at times that did not coincide with

lunch and dinner, when there is the highest concentration of people in their homes, it can be seen that the highest attendance of people at home is concentrated in the age group of 31 to 40 years, with 734 people from the total interviewed.

The results verified for the group with less representation in the sample, people under 20 years old, demonstrate that even in this age group, the youngest, are not home as often in relation to the rest of the sample, which certainly proves that, the older you are, the more difficult it is to get a job. In addition, it must be considered that the 14% of respondents over 50 years old already receive their pensions or have some health problem that prevents them from working.

### 3.1 Analysis of the dimensions of the quality of services provided by the company

As the quality of the services provided by a company can be considered as the difference between the expectations that customers have of the service performance, both for the service itself and for the perceptions of the service received (BITNER; OSTROM; MORGAN, 2008; LEMON; VERHOEF, 2016; MAHMOUD; HINSON; ANIM, 2018), its measurement is obtained through the difference between the desired and the observed score. And from this difference, the idea of service superiority can be detected, considering that the first two columns (Table 2), acceptable minimum and desired maximum, define a limited range between them, the so-called tolerance zone, where the evaluations considered within the limits established for the quality must be found, according to the expectations of the users (PARASURAMAN; BERRY; ZEITHAML, 1991).

In this sense, Table 2 presents the score for each of the twenty-two questions, now called variables, that evaluated the quality of the services provided by the Paraná energy company and which have already been mentioned during the development of this work.

Table 2 - Average scores for MA, MD and NP matrices

Variables	Minimum accepted	Maximum desired	Perceived level
v1	4.2983	7.5557	5.6632
v2	4.2362	7.4774	5.5972
v3	4.4574	7.4911	5.7060
v4	4.4757	7.5745	6.2053
v5	4.5055	7.5889	6.0678
v6	4.4740	7.5221	6.2894
v7	4.4728	7.4681	6.4643
v8	4.4333	7.4434	6.0738

v9	4.2945	7.4004	6.1156
v10	4.3915	7.5715	6.5847
v11	4.6864	7.8498	6.7470
v12	4.2979	7.3647	5.9015
v13	4.2353	7.3263	5.8157
v14	4.5919	7.5987	6.3820
v15	4.2334	7.2664	5.8312
v16	4.7468	7.6906	6.1699
v17	4.5770	7.8102	5.7138
v18	4.4813	7.5774	5.9066
v19	4.4566	7.5047	6.5981
v20	4.6481	7.5962	6.9036
v21	4.1887	7.4260	6.1210
v22	4.0800	7.4562	6.0894

Source: Prepared by the authors (2020).

The variables involved in the evaluation were quoted below the acceptable minimum, since there was no coincidence of levels in any variable, as can be seen in Figure 3.

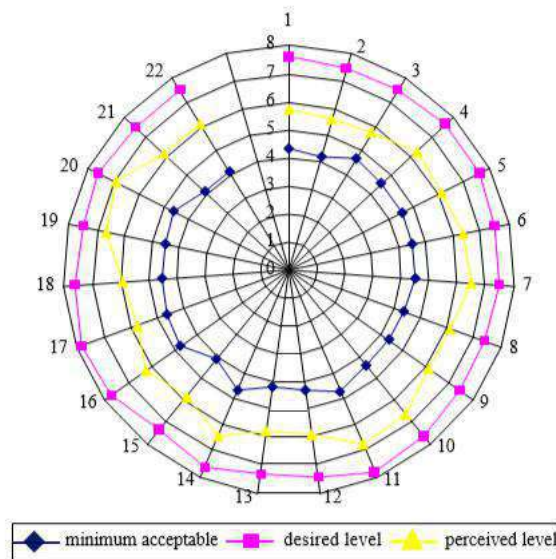


Fig.3: Mean scores for MA, MD and NP matrices

Source: Prepared by the authors (2020).

Prior to the analysis of the information according to each variable, it is important to present the basic statistics on the evaluation levels of the variables: the average of the scores attributed to the minimum level is 4.4083; the desired level is 7.5255; and the perceived level

is 6.1340 (Figure 4). Considering that the average of the nine-point Likert scale is 5, then users have a high degree of expectation in relation to the services provided by the company(CHEN et al., 2017).

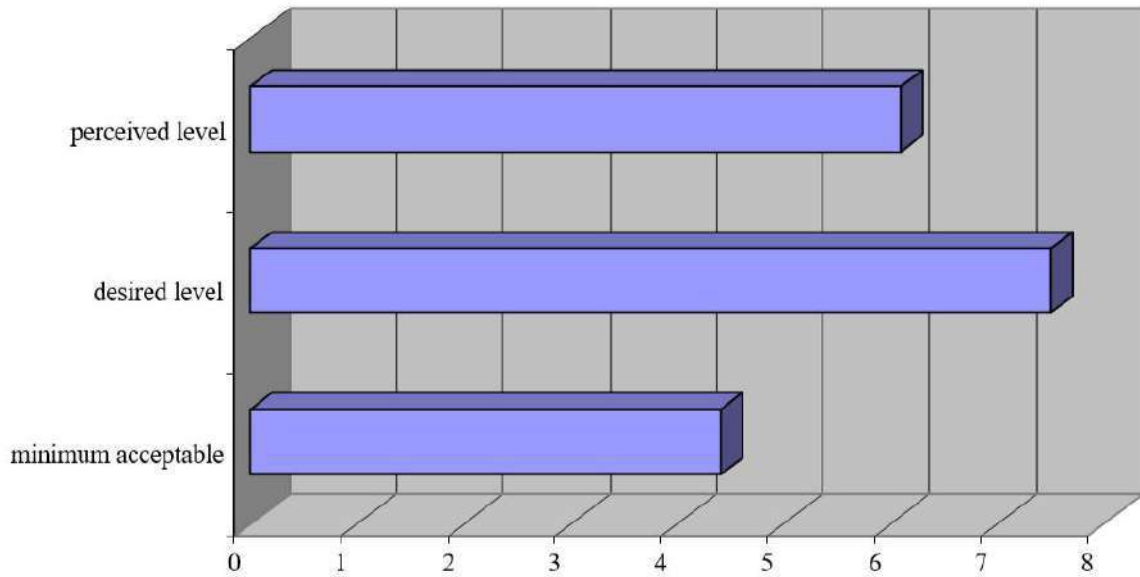


Fig.4: Average scores obtained by variable

Source: Prepared by the authors (2020).

From this information, it is possible to establish the tolerance zone for each of the surveyed variables. This tolerance zone, according to Parasuraman et al. (1994), has what the customer believes can be done, or that the service provider would be able to do, as limits. This constitutes the level of quality desired by the customer and what the customer is willing to accept, in other words, the minimum level of acceptance (PARASURAMAN; ZEITHAML; BERRY, 1994).

Comparing the score obtained in the perceived level fields, desired level and minimum level for each dimension, as shown in Table 5, it can be noted that the ease of clarifying doubts on the company website variable, with index 4.0800, was the one that had the lowest score in the field corresponding to the minimum expected service level, while the variable with the highest demand for the same field was related to the average wait time for urban emergency service variable, with an index of 4.7468.

On the other hand, in the analysis of the notes of the desired service, in other words, the one with the highest degree of expected quality, the quality in billing variable appears first, with an index of 7.8498, followed by the average wait time for rural emergency service variable, with a 7.8102 index (the maximum possible amount being 9.0000).

In the quality in billing variable, a problem arose during the application of the questionnaire in the neighborhoods of city. Several people, when answering

the questionnaire, asked about the service provided by the meter readers. However, it should be mentioned that this service was not part of the twenty-two variables analyzed, since it is a service that is outsourced by the company. However, in order for the company to become aware of this problem, a second questionnaire was prepared only containing questions related to the service provided by the meter readers. 10 neighborhoods in the city were randomly chosen and 20 people from each neighborhood were interviewed. The results are presented in Table 3.

Table 3 - Outsourced service of the meter readers

Neighborhoods	a) Incorrect reading	b) Correct reading
Neighborhood 1	8	12
Neighborhood 2	10	10
Neighborhood 3	8	12
Neighborhood 4	8	12
Neighborhood 5	12	8
Neighborhood 6	9	11
Neighborhood 7	8	12
Neighborhood 8	10	10
Neighborhood 9	10	10
Neighborhood 10	10	10

Source: Prepared by the authors (2020).

In general, correct reading, characterized by

marking consumption and delivering the invoice by mail, took place in five neighborhoods. Incorrect reading, characterized by the consumption marking made by the meter readers only passing in front of the customers' house and not having contact with the meter, happened only in one neighborhood. This neighborhood showed the need for a second study. For the other neighborhoods analyzed, the amount remained practically the same for both readings, correct and incorrect. It is clear that it is important for the company to be aware of this fact and to verify what the factors are that lead the outsourced service of the meter readers to be performed incorrectly (CHEN *et al.*, 2017; LEMON; VERHOEF, 2016).

Resuming the analysis of the dimensions, in relation to the customers' perception of the services provided, in other words, the level of quality observed by the customers, it can be noted that the evaluations with lower indexes were related to the ease of accessing self-service variable, with a score of 5.5972. In turn, the variable best evaluated was accuracy of electricians' external service, with a score of 6.9036 (out of a maximum of 9.0000). This demonstrates that the body of local electrical technicians is very good, but there is room for improvement (ZEITHAML; BERRY;

PARASURAMAN, 1996).

Figure 5 shows the discrepancy observed between the *Perceived Service* and the *Desired Service* and between the *Perceived Service* and the *Minimum Adequate Service* for each of the variables. For MSS (NP-MD), the negative indices represent the distance found between the perception of the quality of a dimension and the maximum desired for it. No variable received a positive index, in other words, no variable was evaluated as having a higher measure of service. It is also observed that the worst evaluations were for the variables average wait time for rural emergency service (-2.0964) and consumer manual (-1.9868). As for MAS (NP-MA), the discrepancies capture how far a service is from being adequate, which Parasuraman (2002) called "a measure of the adequacy of the service." It is observed that all variables were evaluated as adequate to the minimum level of service expected by the respondents. For these variables, positive service adequacy measures were established, in the following order: accuracy of the electricians' external service (2.2555), consumer manual (2.1932) and ability to solve their needs (2.1415) (PARASURAMAN; BERRY; ZEITHAML, 1991).

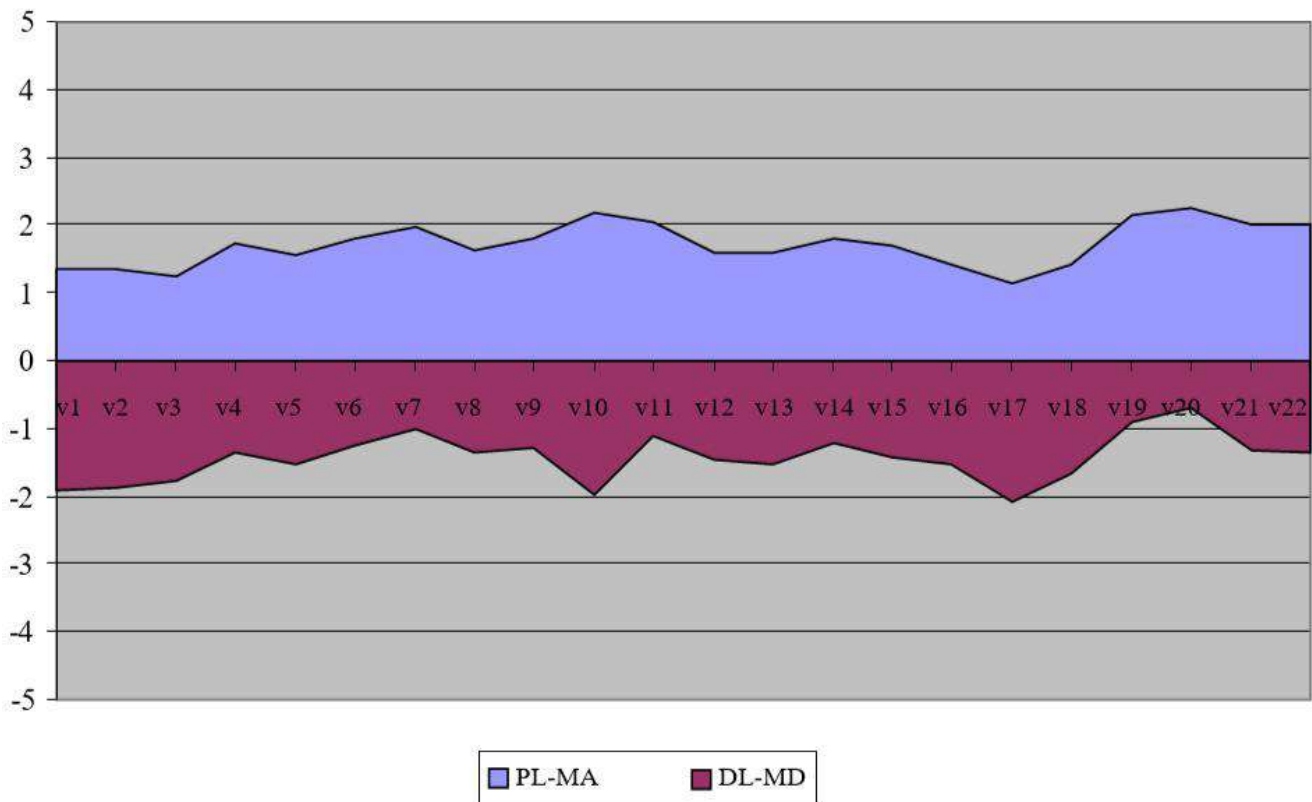


Fig.5: Scores of the differences: NP-MA and NP-MD

Source: Prepared by the authors (2020).

It is observed in relation to the tolerance zone identified for each variable, in other words, the interval between what the customer expects as the minimum adequate for the services and what they really want, the measure can be measured (PARASURAMAN; ZEITHAML; BERRY, 1994) through the difference between the MD and MA matrices of each variable in this study.

The sizes of these zones suggest the customer's willingness to tolerate different levels of quality for the same dimension (PARASURAMAN, 2002; PARASURAMAN; BERRY; ZEITHAML, 1991; ZEITHAML; BERRY; PARASURAMAN, 1996). Here,

the smaller the measurement, the lower the customer's tolerance for variations in service quality, and the greater the measurement, the greater the acceptance of variability in services without loss of quality. It is observed that the variables with the highest tolerance zones are, in order: ease of answering questions on the company's website (3.3762), online access for customers (3.3071), self-service stations (3.2574) and ease of accessing self-service (3.2412). The variables that have the smallest tolerance zones are, in order: average wait time for urban emergency service (2.9438), accuracy of the electricians' external service (2.9481) and need of little information for understanding (2.9953).

Table 4 - Adequate, desired and perceived score by dimension

Dimensions	Questions	Minimum accepted	Maximum desired	Perceived level
Access	P1	4.2983	7.5557	5.6632
	P2	4.2362	7.4774	5.5972
Efficiency	P3	4.4574	7.4911	5.7060
	P4	4.4757	7.5745	6.2053
Receptivity	P5	4.5055	7.5889	6.0678
	P6	4.4740	7.5221	6.2894
Ease of understanding	P7	4.4728	7.4681	6.4643
	P8	4.4333	7.4434	6.0738
Flexibility	P9	4.2945	7.4004	6.1156
	P10	4.3915	7.5715	6.5847
Customization	P11	4.6864	7.8498	6.7470
	P12	4.2979	7.3647	5.9015
Privacy	P13	4.2353	7.3263	5.8157
	P14	4.5919	7.5987	6.3820
	P15	4.2334	7.2664	5.8312
Wait time for service	P16	4.7468	7.6906	6.1699
	P17	4.5770	7.8102	5.7138
	P18	4.4813	7.5774	5.9066
Trust	P19	4.4566	7.5047	6.5981
	P20	4.6481	7.5962	6.9036
Security	P21	4.1887	7.4260	6.1210
	P22	4.0800	7.4562	6.0894

Source: Prepared by the authors (2020).

In Table 4, the questions are grouped according to their respective dimensions proposed by Servqual's model. In it, it is possible to verify the indicated indexes, in each

one of the twenty-two questions used in this work, to verify the perceived quality (that is the perceived level column) and the level of the customers' expectations of the

services provided by the company, both the desired level and the minimum level of adequacy of services (PARASURAMAN; ZEITHAML; BERRY, 1985; PARASURAMAN; BERRY, 2004).

### 3.2 Relative importance of dimension analysis

In the applied questionnaire, respondents were

asked to assign a degree of importance to each of the twenty-two questions mentioned above, analyzing the appropriate service, the desired service and the perceived service. Now considering only the expectations of customers, as this is the main objective to achieve the quality of a service, the questions were grouped according to the dimensions initially proposed, as shown in Table 5.

Table 5 - Indicators of Servqual's model for the ten dimensions

Dimension	Minimum accepted	Maximum desired	Perceived level
Access	4.2667	7.5166	5.6302
Efficiency	4.4666	7.5328	5.9557
Receptivity	4.8989	7.5555	6.1786
Ease of understanding	4.4531	7.4558	6.2691
Flexibility	4.3430	7.4860	6.3592
Customization	4.4922	7.6073	5.8586
Privacy	4.3169	7.3971	6.0096
Wait time for service	4.6017	7.6927	5.9301
Trust	4.5524	7.5505	6.7514
Security	4.0994	7.4411	6.1052

Source: Prepared by the authors (2020).

From the analysis of this table, it appears that the respondents attribute a greater importance of expectations to the dimension that relates to wait time for service (7.6927) and also to that dimension they attributed a higher score to the adequacy of the service (4.6017), in relation to the others dimensions. In relation to the perceived service, the highest score was given to the Trust dimension (6.7514). However, as can be seen, the differences do not appear to be large, and to prove this statement, it was applied to Manova. Specifically, at Manova, the Bartlett test was used (HAIR, J. F. J. *et al.*, 2009; HAIR, J. F. *et al.*, 2009). Then, for each of the ten dimensions, the null hypothesis of the dimensions having the same relative importance was tested. This was done for each of the variables in the ten dimensions represented by vectors corresponding to the adequacy of the service (MA), the expectations of the customers (MD) and the perceived service (ND). And, as mentioned earlier, these ten dimensions emerged from the grouping of twenty-two questions according to the proposal of Parasuraman et al. (1985).

To check whether the null hypothesis would be accepted or not, Manova was used in the Statistica 12.0 software. The program provided the  $p$ -values 0.4872,

0.0845 and 0.1066 for the matrices MA, MD and NP, respectively. The greatest variation occurred in the MD matrix, where the  $p$ -value was 0.0845. If the  $p$ -values were lower than the cut-off value of 0.05, it would be necessary to identify which components would be significantly different from the null hypothesis vector. Regarding the test statistics, as is well known, the Bartlett test with  $n = 22$  and the Fischer test with  $p = 1$  and  $k = 10$  were applied. Thus, for all vectors, the theoretical value was greater than the statistic, which proves the non-rejection of the null hypothesis that all means are equal (HAIR, J. F. J. *et al.*, 2009). Arranging the data of the vector of customer expectations in relation to the twenty-two questions, grouped in the ten dimensions already foreseen, the previous result is confirmed, in other words,  $H_0$  is not rejected at a significance level of 5% because the theoretical value 32.7 is greater than the value of the 8.6830 statistic. This result occurred in the arrangement of the data for the adequacy of services and perceived services vectors.

### 3.3 Factorial analysis of Servqual's gap

So far, Servqual's model has not been called into question, it has been considered as correct. Then, using the Statistica 12.0 software, Cronbach's alpha coefficient was

extracted to verify the consistency of the questions and it was concluded that the dimensions proposed by Zeithaml et al. (1996) are adequate to the data, in other words, the values obtained for Cronbach's alpha show great internal consistency, indicating a high homogeneity and equivalence of responses to all items (HAIR, J. F. J. et al., 2009). For the minimum, desired and perceived levels, the coefficients indicate indices in the amount of 0.9629, 0.9702 and 0.9450, respectively. Also, the total item-score correlation indexes obtained are acceptable, in other words, for the minimum, desired and perceived levels, the indices showed 0.5466, 0.6003 and 0.4437, respectively, satisfying the minimum criterion of 0.2000 considered for that instrument. This means that the levels have a good level of discrimination, which allows the presence of homogeneity between the items that make up the instrument to be confirmed. Furthermore, if any variable indicates little functional equivalence between the response of that item and the response obtained in the total scale, it can be eliminated by observing the lowest values for the total item-score correlation index.

It was also verified if the five dimensions proposed by Zeithaml et al. (1996) are similar to the ten that were determined for this study. However, it is important to mention that the factor analysis was performed in the measure of superiority of the service (MSS), considering that this is the main difference for the company to check its quality in relation to its services

provided. Applying factor analysis, extraction of the main components took place using a specified proportion of the variance ( $\lambda = 0.6$ ), and the explained variance of all components was considered to be greater than 60%. In addition, a maximum number of factors equal to five was also set and after Varimax Rotation, there were factorial loads (HAIR, J. F. J. et al., 2009; HAIR, J. F. et al., 2009). Looking at Figure 6, the proportion of variance explained by the first factor, which is 51.8%, by the second factor, which is 5.9%, by the third factor of 4.6%, by the fourth factor of 3.7% and the fifth factor of 3.1%, totaling an explanation of the variance of 69.1%. Thus, the F1 factor presents the largest factorial loads for variables 11 to 15, which are those defined to evaluate the dimensions conceived as customization and privacy. The F2 factor has greater factorial loads in variables 5 to 7, which intend to evaluate the receptiveness and ease of understanding dimensions, but disregards variable 8, which would be a component of the latter dimension. The F3 factor presents the factorial load in variables 1 to 3, created to evaluate the access and efficiency dimensions, but also disregards variable 4, which in the applied questionnaire was part of the efficiency dimension. The F4 factor, in turn, has factorial loads in variables 21 and 22, responsible for the security dimension. Finally, the F5 factor presents a factorial load in only one variable, variable 16, which is partly responsible for the wait time for service dimension.

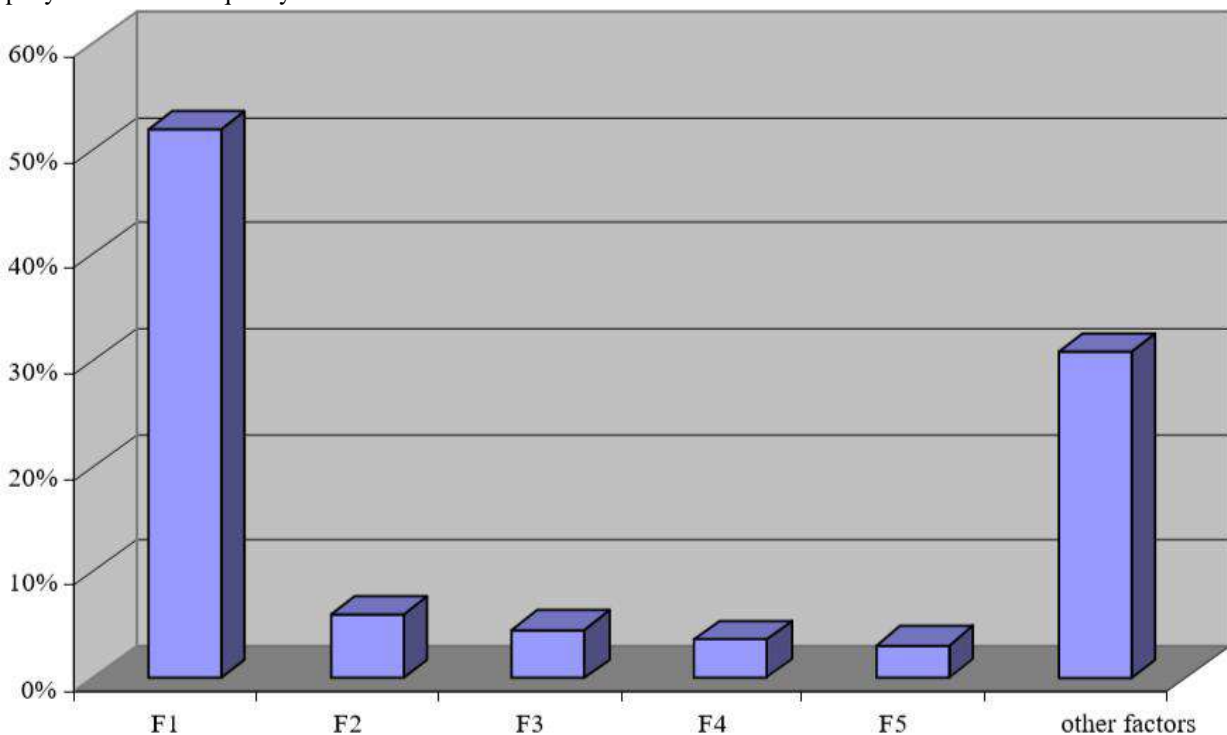


Fig.6: Factors extracted by Varimax Rotation

Source: Prepared by the authors (2020).

In addition to observing the factorial loads, it is important to mention that the commonality of the variables was considered good, since they are greater than 0.6 (HAIR, J. F. J. et al., 2009). This occurred in virtually all variables. With the results of the factor analysis by the principal component method, five latent variables (factors) are identified, representing the dimensions of perceived quality, since the F5 factor represents a single variable and, in this case, it is directly defined by variable 16. The F1 factor brings together variables 11 to 15, merging the dimensions of customization and privacy, which were initially established and which are now called Trust in the company. The second F2 factor groups the variables 5 to 7, established to evaluate the receptiveness and ease of understanding dimensions, now called flexibility in providing services. The F3 factor aggregates variables 1 to 3, initially created to represent the dimensions of access and efficiency and are now called ease of self-service. The F4 factor aggregates variables 21 and 22, representing the security dimension and which will continue to be called the *security* dimension. And finally, the F5 factor is defined by variable 16, partly representing the wait time for service dimension, which is now called *speed*. Some variables that were part of the pre-established dimensions were eliminated, as is the case of variable 4, representing the simplicity of service via the agency and which was part of the efficiency dimension. Likewise, variable 8, which represented the opportunity for the agency to easily adapt to customer requirements and included in the ease of understanding dimension, was also eliminated. The criterion for these exclusions was the low commonality between the variables.

#### IV. CONCLUSIONS

The growing modernization of society requires that there is, increasingly, an improvement in the quality of services provided by any organizational institution. And the satisfaction of customers' needs and expectations has been a constant in this search for quality, especially considering that the quality perceived by the customer must match or exceed their expectations (GHOBADIAN; SPELLER; JONES, 1994). In this context, and through the interdisciplinarity between service management, quality, customer satisfaction and technological innovation, this work sought to identify the services provided by energy company, define dimensions of the quality of these services and validate them through the application of a tool measurement. All of this to achieve the main objective, which was to measure the quality levels of the services provided by the company. From the results obtained, it can be concluded that the services provided by the company, in

general, are at average levels of perceived quality, in the first half of 2018, along with a sample of the population of the municipality. Furthermore, considering the opinion of Ramaswamy et al. (1996) that service quality measures must be *reliable*, since the measurement instrument or the measurement procedure must always assign the same value to something that is being measured, *valid*, as they have to measure what they really propose, *relevant*, because they have to provide useful information, which cannot be replaced by other measures that are already being used, and *consistent*, because they have to present a certain degree of balance in relation to the objectives of the system of measurements and consistency with the other measurements used, it can be said that Servqual's model, developed by Parasuraman et al. (1985), proved to be reliable, valid, relevant and consistent as a tool for measuring the quality of services provided for the company. Regarding the adaptations in Servqual's model carried out in this work, with the changes in the questions, directing them to the services provided by the company, it is concluded that they proved to be effective for the success in obtaining the opinion of customers who use this type of service.

It was also found that the services provided by the company are already part of the daily lives of customers, and that, in this type of service, the level of quality requirements is high, highlighting the dimensions related to wait time for service, customization, responsiveness and trust, which must be carefully worked on by the company. This fact shows that services must be provided according to the customer's time availability, since the service process takes place remotely and with extensive participation from the user.

In addition, it was evidenced that there is no restriction on the use of services regarding the level of education, sex or age of the customer. The quality observed (according to data analysis) obtained a low evaluation, mainly in the tolerance zones of the customization and wait time for service dimensions, all linked to customer service, which confirms the survey carried out by Noor and Nasirun (2015). According to him, the main problems detected by service providers are exactly those related to customer service, such as agility in solving problems and speed in service.

The trust dimension, which had the highest perceived quality index, was also the one that reached the lowest tolerance zone, between 4.5524 and 7.5505. As Lemon and Verhoef (2016) argues, this dimension is considered by customers to be the most important because they increasingly value trust in the services provided, which is also confirmed by the results of this survey, since



the dimensions linked to trust and ease of understanding were those that obtained the highest levels of need from the customers.

In addition to these factors, it is important to highlight the achievement of the results through factor analysis. The ten dimensions proposed in preparing the instrument were re-grouped into five, namely: *Trust in the company*, *Flexibility in providing service*, *Ease of self-service*, *Security* and *Speed*.

In general, it can be concluded that quality management of organizations is a promise to improve the quality of life, reconsidering work relations and social responsibility, especially when they aim at transforming people. Thus, the dimensions investigated in this work (access, efficiency, receptivity, ease of understanding, flexibility, customization, privacy, wait time for service, trust and security.) Proved to be valid for the purpose of measuring the quality of the services provided by the company. And even using factor analysis, the five new dimensions reaffirmed the results obtained through Servqual's Gap, that is, the services that obtained the highest scores, as is the case with the Accuracy of the service provided by electricians variable, were not part of the new dimensions, but not because it is a less important service. The fact that this variable and some others, which also obtained high scores, were excluded does not mean that they are not necessary to prepare a new question to evaluate the quality of the services provided.

Finally, it can be said that the services provided by the Paraná energy company must continue to be improved, especially with its customers, to expand and develop new businesses and provide customers with sources of satisfaction and reliability.

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## **Extracorporeal Membrane Oxygenation in the COVID-19 Pandemic**

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**Abstract**— *Objective: This study aims to discuss the risks and benefits of ECMO in the treatment of patients with severe COVID-19. Method: This is a narrative review study of the literature with a qualitative approach, carried out in the PubMed, MEDLINE, LILACS, SciELO and Google Scholar databases in April 2021. Results: The analysis of the literature shows the importance of applying conventional treatment before opting for ECMO, and should be considered when other measures that have been*

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**Keywords— Extracorporeal Membrane Oxygenation. COVID-19. Acute Respiratory Distress Syndrome.**

*proven to be effective and relatively inexpensive have been performed, but without success, such as pronation, neuromuscular blockade and lung protection ventilation. Conclusion: It is concluded that further studies are needed with a larger sample and a comprehensive analysis of the evaluation of the use of ECMO in patients with COVID-19.*

## I. INTRODUCTION

Coronavirus 2019 disease (COVID-19) caused more than 3 million deaths worldwide until April 2021. After more than a year of pandemic, new studies are still emerging to treat and manage severe cases of the disease. One of the main complications of this pathology is the Acute Respiratory Distress Syndrome (ARDS), being responsible for deaths and hospitalizations due to COVID-19. [1]

Most patients with COVID-19 have mild symptoms and progress to cure. However, some of them progress to a severe disease state, developing dyspnea and hypoxemia about a week after onset, which can rapidly progress to ARDS and, later, to multiple organ failure or even death. [2]

Treatment of patients with ARDS by COVID-19 includes conventional therapies such as invasive mechanical ventilation with lung protection strategies, prone positioning, neuromuscular blockade, and inhaled pulmonary vasodilators. [3]

For patients who present with progressive respiratory failure despite these conventional therapies, Extracorporeal Membrane Oxygenation (ECMO) may be considered to support gas exchange and minimize ventilator-induced lung injury. ECMO has been used for decades in the treatment of severe ARDS of various etiologies [4] and constitutes one of the advanced resources in the management of patients with severe and refractory hypoxemia. The device can provide circulatory and pulmonary support. Equipped with a membrane capable of oxygenating the blood, in addition to a continuous pulse pump, it drives blood through venous and/or arterial cannulas. [5]

It is an advanced form of life support as it works directly on the heart and lungs. It may be indicated in cases of severe acute heart or lung failure that is potentially reversible and does not respond to conventional treatment. Usually in the Intensive Care Units (ICU) there are two main types of ECMO, veno-venous and veno-arterial. [6]

A multicenter study published in the Lancet in 2021 shows an analysis of data from 1,035 patients with COVID-19 who received ECMO support. Of these, 67 (6%) remained hospitalized, 311 (30%) were discharged home or to an acute rehabilitation center, 101 (10%) were discharged to a long-term intensive care center or unspecified location, 176 (17%) were discharged to another hospital and 380 (37%) died. [7]

In patients with COVID-19 who received ECMO, the estimated mortality 90 days after ECMO and the mortality in those with final disposition to death or discharge were less than 40%. These data from 213 hospitals worldwide provide a generalizable estimate of ECMO mortality in the context of COVID-19. [8]

A study carried out in the Paris-Sorbonne University Hospital Network by Schmidt et al. (2020) examined the outcome of treating 492 critically ill patients with COVID-19 with ECMO in the ICU and found positive results. The estimated 60-day survival of patients rescued by ECMO with COVID-19 was similar to studies published in the last two years on ECMO for severe ARDS. [9]

Given the above, the following question was formed: What is the published evidence about the use of ECMO for the treatment of Acute Respiratory Distress Syndrome in critically ill patients of COVID-19?

The aim of this review was to discuss the risks and benefits of ECMO in the treatment of patients with severe COVID-19.

## II. METHOD

This is a study with a qualitative approach, of the narrative review type. The survey of bibliographic studies took place during the month of April 2021, in which articles published in national and international journals, available free of charge, in full, in electronic format, in the PubMed, MEDLINE, LILACS, SciELO and Google Scholar databases were selected.

The focus in the elaboration of the research was to understand the findings about the use of ECMO for severe cases of COVID-19 for presenting the ARDS, one of the main problems of COVID-19.

Therefore, the six steps indicated for the constitution of the integrative literature review were adopted: 1) selection of the research question; 2) definition of study inclusion criteria and sample selection; 3) representation of selected studies in table format, considering all common characteristics; 4) critical analysis of findings, identifying differences and conflicts; 5) interpretation of results and 6) clearly report the evidence found.

The following criteria were adopted for the selection of articles: all article categories (original, literature review,

reflection, update, experience report, etc.); articles with abstracts and full texts available for analysis; those published in Portuguese and English between the years 2020 and 2021 and articles that contained in their titles and/or abstracts the following descriptors in health sciences (DeCS): Extracorporeal Membrane Oxygenation; COVID-19; Acute Respiratory Distress Syndrome. The resource used in the research was the expression “exact term”, associated with specific descriptors.

The exclusion criteria for the articles were studies that did not meet the mentioned inclusion criteria. In the databases search, 263 articles were found that address ECMO, related to ECMO with COVID-19 there were only 25. Each abstract/article was carefully read, highlighting those that responded to the objective proposed by this study, in order to organize the findings.

### III. RESULTS AND DISCUSSION

In this narrative review, after successive readings of the texts, it was possible to detect the different approaches in the perspective of the theme produced. From this finding, different thematic approaches were built in order to group the results found in an understandable pattern and for a better elaboration of the synthesis of the contents focused by the researches.

SARS-CoV-2 infects host cells by targeting the angiotensin-converting enzyme 2 (ACE2) receptor, which is present in endothelial cells of the lung, heart, kidney, and gastrointestinal tissue. [10] The lungs are particularly vulnerable to SARS-CoV-2 because of their large surface area and because alveolar epithelial cells apparently act as a reservoir for virus replication, causing direct damage to lung tissue, and consequently an uncontrolled inflammatory response. [11]

Conventional high-flow oxygen therapy, non-invasive or invasive mechanical ventilation, in combination with prone positioning, have been reported to be effective in most patients. However, in severe cases, refractory hypoxemia may occur, with risk of life and secondary infections, myocardial disease involvement and a hyperclotting state, and pulmonary embolism may also occur. [12]

Given the pandemic and the high number of severe cases with refractory hypoxemia, a new possibility of therapy emerged in the scientific debate, the so-called ECMO [1]. This therapy aims to replace the pulmonary function of oxygenation, elimination of carbon dioxide and allows the use of protective or even ultra-protective ventilatory parameters, reducing the risk of lung injury induced by

mechanical ventilation and providing greater pulmonary protection. [13]

The first ECMO machine was used for cardiac surgery in 1965. Modifications were made to this system to support the heart and lungs for an extended period of time. [14] ECMO is a supportive therapy where blood is pumped out of the body through a machine, indicated for patients with severe lung injury, respiratory failure and/or heart failure and has shown promise in the treatment of patients with COVID-19 serious. [15]

The main modalities of ECMO are veno-venous, which provides pulmonary support, and veno-arterial, which provides pulmonary and cardiac support, and in both, a drainage cannula removes blood from the body and directs it through a pump to a membrane in which it will be oxygenated, working as a kind of dialysis. Meanwhile, carbon dioxide is removed from the bloodstream and the device then returns oxygenated blood to the body through a return cannula. [4]

Another modality of ECMO is the venoarterial, which removes blood from a vein and returns it through an artery. It is used for both cardiac and pulmonary support. The primary objective is the restoration of tissue and end-organ perfusion to allow for stabilization or recovery of function. [16]

Regarding the atypical manifestations of COVID-19, such as predisposition to intrapulmonary thrombosis, right ventricular failure and the immunological insult aggravated by infection by COVID-19 and by the extracorporeal circuit, it has not been fully explored by recent publications. There are still few published studies that perform comparative analyzes of the effects of ECMO in patients with COVID-19, so the choice must be based on scientific evidence already available. [5]

Indications for ECMO are: acute and reversible lung disease, P/F ratio lower 50-80 with FIO<sub>2</sub>=1, patient with Murray score=lower 3.0, lower ph 7.2 due to refractory hypercapnia with little metabolic acidosis. Relative contraindications for ECMO are: prolonged period of mechanical ventilation longer than 7 days, age over 65 years, post-cardiac arrest coma, advanced cancer, incoercible bleeding and central nervous system hemorrhage. [17]

It is important to apply the conventional treatment before moving to ECMO, and it should be considered when other measures that have been proven to be effective and relatively inexpensive have been performed, but without success, such as pronation, neuromuscular blockade and lung protection ventilation [8]. In addition, the underlying diagnosis, the patient's specific risk factors, the expected duration of support, and especially whether there is a viable

exit strategy, such as recovery, must be taken into account. [18]

ECMO is a therapy whose priority is preferentially given to younger patients, with a relatively low prevalence of comorbidities and with an acceptable probability of reversal of the pulmonary insufficiency typical of these patients. The ideal window for implantation is after other less invasive treatments have been considered or exhausted, but before significant target organ dysfunction begins. [7]

In 2021, if the second wave of COVID-19 started, it is inevitable that the demand for ECMO will exceed its supply. [19] In the case of multiple candidates with suitable nominations, the ICUs will need to implement a screening to select candidates who best fit the ECMO nomination profile. This is an expensive technology that consumes a lot of resources, another important point is that it must be performed with qualified professionals and monitored by a multidisciplinary team. [8]

Regarding veno-arterial ECMO and other precautions with its maintenance, it is important to adjust the ECMO flow to maintain or restore, if possible, the function of other organs such as neurological status, renal function, liver function and pulmonary function and also provide an acid-base balance in the body. The initial flow for ECMO-VA should be 50 to 70 ml per kilogram every one minute with a mean arterial pressure > 60 mmHg. [20]

In ECMO-VA, blood ejected from the left ventricle is a mixture of venous blood supplied by the right ventricle and bronchial and pulmonary collateral blood flow. In the abnormal pulmonary gas exchange scenario, even when combined with fully oxygenated blood from the femoral arterial cannula, the blood that permeates the brain, heart and upper extremities can have a saturation below 90%, causing cyanosis in the upper body, a condition called harlequin. [6]

Patients with ECMO-VA support should be monitored with an arterial line, arterial line monitoring allows you to monitor pulse pressure as a reflection of cardiac contractility during support and weaning. Absence or low arterial pulsatility indicates that the left ventricle is not ejecting or is ejecting less than ideal volume, which can lead to an increased risk of thrombus formation. [21]

Circuit line pressures should be monitored because significant changes may indicate filter or tubing obstruction, potentially by thrombus. Therefore, the prevention of thromboembolic complications is extremely important in the management of these patients. The oxygenator should be checked frequently for evidence of clot formation directly by visual inspection of the membrane and indirectly by evaluating hemolysis measurements and gas exchange efficiency. [6]

Systemic anticoagulation is recommended, with heparin being the most used anticoagulant. The most frequent complication of ECMO is hemorrhage, whose bleeding can be increased due to systemic heparinization. However, direct thrombin inhibitors such as bivalirudin and argatroban are drugs that have been reported as safe and effective alternatives in patients with heparin-induced thrombocytopenia or heparin resistance. [19]

It is noteworthy that the role of ECMO in the treatment of disease caused by this new virus remains uncertain and, in the meantime, further research by several authors is always suggested. From this perspective, the position among researchers can be controversial, as while some authors tend to be more pessimistic when observing high mortality rates with this type of treatment, including reports of septic shock and multiple organ failure, others suggest that it may play an important role and to assist those in critical condition of ARDS due to COVID-19. [22]

#### IV. CONCLUSION

Advances in circuit technology have required parallel advances in the management of patients with ECMO at the bedside, including the development of multidisciplinary ECMO teams. This procedure plays an important role in the stabilization and survival of critically ill patients with COVID-19, but the usefulness of ECMO in reducing the mortality of severe ARDS caused by COVID-19 has been limited.

Therefore, the results allowed us to conclude that it is still necessary to carry out more studies with a larger sample and a comprehensive analysis of the evaluation of the use of ECMO in patients with COVID-19. Providing ECMO to a patient during a crisis also depends on the capabilities of each hospital, including the actual effectiveness of this intervention under current circumstances.

It is important to think ethically about the use of ECMO, because in the face of a pandemic it is necessary to reflect on ethical principles and screening guidelines that may or may not result in the interruption of ECMO services when demand exceeds available resources, depending on the circumstances and choices made.

It becomes evident that there is no clear or operational ethical imperative requiring the interruption of ECMO services during a public health crisis such as the COVID-19 pandemic. However, considering the high frequency of serious adverse events, ECMO should probably remain a rescue therapy and therefore only be performed in centers specialized in ECMO with adequate resources.

It was possible to observe limitations in the study, such as the lack of production of studies that made a comparison



between the use of ECMO in patients with COVID-19, taking into account all the risks and benefits that this therapy involves. There is still discussion among academic and scientific circles on the subject, in which some researchers claim that ECMO is a valid support therapy to treat ARDS, and others already defend the idea that, as it is an economically expensive therapy, it needs a specialized team, which the ECMO may not compensate by taking into account all the factors that have been suppressed, including the ethical ones.

The main strength of this study is to prospectively describe the clinical course of patients with COVID-19 who required ECMO, mainly because few data are available. Our results are, however, limited by its single-center character.

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# Solidarity Economy and Ecologically Based Agriculture: An action plan for the development of educational materials

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**Keywords**— *Solidarity Economy, Sustainability, Educational Videos, Action Plan.*

**Abstract**— *In view of the need to support social entrepreneurship and promote territorial development, the purpose of this text is to describe and discuss an action plan for the development of educational material on Solidarity Economy and Ecologically Based Agriculture. The 5W2H method was used for the action plan for the preparation of the educational material. Methodologically, the research has a quantitative and qualitative approach, with market research involving students from higher education courses (Agrarian Sciences) and High School Integrated to Agricultural Technicians, from the Federal Institute of Bahia - Campus Senhor do Bonfim and professionals who work NGOs, educational institutions and rural extension bodies. From the data analysis, it was concluded that the elaboration of the action plan using the 5W2H method in the production of an educational video was shown in a positive way, allowing an expanded view of the best strategies for the planning of actions and the acceptance of the product by the target audience, as an intelligible language material and accessible online, which can promote sustainability in local production units, adding value and strengthening the identity of crops originating from family farming; and territorial development, with the socialization of information that favors collaborative networks, the economy and integrates actions and partnerships in a collective and solidary way.*

## I. INTRODUCTION

By using natural resources, man has been leaving a trail of environmental destruction in large proportions. In this process, nature has been exploited in a maximized way, and there is no satisfactory national management

acting in this movement. Given this, problems of a social and/or environmental nature, they can present their effects quickly or on a large scale of time (RODRIGUES, 2011).

In this sense, a change in posture is needed in the way of producing and marketing products, using agricultural

practices that respect natural resources, as well as obtain a fair market for the sale of products. In this perspective, Solidarity Economy and ecologically-based agriculture act in a complementary way, providing principles and values that strengthen sustainable development.

It is from the perspective of complementarity that it is possible to implement an agricultural activity that deals with the preservation and conservation of natural resources, in a scenario in which the natural ecosystem provides subsidies for a significant improvement in the quality of food and the environment. For De Molina et al (2019), sustainability in food agroecosystems is based on the organization of agricultural work in synergistic interactions of mutual transformation between human work and nature's work, which contributes to the management of practices to converge with the dynamic ecological ecosystems; in valuing ecological capital that reduces dependence on inputs; in the conception of natural assets as patrimony of the peasant family; in the management of complex and biodiverse agroecosystems - ecological flows at the level of the rural territory;

In this context, Solidarity Economy emerges as an alternative mode of production, distribution, consumption and coexistence to capitalism, marrying the principle of unity between ownership and use of the means of production and distribution, thus organizing workers in cooperative projects, such as such as: self-managed production units, or union of small producers for joint purchase and sale, fair trade networks, business incubators, exchange clubs, among many other experiences, supported by income generation in a fair, solidary and sustainable manner (SANTOS, BORINELLI, 2010).

In the decision-making process, the proper use of a management tool can significantly help the interpretation of qualitative information and support future decisions. In this sense, according to Rodrigues Júnior et al. (2017), 5W2H is a management tool that allows you to predict uncertainties and unforeseen events in the process unknown by the manager, while helping to collect, organize and analyze data.

The 5W2H method improves the planning of activities in a project. According to Moraes and Costa (2013), 5W2H is used in the mapping and standardization of processes, in the preparation of action plans and in the establishment of procedures associated with indicators. For Freitas (2013), this tool is summarized in answering seven questions - detailed in the methodology - about an action to be taken in order to obtain information that will support planning in general.

Seeking preventive measures to improve management, some studies in the social area are being developed with

the aim of contributing to the decision-making process in social enterprises. Like Peres et al. (2015) who carried out a project to implement a family-based horticultural cooperative in the city of São Miguel do Oeste-SC. According to the authors, the relevance of the project was due to the fact that cooperatives help to reduce rural exodus, strengthen small farmers, making them competitive. Among the strategies outlined to develop the project, the authors used the 5W2H tool as a methodology for the action plan.

The results of the elaborated plan showed that it is feasible to implement a family fruit and vegetable cooperative in the city of São Miguel do Oeste-SC, emphasizing that the aim is to guarantee food production, expanding family farming, in addition to expanding the productive capacity to in order to supply the existing demand and reduce the rural exodus, keeping young people in the countryside.

The article by Silva et al. (2016) dealt with the experience report and the methodological process of incubation of Solidarity Economic Enterprises, which had been carried out at the Solidarity Economy, Development and Social Technology Incubator – Itecsol Unijui. The authors developed a bibliographic and documental research, in addition to an action research to systematize and socialize the practices developed by solidarity enterprises using the 5W2H tool.

The aim was to meet the demands of groups belonging to the handicraft, recycling, family farming and sewing sectors, making them available to different interested audiences for evaluation and contribution. The results showed that the incubation of solidary enterprises is a didactic, pedagogical and methodological process, which requires permanent planning, monitoring and feedback.

Servat (2016) conducted a study that aimed to propose and apply a diagnostic tool for family farming cooperatives advised by Emater/RS. The action research also used, among others, the 5W2H method to outline diagnostic actions. For the author, cooperatives play a fundamental role in the economic and social context of the communities in which they are inserted.

Therefore, a diagnostic instrument was developed covering the areas of organizational management, people management, finance, costs, marketing, planning, production control, environmental and sanitary management that met the characteristics of the cooperatives in the study and thus provided for the development of same and subsequent applications by other institutions.

Among the results, the author identified that the proposed instrument meets the organizational

characteristics of family farming cooperatives, both for the initial diagnosis for planning, and for the elaboration of a plan for improvement and development of specific actions in each area of a cooperative, thus achieving better performance.

The research by Weide (2016) aimed to develop an action plan to minimize damage to the production of the Rural Association of Lajeado. Therefore, the author used the exploratory-qualitative methodology with interviews and observation. The study addressed concepts and characteristics of materials management, such as: internal logistics, receiving, storage, packaging, processes, process improvement, training and the 5W2H methodology. The research results showed that it is a relevant tool for the enterprise, as opportunities were developed to seek strategies for planning, understanding and managing internal logistics processes, in order to minimize costs.

The "Pedagogical Rural Tourism in the Community of Marrecos in Lagoa de Itaenga-PE" is the study carried out by Silva et al. (2017). The research was carried out in a participatory manner with the community of Marrecos. Thus, a Pedagogical Rural Tourism project was presented to the community as a possible source of extra income for its residents and a didactic proposal for students from the 5th to 9th grades of private schools in the city of Recife. Management tools, such as 5W2H, were used to support the planning of actions, such as the visual identity, the financial and economic-financial feasibility plan, the marketing plan and the execution plan.

The study's conclusions show that Pedagogical Rural Tourism can become an opportunity for the balanced and sustainable growth of the community, as it includes: proposals that seek the most efficient use of resources; greater community involvement in the developed actions and encouragement to form partnerships that contribute to the project's success.

Oliveira Filho (2018) developed a qualitative exploratory research and aimed to analyze conceptual and methodological elements that contribute to the planning of agroecological production based on management tools such as the 5W2H. In addition, a literature review was carried out on agroecology and production management, as it is understood that these are areas with great potential to contribute to training strategies and organization of cooperative work in the field. The author noted that the study was emancipatory, creative, in which the activities of conception, planning and execution are inseparable, as well as an imminent need to articulate agroecology and production administration for self-management.

Viana et al. (2019) developed a study that aimed to present the development of an organizational strategic plan

with the purpose of identifying and solving problems existing in the Centro Mulheres de Barro cooperative, located in Parauapebas in the state of Pará. The methodology adopted in the study was the interview, and management tools were worked on to support strategic planning, including the 5W2H.

The results of the study by Viana et al. (2019) indicated that, through planning, it was possible to identify the difficulties of the cooperative as well as its qualities. In view of this, strategies and an action plan were drawn up that will enable better management and direction of processes and activities, cooperating for growth, strengthening and the solution of future problems.

Given the above, It is important for society to have access to information regarding the conduct of more sustainable agricultural practices and self-management tools, as well as the marketing and production of products based on the principles of Solidarity Economy. To this end, techniques that help the process of inserting educational materials that deal with such topics help in the dissemination of knowledge. In this context, this study aims to prepare an action plan for the development of educational material on Solidarity Economy and Ecologically Based Agriculture as a contribution to territorial development. For the action plan for the development of educational material, the 5W2H method was used.

## II. RESULTS AND DISCUSSION

To support the action plan, the "preparation and implementation of an educational video to strengthen the Solidarity Economy and Ecologically-Based Agriculture" was used as the META, using the 5W2H method, including the stages of development of the initial prototype, analysis of circumstance for validation, with intervention in a real environment, and changes in the prototype to obtain the final product, whose details of the actions are shown, according to the method, in Table 1.

Table 1: 5W2H method for educational video

What to do? What action will be taken?	Who? Who will execute/participate in the action?	Where? Where will the action be taken?	When? When will the action be taken?
Market research and analysis	03 PhD students from PPGADT/Univasf and Students from the Agricultural and Agricultural Sciences Courses at IFBaiano, Senhor do Bonfim.	Instituto Federal Baiano – IFBaiano, Senhor do Bonfim campus (online)	November 2020
Conducting bibliographic research to build the video script	03 PPGADT/Univasf PhD students	Databases of scientific articles and booklets available related to solidary enterprises	December 2020
Script writing with lines and characters	03 PPGADT/Univasf PhD students	Individual studio of the three PPGADT doctoral students	December 2020
Creation of scenes, with selection of images and speech recordings	03 Doctoral students of PPGADT/Univasf	Individual studio of the three PPGADT doctoral students	December 2020
Joining the scenes and creating the video opening vignette (part of the prototype)	Doctoral Student 1 of PPGADT/Univasf	PPGADT doctoral student 1 central studio	December 2020
Application of questionnaires to experts to analyze possible changes in the material or prototype.	03 PPGADT/Univasf PhD students and PPGADT professors/students (Agronomers, Pedagogues, Biologists, etc.)	During the seminars of the discipline of Basic Agroecology and Markets	December 2020
Establish partnerships	03 Doctoral students of PPGADT/Univasf, CESOL / Pro Semiárido / Bahiater de Senhor do Bonfim	Through contacts with representatives of the aforementioned organizations	February 2021
Disclosure of the video	03 PhD students from PPGADT/Univasf and	Conversation wheels, radios, blogs and	March 2021

Why Because? Why will the action be taken?	How Like? How will the action be carried out?	How Much How much? How much does it cost to perform the action?
To understand the needs of the target audience	Google form online forms (contact maintained by the classroom teacher (Wellington Dantas)	No expenses involved
To support the theoretical support of the theme. Materials were collected with authors and reference entities in the subjects	Search on websites of non-governmental organizations and databases of scientific articles	No expenses involved
Subsequently simplify the dissemination of technical content in a language accessible to the target audience.	Through Zepeto apps and voice recorders	Investment in application subscription, R\$50.00
Subsequently simplify the dissemination of technical content in a language accessible to the target audience.	Through Zepeto apps, voice recorders.	Investment in application subscription R\$50.00
Later post on video platforms, distribute on social networks and scientific events, in order to facilitate the understanding of the themes for the communities (target audience)	Through Zepeto apps, voice recorders and Kinemaster Video Editor	Investment in application subscription R\$50.00
For technical and scientific validation of material/content	Online quiz (google forms)	No expenses involved
To enable communication and inclusion of the target audience in the project	With lectures and seminars on the themes	Travel and food expenses R\$150.00
To expand project actions	Radio interviews, blogs and dissemination of materials on social media	Travel and food expenses R\$150.00
To monitor the dissemination and breadth of content	Access control and partner feedback	No expenses involved (online)
Seek to understand the perception and acceptability of the material made available	Google form online forms (contact maintained by the classroom teacher (Wellington Dantas)	No expenses involved

The research was carried out by three doctoral students from the Postgraduate Program in Agroecology and Territorial Development (PPGADT) at the Federal University of Vale do São Francisco (UNIVASF). The action plan started in November 2020 and will be completed in June 2021. The first stage took place during the month of November with a market survey (first item of the 5W2H method) to understand the needs of the target audience. The online questionnaire with the market research was answered by 60 students from the Higher Course in Agricultural Sciences and the Technical Course in Agriculture, both from the Federal Institute of Bahia (IFBaiano), Senhor do Bonfim campus.

In addition, 06 professionals who work in Non-Governmental Organizations, Educational Institutions and Rural Extension Agencies participated in the survey. It is noteworthy that a significant part of the participants did not fill in the justifications for the answers "YES" and "NO", thus a summary with the main open answers will be presented. The questionnaire was carried out through a circumstance analysis, as shown in table 2:

**Table 2: Circumstance Analysis for the Implementation of the Educational Video**

<b>DESIGNER(S):</b> 03 PhD students from PPG AD I/UNIVASF	<b>MONTH:</b> 11/2020
<b>CIRCUMSTANCE</b>	
<ul style="list-style-type: none"> <li>• <b>Family farmers/Solidarity Economy entrepreneurs:</b> When I want to improve productivity on my site, I have difficulty finding information to help me apply more efficient alternatives to earn income and conserve nature. I also have obstacles to commercialize my products and form partnerships with other farmers, strengthening our production process.</li> <li>• <b>State/Social Organizations:</b> When we carry out interventions in rural communities to contribute to: improving the quality of life of rural people; to encourage the appreciation and permanence of young people in the countryside, we need educational materials with a language that facilitates the understanding of the themes addressed.</li> <li>• <b>Country youth:</b> When I think about my future, I am unsure of continuing to work in the field with no prospect of growth I feel like having more knowledge in my formative process, about more current changes on how to progress in my place of origin.</li> </ul>	

The questionnaire was initially directed to students. Thus, when asked about "the difficulty in finding information about ways of living in the field", question 1 brought 58% of students reporting difficulties and 42% reporting no difficulties. Students who answered "NO" were analyzed in two categories and the summary of the main answers is shown in sequence:

- Category 1: They consider they have no difficulties in finding information about living in the semiarid region, stating that they can easily find these materials on the internet and in books:
- Category 2: They consider that they have no difficulties in finding information about coexistence in the semiarid region, as they live in the rural area, which leads to the understanding that, in a way, they already understand some production techniques that are passed on by family members.

Students who answered "YES" were analyzed in three categories and the summary of the main answers is presented as follows:

- Category 1: They claim that there are few materials on the subject on the internet:
- Category 2: They claim that there are few materials and they also present a language that is not easy to understand:
- Category 3: It is not interested in looking for this type of materials:

Regarding question 2 on the question "do the educational materials you find about agriculture and entrepreneurship present an understandable language?", 43% of the students answered "NO" and 57% answered "YES". Thus, the negative responses were analyzed into 3 categories, and the summaries of the main evidence are presented as follows:

- Category 1: The material as a whole has a formal language, as they are academic texts, such as: scientific articles, Course Conclusion Work, among others.
- Category 2: The materials are difficult to understand as they have technical terms that are not yet familiar.
- Category 3: Materials are difficult to understand in general, this category covers different materials.

Regarding the students who answered "YES", it was only possible to extract the results of the open question from the information that summarizes to this statement: "books and blogs demonstrate that they have a very accessible language for all audiences".

When asked if "they received stimuli to stay in the field", question 3, more than half of the students answered "YES" (58%) and 42% answered "NO". In this sense, it was possible to extract additional answers only for the "YES" respondents, and their answers were analyzed in 4 categories:

- Category 1: He receives the encouragement to stay in the countryside through his family.
- Category 2: Self-motivated, as he enjoys country life.
- Category 3: Stimulus through knowledge gained through the educational institution or other sources.
- Category 4: Stimulus to stay in the countryside due to good infrastructure conditions or financial assistance.

Finally, the students were asked as follows in question 4: "If you could choose ways to access information on topics related to living in the countryside, which of these would you choose?" As participants could mark more than one option, the answers that stood out the most were: Videos (92%), Manuals (37%), Booklets (27%), Scientific Articles (23%), in addition to books, conversation circles, reports, among others, which revolved around 2 and 3%.

In this item, it is observed that most students prefer video as a source of learning for living in the field. It is therefore concluded that the product in video format will have a good acceptance by the young people in the field, as evidenced in the market research.

The second part of the research presents the answers of professionals who work in Non-Governmental Organizations, Educational Institutions and Rural Extension Agency, totaling 6 responses collected, however it is important to highlight that in some items the total of responses is less than this amount.

Question 1 asked whether the participants had difficulties in finding information about ways of living together in the field. 5 interviewees said they had no difficulties, only one respondent answered "YES", but he did not justify it. This facility to find material is due to the function they play in their respective work, working directly with rural extension. Continuing, question two asked whether educational materials on agriculture and entrepreneurship present an understandable language. In this regard, three professionals answered "YES", the main points being justified as follows:

- I use booklets and folders made directly for this audience.
- Especially material produced by NGOs that provide advice to family farmers.
- There is an effort by people who write about this theme to make themselves understood by their readers because of their basic training (the vast majority)

Regarding the professionals who answered "NO" only one justified that "language is always accessible". Based on the answers shown in question 2, it is clear that the materials found have accessible language, and the booklet is an example of this modality of access to information.

Question 03 asked the interviewees "What do you consider as a motivator(s) for the permanence of farmers and young people in the field?". The open question collected the main answers:

- Generate their own income and better quality of life.

- Public policies for social inclusion focusing on rural youth.

- New ways of generating income, working with beekeeping, working with cooperation for animal processing, etc.

- To guarantee the permanence of families and young people in the countryside, it is essential that a set of actions, programs and public policies are implemented aimed at meeting the needs of families. In this process, it is essential to ensure access to land, so that these families can be advised (by ATER entities), it is also essential for young people to have access to contextualized education.

- Putting myself in the place of young people in the countryside, I don't see motivation.

- Agricultural and non-agricultural activities that generate income, cultural and sports activities.

Thus, it can be inferred that income generation is presented as the main motivation for the permanence of farmers and young people in the countryside, as well as the implementation of public policies focused on rural youth. Finally, the participants were asked about the resources (videos, manuals, booklets, scientific articles) that they consider to present accessible language for training on living in the field. The results are presented below:

In this item, it is observed that most professionals prefer video and booklet as educational materials, to be used in training on living in the field. It is then concluded that the product in video format will have a good acceptance and recommendation by professionals who work in Non-Governmental Organizations, Educational Institutions and Rural Extension Agency. The results of the second part of the research corroborate the findings of the first part of the circumstance analysis, showing, in this case, the educational video as a recommended instrument to meet the needs of the researched population.

Given the results, it was evident that there is indeed interest in the proposed material. This step is extremely important to avoid efforts and costs to produce something that the target audience will not absorb. This happens when it is considered only an idea that the target audience is interested, but the circumstance analysis for validation is not performed.

Thus, after proper analysis of the circumstances for the validation process, the action plan outlined through the 5W2H was continued, following the steps established in the methodological proposal, with the educational video being validated during the seminars of the discipline of Basic Agroecology and PPGADT/Univasf Markets in the last school week of the year 2020.



Finally, the future steps, as shown in table 5W2H, are related to establishing partnerships to enable communication and inclusion of the target audience in the project; promote the educational video through conversation circles, radios, blogs and social networks aimed at expanding the project's actions; monitor the acceptability of the product and carry out new market research to make the necessary decisions to streamline the action plan.

That said, the action plan allowed a macro and prior vision of the actions needed to develop educational material for the purpose of promoting ecologically-based agriculture, including actors involved, identification of possible infrastructure or financial resource needs, and also containing descriptions of how to carry out and who can be responsible for each action to be developed in a manner fast and simple. In addition, the action plan contributed to the success in achieving the goal, with the elimination of rework or failures due to limiting steps that are the basis for the next steps, that is, it promoted the self-management of this socially-based project, whose methodology and results can serve as a reference for achieving new goals, especially those linked to solidarity economy and ecologically-based agriculture.

### III. CONCLUSION

Contemporaneity demands, from society, a way of thinking and acting that lead to more sustainable existential behaviors and attitudes, which are allied to the processes of economic and social development. It is a fact that the construction of a more aware society involves access to information and knowledge, from the various sectors that meet the daily demands, for the continuous improvement of the quality of life.

In this study, it was possible to verify that the elaboration of a proposal for a Social Base business model, using the 5W2H method, for the production of a video as educational material, on the themes of Solidarity Economy and Ecologically Based Agriculture is shown to be positive considering that it allowed to define the best strategies for planning each action to be performed, whose prior vision enables the anticipation and solution of challenges that could make the proposal unfeasible or generate rework, when identified only in the long term.

On the other hand, it was possible to verify the acceptance of the product by the target audience, as an educational tool that meets their needs for a material that presents an intelligible language and can be accessed online on free digital platforms; as well as promoting sustainability in local production units that add value and strengthen the identity of crops originating from family

farming; and territorial development, with the socialization of information that favors the creation of collaborative networks, the economy and integrates actions and partnerships in a collective and solidary way.

Furthermore, it is expected that the methodology and results, described and discussed in this chapter, can contribute to the success of new social projects, especially those aimed at promoting the solidarity economy and/or ecologically-based agriculture, which in fact constitute necessities communities, as this directly impacts the acceptance of new social technologies. It concludes with the following sentence: No matter how complex and beautiful a technology is, there is no merit in producing something that the community is not interested in, that is, that it does not need at that moment in their lives or in those circumstances.

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# The Process of Continuous Teacher Training in the City of Várzea Alegre – Ceará

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**Keywords**— *Education, training, school.*

**Abstract**— *This article seeks to encourage the basic education teacher to take the lead in the systematization of their experiences and training, considering them as the subject of their own training, with a permanent character and articulated with the experiences lived in daily school life. When the school is unable to promote the training of its teachers, with a view to qualifying its practices according to the wishes of its students, and continuing to propose training itineraries for children, young people and adults who do not fit in with the current agenda of the country. The strategies of an educational policy can and must explore the autonomy margins of the educational system; betting on the repercussion throughout the network of the action exerted on one of the main nodes. The mere adaptation of school and paraschool education to the needs of employees, of the living forces, of the labor market, always imprecisely clarified, which becomes a rule, defined in terms of the conjunctural state of various power relations.*

**Resumo**— *Este artigo busca estimular o professor da educação básica a assumir o protagonismo na sistematização de suas experiências e formação considerando-o como sujeito de sua própria formação, de caráter permanente e articulado com as experiências vivenciadas no cotidiano escolar. Quando a escola não consegue promover a formação de seus docentes, na perspectiva de qualificar suas práticas por anseios de seus estudantes e continuar propondo itinerários formativos para crianças, jovens e adultos que não se coadunam com a agenda atual do país. As estratégias de uma política educativa podem e devem explorar as margens de autonomia do sistema educativo; apostar na repercussão ao longo da rede da ação exercida sobre um dos nós principais. A mera adaptação da formação escolar e paraescolar a necessidades dos empregados, das forças vivas, do mercado de trabalho, sempre imprecisamente esclarecidas, o que vem a ser regra, definido em função do estado conjuntural de diversas relações de força.*

**Palavras-Chave**— *Educação, formação, escolar.*

## I. INTRODUCTION

It is noted that the search for educational efficiency and effectiveness requires the solidity of an education system

based on the nation's economic, social and cultural political circumstances. By this we mean that the school institution needs to structure itself pedagogically to respond to the demands of its time, prepare itself to deal with subjects who

socialize in the context of contemporaneity.

Thus, professionals working in education must understand these characteristics from the perspective of effectively positioning themselves in relation to the educational service that is required.

The continuing education of teachers, in this analysis, becomes a strategic theme, of great relevance for the school to strengthen itself in the society in which we live. When the school is unable to promote the training of its teachers, with a view to qualifying its practices according to the wishes of its students, and to continue proposing training itineraries for children, young people and adults who are not in line with the country's current agenda.

The process of continuing education of teachers in the city of Várzea Alegre – Ceará, and its articulations with the curriculum and pedagogical practices, within an integration between the 9th grade classes of the EEIFM DR. Pedro Sátiro, to what extent do teachers need to be prepared to have current curricular training?

The general objective of this article is to evaluate the continuous training strategy for teachers in the municipal network of Várzea Alegre – Ceará developed through the actions of the Mais Paic program. Present historical aspects related to the formation of Elementary School II and continued in the city of Várzea Alegre – Ceará; Know the influences of the curriculum on Teaching Practice; Characterize the knowledge and pedagogical practices of teachers in the area.

This article seeks to encourage the basic education teacher to take the lead in the systematization of their experiences and training, considering them as the subject of their own training, with a permanent character and articulated with the experiences lived in daily school life.

The construction of pedagogical knowledge must be conceived through the exchange of professional experiences, through the construction of actions that seek to train teachers-researchers of the practice. This transformation of this teaching practice, which is so sought after in the execution of educational public policies, is only possible through the involvement of teachers in learning situations that work effectively, the professional knowledge that signal good expectations for transformation.

Following this line of reasoning, the proposal for professional teacher training can be built from situations that have not been previously systematized, as many of the training elements can be produced in the course of the process, generated by the interaction of the subjects. Thus, knowledge in action is not always enough.

The research includes bibliographic studies, and will include data collection from the educational institution and

the activities of teachers in the municipal education system of Várzea Alegre - Ceará, which show, in the context of different education reforms, the trajectory of conceptions and policies of teacher training.

## II. THEORETICAL DEVELOPMENT

### 2.1 Historical aspects related to the formation of elementary and continuing education in the city of Várzea Alegre – Ceará

In the theory of teaching for the development of continuing education, it presupposes a pedagogical-didactic approach with an epistemological content. Thus, the methodological principle related to pedagogical content knowledge that the formation of scientific concepts by students results from the appropriation of ways of thinking investigating and acting on a taught science, concepts become internalized mental tools to deal with a more objective world, with others and with themselves. The school is a place of cultural and scientific training for students in conjunction with the diversity of cultural society, through a teaching-learning process centered on the formation of psychic processes aimed at the cognitive, affective and moral development of students. instance of democratization and promotion of social inclusion. Therefore, teachers with pedagogical knowledge are needed to help teach the student to think and act with these concepts.

In the theoretical perspective suggested here, teacher training practices imply the interpretation of disciplinary training and pedagogical training, involving both content and pedagogical subjects teachers. According to Libâneo, didactics (p.89, 1993), teaching is a fundamental means of the intellectual process for students. However, there is no identity between the assimilation process and the teaching process, as if the assimilation stages were the same teaching stages, which are summarized in instruction, core and contents.

About this, the proposal to develop the external evaluations from the 6th to the 9th year will include the holding of meetings with the objective of designing the proposal for the elaboration of the evaluation at this stage of teaching and individual work. These works will be carried out by the components of the team responsible for drawing up the design of a protocol that will involve all teachers, plus the appropriation of knowledge already available through copies.

Therefore, the development of this protocol would be the elaboration of an assessment that can, at the same time, maintain parameters of comparison with other existing protocols and innovate in the procedures used to assess the process of appropriating the appropriate knowledge for its

year (grade), which in the 9th grade in Portuguese it is above 275 points and in Mathematics above 300 points on the SAEB scale.

Regarding teacher training, there is a consensus among education specialists that it is a fundamental role of departments to bring training programs closer to the school reality, setting up content based on the demands that affect teaching practice.

Education in Várzea Alegre has paid more attention to Spaece, encouraging teachers with pedagogical initiatives and awards for the creation of the *Passe o Bastão* project, which rewards teachers who achieve the best results in municipal schools.

Results also improved in 9th grade. In Portuguese, the increase was 16.5 points and in mathematics, the growth was 9.7 points, when compared to the 2016 fiscal year. Best Result of all time

In the last 11 years, Várzea Alegre Education has had its best results at Spaece, ranking 1st in the historical series from 2008 to 2018. MAISPAIC, all this is the result of hard work and dedication. We improved the educational system with better quality school transport, school lunches, uniforms, teachers' salaries on time, attention to educators and their proposals, and more dialogue with families. Let's follow this line of working more for the people.

Várzea Alegre education stands out in CREDE 17, headquartered in Icó, with 4 Grade 10 Schools. This is the result of SPAECE – Permanent Assessment System for Basic Education in Ceará, for the year 2018. The municipality of Várzea Alegre, has shown a good growth in the results of these assessments and that there is a concern with the equity of the education system, which has a more real demonstration of the evolution of the quality of education.

Teachers, like any other professional category, face many challenges in developing their roles. In addition to the individual decision to change to give better, more effective classes that ensure student learning, improved teaching can also be induced by the network to which it is linked, through continuing education, that is, often external to the attitude individual teacher.

In many cases, there is talk of the need to change pedagogical practice in order to adapt to the expectations of the new profile of students and social demands for the development of professional skills.

The decision to enter a field of studies and professional improvement, either on its own initiative or through the induction of the employing institution, triggers a series of uncomfortable sensations, of experimenting with many new experiences, foreign to one's professional routine.

The objective was to understand the vision that these professionals developed about this training process and identify the senses and meanings that have been built about this experience of teaching protagonism. Capturing this perception is very important to deepen discussions on the relevance of this initiative in the municipal network of Várzea Alegre - Ceará.

## 2.2 The influences of the curriculum on teaching practice

In undergraduate courses, the curricular guidelines imposed the reorganization of the pedagogical projects of the courses, leading to the need for greater reflection on the theoretical and practical issues surrounding the curriculum, its different concepts and conceptions, its nature, modes of planning and operationalization and the implications of curricular decisions taken by collegiate courses for the training of future teachers.

The social, political and economic changes that have shaped the current model of higher education have been reshaping teacher education and are directly and concretely impacting the traditional curricular conception of higher education: the curricula that are there are unable to provide undergraduates with all the skills necessary to face the world of work.

The importance of curriculum planning is increasingly perceived, as the major issues that guide the social function of higher education, at some point, will become curricular components.

Hence the importance of understanding the meaning(s) of the curriculum, since it will define and organize knowledge and practices that reflect a conception and ideal of education and that will be appropriated by undergraduates, future teachers.

The answer to the question “What should a curriculum for a teacher education course contain?” it needs to consider the multidimensionality of the educational phenomenon and, at the same time, it must respond to the historical and emerging challenges of Brazilian Basic Education and, at the same time, constitute an element of resistance to the lightened and pragmatic conceptions of education that have been imposed.

According to Goodson (2003), the word curriculum comes from the Latin word *scurrere*, to run, and it refers to a course (or race car). The etymological implications are that, with this, the curriculum is defined as a path to be presented and followed.

Resorting to the etymological sense, rather than an attempt to clarify the concept, is a way of perceiving how the meanings of the curriculum have been changing and

improving, but they have not completely lost this original connotation.

In the case of Goodson (1995 and 2001), for example, the curriculum must be considered the main aspect in the analysis of schooling, providing clues to investigate the relationship between school and society, and may constitute an expanded paradigm in the History of Education.

After all, according to the author, the continuous negotiation of reality [...] reveals the antecedent structures of power in education and suggests how the attitudes of dominant groups in society continue to influence schooling, despite signs of conflicts and contestations (GOODSON, 1995).

We cannot fail to emphasize that the discipline according to the dictionary is about obedience to the set of rules and norms that are established by a certain group. It can also refer to fulfilling each person's specific responsibilities. But for Chervel (1990), discipline would be: The analysis of the term discipline evidences this placement, thus, "in its school usage, the term "discipline" and the expression "school discipline" do not designate, until the end of the 19th century, more than that the surveillance of establishments, the repression of conduct harmful to their good order (CHERVEL, 1990)".

We see in Chervel's (1990) statement that the word discipline denotes an intention different from what we can say today as a synonym for matter, it had the purpose of training civilized subjects to serve society.

Thus, we searched for the quote by IMBERNÓN (2010) who states that there is, with attitudes like this, the need to: Abandon the obsolete concept that teacher education is the teacher's didactic scientific and psycho-pedagogical update to adopt a training concept that consists of in discovering, organizing, substantiating, reviewing and building theory (IMBERNÓN, 2010).

It is pertinent to say that when thinking about teacher education means going beyond concrete actions, it is, above all, mobilizing knowledge about teaching itself, and all aspects and concepts that involve it, this is what we see in the statement above.

The study of continuing education favors the entire teaching class, as whoever participates, according to the teachers, opens up a range of possibilities for expanding knowledge in a multitude of aspects.

This thought is based on the studies of Imbernón (2010) who say: The continuing education of the teacher is found in some major axes, among them is the exchange of experiences between equals to make it possible to update in all fields of educational intervention and increase the communication between teachers (IMBERNÓN, 2010).

We can see that the above quote intensifies the importance of continuing education so well it highlights in various parts of this work, in addition to strengthening knowledge and renewing it, giving a quality to the teaching-learning process.

But, if we think about Paulo Freire's conception within the process of reading and writing related to the discipline where the subject learns by giving meaning to words, which must be a tool to read the world, to (re)interpret reality, and to insert themselves in it, that is, for Paulo Freire, the curriculum and the discipline must be within the context of the subject's experience so that it can fully develop.

For Hoffmann (2010), the understanding of assessment corresponds to the theory adopted and structured in the curriculum, which is intrinsically linked to the objective and the desired purpose. This author states that: Assessment is reflection transformed into action. This action drives us to new reflections. The educator's permanent reflection on his/her reality, and the monitoring of all the steps taken by the student in his/her knowledge construction trajectory. (HOFFMANN, 2010)

The statement shows that despite the assessment corresponding to the theory adopted and structured to the curriculum, as mentioned above, they have different functions, but they do not have opposing concepts, that is, they are linked to the student's steps in the trajectory of the acquisition of their knowledge.

The most contemporary conceptions of curriculum revolve around the idea of study programs, a set of experiences lived by students at school or, in a broader sense, educational projects and guidelines defined by central administrations to be adopted by education systems.

We can say that in this process of teacher education, both the trainer's knowledge and the trainees' knowledge is a social knowledge that, according to Tardif (2007), is shared by all agents who have a common education.

Labor relations are put through representations or practices of these agents who are subject because of the collective structure of their work. In other words, no matter how different a program or subject may be, they make sense when arranged in relation to this collective work situation, reinforces Tardif (2007).

Another important aspect to consider in the formation of professional teacher identity is how to legitimize their social knowledge through educational agencies. We must be judicious regarding the definition and use of these means of training: universities, scientific groups, graduate studies, competence attestation and approval body, etc.

In this sense, what a teacher should teach is not, above all, a cognitive or epistemological problem, but a social issue,

as shown in the history of the teaching profession (TARDIF, 2005).

However, following this author's reasoning, what a teacher knows depends on what he does not know, or what others know in his place or on his behalf. Or even the knowledge that others oppose or attribute to him (TARDIF, 2007).

In this way, we will build our professional identity, through the knowledge already established by science, where we will be able to have a base to give shape to other new knowledge.

Curricular knowledge imprints the discourses, objectives, contents and methods from the programs that each institution organizes and defines as culture and models of initial and continuing education, articulated, identity and professional.

In this logic, we can say that this entire process is what recognizes the teacher's identity as a specific field of knowledge. The continuing education of teachers can be a means of cultural dissemination and training of the individual that can contribute to forming individual and social identities, hence the importance of the curriculum, as it can enable the construction of knowledge and knowledge of the subjects of the process of which they are structured. by the model of society, contributing so that these subjects, based on the contents studied and the pedagogical processes experienced, assume a praxis of transforming their realities.

### **2.3 The knowledge and pedagogical practices of teachers in the area**

Currently, a lot is debated about the formation of citizens, their role in the community as well as their duties and commitments before the established collective. And on this issue, Freire points to other concerns that permeate this process of reflection, as it is not enough for the individual to be constantly reflecting on their environment and their role in this space, but knowing how to act and act in the face of situations that present themselves daily.

For the author Paulo Freire, in his book *Education and Change*, he describes that: "The first condition for a being to take on a committed act and be able to act and reflect". (FREIRE, 1979, P.1)

Thinking like this, the human being intrinsically has its ideal safeguarding in its own individual and collective way of being. The social structure we observe today is the result of an ancient construction of thinking and reflective beings who tested their instincts and bet on community coexistence, knowing their commitments, even if no one has defined them.

It is the awareness of being in the world in the condition of

an unfinished being, the presupposition for a true commitment to reality and men, according to Freire. It is not possible to act in this reality-society without having knowledge or a naive conscience. The non-responsible action of the being must be based on a libertarian knowledge that provides them with the intellectual tools necessary for reading this society, hence the reading of the world.

Criticism understands a world as a historical construction, therefore cultural, abandoning the false idea that things are like that because they have always been like that by divine will; it allows us to perceive the dynamics of history and human life, abandoning the principle of inertia and neutrality (fallacious act) in doing in society. Criticality, characteristic of conscious thinking, seeks in the historical complexities, the reasons for being of the reality that is presented to us as natural.

The teaching and learning of any school subject occur as - and result from - a social relationship, the result of human interactions and, therefore, cannot be summarized as isolated methodological procedures. This set of human and consequently social and historical interactions can be understood under the name of pedagogical relationship, which encompasses the set of interactions that are established between the teacher, students and knowledge (CORDEIRO, 2009).

This pedagogical relationship between teachers and students, but also involving other dimensions and characters of the reality of the teaching and learning process, manifests the vision of overcoming that the teacher is only a transmitter of knowledge, following the path that this, through of its pedagogical practice, with students taking on the incentive to search, discover, compare, analyze and organize knowledge; in addition, the encouragement of criticism, co-responsibility in the learning process and their own autonomy (MASETTO, 1999.).

In this way, the pedagogical practice can assume the character of repetitive, utilitarian and spontaneous practice, without reflection and without clearly defined intentions. Or, on the other hand, assume an inseparable relationship between theory and practice, with conscious pedagogical intentions that want renewal, transformation and changes in the construction of knowledge.

Humanism is not linked to an ideal of a good man, but to a radical commitment to the concrete man is being prevented from being more, in the sense of making himself more human, building himself and not adapting to the world. It is a historical process in which people do not naturalize themselves, but humanize the world. For this reason, I cannot reduce man to a simple object of technique, to an autonomous manipulable. (FREIRE, 2014).

For Freire, the subject must be aligned with his time, have a sense of belonging to live it fully and adapting to current technologies. If man is considered an empty container where technical information is deposited. It will never be seen in its entirety. Making it impossible to guarantee the human being of dignity as a person to build the authentic human being. The challenges are much more related to how society can intervene dialogically in the production of scientific and technological knowledge.

The moment society turns to itself in search of its authenticity, it starts to worry about its historical project. The social worker as a man has to make his choice. Either he adheres to the change that occurs in the true sense of humanization of man, of his being more, or he favors the permanence of the current situation. The attempt to raise awareness of the individuals we work with, while also raising awareness with them, seems to be the role of the social worker who opts for change.

In the pedagogical thinking of the Brazilian educator, a conception that educating cannot be understood as synonymous with teaching or transmitting knowledge becomes noticeable. Education is a dialogic action that allows students to become aware of and transforming action about their own reality.

The educator positions himself as a mediator in educational spaces, forming reflexive critical and self-critical subjects and not imitators of ideas. Understanding that the notion of educating can be seen with new transformations and idealizations, based on the reciprocal exchanges of knowledge, realizing that the student also places himself in the position of subject of knowledge production and not as an object.

The learning process takes place through the mutual exchange of knowledge between subjects. Since, the learning process only occurs when learning makes some sense to the subjects, because our cognitive skills have a beautiful ability to store, however, only store what is directly connected with our own interests, which somehow makes us sense.

Teaching practices consist in provoking critical reflection and instigating curiosity about the reality of all subjects, since we understand that each subject already has a baggage of knowledge that makes sense in some way, as it is knowledge that survived after the oblivion curve that every individual has.

The great task of a democratic educator is to make the student get as close as possible to his perceptible knowledge, producing conditions for him to learn to develop his knowledge and thoughts through research, questioning, debate and criticism, transforming himself into restless people and accurate in your actions and thoughts.

The educator is not transferring knowledge, but being a mediator for the student to conquer their own autonomy, their criticality through directions for them to seek their own knowledge.

Among the existing educational modifications, the need for a continuous improvement of the educator to improve their educational practice is perceived. The classroom has become an environment for acquiring knowledge, where the educator is no longer the only holder of knowledge and has become a conductor of this process. It is necessary to insist: this knowledge necessary for the teacher – that teaching is not only necessary to be apprehended by him and by the students in their reasons for being – ontological, political, ethical, epistemological, pedagogical, but also needs to be constantly witnessed, lived. (FREIRE, 1996)

In order to reach the necessary knowledge, it is evident that students and educators need stimuli that start to arouse curiosity and, consequently, the search for knowledge, working on mutual learning within the classroom.

The teacher must have the humility to always be in search of new knowledge, because the search for the new is what will make him a critic and only in this way will he help his students to build the long-awaited criticality. Different from banking education where the educator is the holder of knowledge that transfers the contents to their students so that the student is only a receiver of knowledge.

Students must keep criticality and curiosity flourishing in them, through a horizontal education that is not stuck in banking conformism. Conquering the utopia of a formation of thinking subjects, through a dynamic and dialectical process.

Thus, a class or an educational meeting will become a pedagogical practice when organized around intentions, as well as in the construction of practices that give meaning to intentions. It will be a pedagogical practice when incorporating continuous and collective reflection, in order to ensure that the proposed intention is made available to all; it will be pedagogical as it seeks to build practices that ensure that the referrals proposed by the intentions can be carried out.

It is necessary, when studying the educational practice experienced in public schools, in particular, to understand it as a process, which must necessarily contain three fundamental and inseparable phases: planning, a pedagogical intervention itself and an evaluation of the action undertaken, since the pedagogical intervention has a before and an after that constitute the substantial pieces in all educational practice. The planning and evaluation of educational processes are an inseparable part of teaching activities (ZABALA, 1998).



Also according to Zabala's (1998) understanding, however little explicit the processes of prior planning or evaluation of the pedagogical intervention may be, this cannot be analyzed without being dynamically observed from a model of perception of the reality of the classroom, where planning, application and evaluation are closely linked (ZABALA, 1998)

The teaching practice, preferably, can be analyzed through its didactic sequences, which are a set of ordered, structured and articulated activities for the achievement of certain educational objectives, which have a beginning and an end known by both teachers and students.

The analysis of teaching practice through the study of didactic sequences involves a broad understanding of its three constituent pillars - planning, intervention and assessment, the role of teachers and students and the links established between them, the social, spatial and temporal organization of the class, the organization of the contents, the characteristics and the use of the existing teaching materials and the path and evaluation strategies used.

### III. FINAL CONSIDERATIONS

The objective of this work was to evaluate the ongoing teacher education strategy currently in force in the municipal network of Várzea Alegre - Ceará. This Project has the teaching protagonism as its main premise. This strategy, therefore, is developed from the belief that basic education teachers themselves can assume the coordination of in-service training processes, in which teaching practice is configured as the main instrument of study and reflection.

The great challenge for any proposal for continuing education is to provide teachers with the conditions to carry out their work safely and with a high level of qualification. We understand that it is extremely important that basic education teachers take the lead in their training process as knowledge builders from the systematization of their experiences through the development of research as a construct of their professional identity.

Thus, it introduces into the educational scenario Várzea Alegre the possibilities of developing the potential of teachers through the protagonism and structuring of management mechanisms of the training process that enable them to fully develop their teaching functions, qualifying the teaching and learning process.

But the implementation of this scope of formative policy needs improvement to reach its objectives. Basic education teachers need to be encouraged even more, a proposal for continuous training has been approaching school units, a strategic locus of the entire process that aims to positively change pedagogical practices.

However, many teachers still do not understand how significant the regular meeting with their professional colleagues is, in addition to the regular exchange of experiences, to sign a cooperative study pact in the perspective of self-training and collaboration with the training of the other. Viewing this process in this way can lead to the strengthening of the professionalization of the teaching category.

Aiming to qualify this training proposal of continuous character, it is very important to ensure the integration between teacher training and academic knowledge; the creation of study groups as a way to strengthen training in the educational ideas of each teacher;

Finally, we still have many gaps to understand the impact that this action has generated and can still generate in the municipal education system of Várzea Alegre Ceará. The expectation is that the teachers themselves will take a stand against this proposal and be able to point out directions for qualification or change of direction.

What matters, in the end, is that education systems, preferably articulated with universities, can provide basic education teachers with continuous training that can respond to the concerns of professionals and provide greater security for the exercise of teaching.

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# Use of Design Thinking by the Regulator in the process of applying Public Hearings in the electricity sector.

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**Keywords** — *Contribution, Design Thinking, Electric Sector, Public Hearing, Regulation.*

**Abstract**— *The article analyzes the role of Public Hearings - PHs in shaping Regulation in the electricity industry in Brazil. A total of 1,077 PHs were examined where the Government, represented by the Regulator (National Electric Energy Agency – ANEEL), consulted civil society in the period from 2010 to 2019. The statistical survey separated agents by category, in order to better understand the leading role that each typology plays in the electricity sector industry. The article ends with an analysis of the use of the concept of Design Thinking - DT in the methodology of interaction with those interested in participating in Public Hearings. The DT can act in the integration of solutions between the themes proposed in the PHs, serving as an integrating agent in the simplification of regulatory policies.*

## I. INTRODUCTION

Public Hearings (PHs) are mechanisms intensively used by the Government in the formulation of public policies normally related to the executive power. These instruments have become particularly useful for collecting society's opinions and data, aiming at the well-being and continuous improvement of regulation. In this article we will designate both tools as AP, except when explicitly detailed as CP for a specific analysis purpose.

There are countries with a great tradition in holding Public Hearings, such as the United Kingdom and the United States, the first of which has more than two hundred years of history of holding PHs.

The United States inherited the practice, from the time of its colonization, of holding Public Hearings from England and integrated it into its legal system, making it

an important instrument of popular participation, heavily influenced by the Common Law<sup>1</sup>.

Society's behavior and opinions have always influenced government decision-making and the elaboration of regulatory standards. For this, the governors can use the PHs (Poddar, 2017) as one of the forms of citizen participation.

Not only countries considered developed, but developing ones such as Mexico, Brazil and India represent some examples of countries that also hold public hearings.

Taking India as an example, it is recorded that since 1997 public hearings have been held to discuss environmental issues, which is one of the first issues in the country to have society's participation after independence (Poddar, 2017).

<sup>1</sup> Common Law is a legal system used in English-speaking countries. Its main characteristic is that it is based on precedents created from case law and not statutes.

In the electricity sector, the Central Electricity Regulatory Commission (CERC), an Indian Regulatory Agency which, although founded in 1998, only started its process of public hearings in 2013. By comparing this performance with that of Brazil, the National Electric Energy Agency (ANEEL) began discussing PHs in 1998, two years after their constitution.

In Brazil, the obligation to hold a public hearing in the legislative process or even before it for certain matters is based on the Federal Constitution in the following articles: 5th, item XXXIII, which ensures the right to information; art. 58, § 2, item II, which guarantees the holding of public hearings in the Congress Commissions, applied by symmetry to states and municipalities (Piesanti, 2014).

The evolution of society and public administration in holding Public Hearings will increasingly demand popular participation in matters ranging from those that generate the greatest impact to matters of interest to a local minority.

## II. PURPOSE

During the last decade, between 2010 and 2019, the National Electric Energy Agency - ANEEL proposed 1077 opportunities in which representatives of society could contribute to the improvement of the Brazilian Electric Sector - SEB.

Considering this universe, the objective of the research work was to analyze both qualitatively and quantitatively the PAs. The survey analyzed the participation of contributing agents represented by certain groups in society in search of defending their own interests.

Finally, after surveying and analyzing qualitatively and quantitatively the data tabulation, it was possible to map the deficiencies, and thus propose as an improvement the incorporation of the concepts of Design Thinking - DT as a standard tool in the preparation of SEB Public Hearings.

## III. METHODOLOGY

The methodology used was the empirical basis from real data from 1,077 Public Hearings held in the period 2010 to 2019. Statistical data on PHs were obtained directly from the ANEEL website and compiled in order to allow quantitative analysis over the last decade.

Also, the fundamentals and processes applied to the DT were used to propose improvements throughout the chain, from the beginning to the conclusion of a PH.

## IV. REASONS FOR PROPOSING PUBLIC HEARINGS

The need to hold a Public Hearing can be motivated by multiple reasons, listed below: (i) comply with the law; (ii) obtain information about citizens; (iii) provide information to citizens; (iv) improve public decisions or programs; (v) improve acceptance of decisions about programs and public policies; (vi) altering the role of political power and resource allocations; (vii) respond to citizens' concerns; (viii) assisting difficult public decisions; (ix) obtain political advantage; (x) seek collaborative solutions to problems (Mater, 1984).

In many cases, the government uses more than one of the reasons described, because there is a need to propose an improvement in a given norm, at the same time it can improve decisions on public policy programs and seek collaborative solutions with society.

A concept that can be used in the preparation of a proposal by the society is the use of "Advocacy". As a definition, "Advocacy" is used as a synonym for defending and arguing in favor of a cause. It is a process of claiming rights that aims to influence the formulation and implementation of public policies (Sabatier, 1988).

In addition to the definition of "Advocacy", its application usually through structured actions (texts, articles, web sites, events, lectures, interviews, among other mechanisms of interaction with the target audience), aims to gain sympathy and support from society towards a belief, public policy goal or project. Eventually, "Advocacy" strategies can be built for actions in opposition to a certain theme (Silva, 2019). The practice of "Advocacy" may arise from these representations and from the strategy chosen in the presentation of a certain regulatory issue.

"Advocacy" fits very well when used in conjunction with society's contributions in PAs, since the process allows for improved regulation. By organizing themselves, segments of society develop a structure and strategy in the area of action when they participate in PAs to defend specific interests.

Control is needed so that the objective is not lost, and the "Advocacy" could be used in order to serve the interests of certain groups, generally those most powerful in exerting influence in the elaboration of regulatory norms. It is a fact that does not contribute to the essence of "Advocacy": improving regulation in favor of a cause.

Strategy and tactics are needed to discuss and present contributions at Public Hearings. First, knowing in depth the problem to be discussed is the first step in defining the strategy. Then, it is necessary to choose the methodology

of how to develop the subject with the government and society impacted by the proposal (Mater, 1984).

An appropriate tactic defined together with the strategy can be the difference in the success or failure in the presentation of ideas in the proposed normative improvement in a PA. In certain situations, when an issue is controversial or a consultation with society may not bring the result expected by the Regulator, it is interesting to use a useful tactic: do not take any action for a certain period causing a certain issue, when approached in a Hearing Public, in the future, will not be remembered by many in society. Taking no action is also a strategy to be followed by the Regulator (Mater, 1984).

Finally, once the approach strategy and execution tactics have been defined, it is necessary that communication with all those involved is also defined in order to ensure successful contributions to the Regulator (Mater, 1984).

Fig. 1 schematically shows the approval cycle of contributions in public hearings considering an ideal methodology.

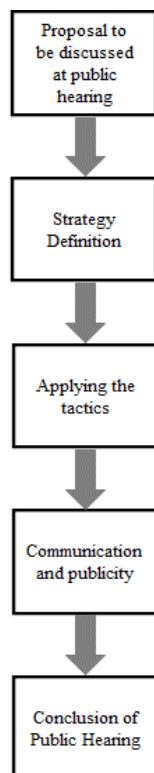


Fig. 1- Stages of holding a Public Hearing

Once a Public Hearing is proposed, in a macro way, Fig. 2 shows the stages of its realization.

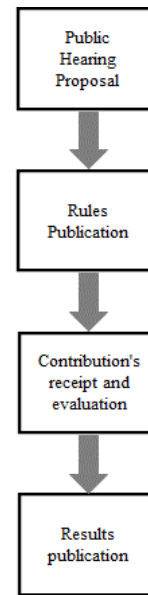


Fig. 2 - Stages of carrying out a Public Hearing.

First, the proposal for a public hearing is conceived by the Regulator. It contains the proposed regulation, its justification and other items that justify the proposal.

Once the initial items are defined, the PH is published to the society. In the publication are the deadlines and form for contribution, and if in person, the place and date of the meeting. This step consists of how the contributions will be received by the Regulator.

The next step is to receive contributions and review them. Just as the company makes the contribution and justifies any change in the original proposal, the Regulator must justify whether each of the proposals was considered and its justification for acceptance or not.

The conclusion of the process is the publication of the proposed regulation containing the contributions sent and approved by the society.

## V. PUBLIC HEARINGS - AN INTERNATIONAL VIEW

The following is a vision of countries where PHs have been tools used by public authorities for centuries and constantly contribute to regulatory improvement.

### 5.1 PUBLIC HEARINGS IN THE US

The United States has a robust history about PHs. During the early years of the US colonies, various forms of participatory, representative, and inquiry hearings were written into federal and local law. Today, more than 97% of local governments hold public hearings, open by law to all US residents (Holliday, 2018).

American social behavior and culture have a great influence on the formation of the legal system. In meetings to debate issues that impact the entire local society, the contributions made by residents consider their lifestyle, customs, upbringing and the way they were inserted into society (BLACK, 2009). Looking at American customs and history, public hearings are “the purest form of democracy that ensures that all political decisions are in the public interest, as no intermediary is placed between voters and public decisions.” (Holliday, 2018)

It is possible to find the participation of the population in practically all spheres of government, which have communication channels to receive suggestions from society and inform the holding of public hearings. Regulatory bodies such as the Federal Energy Regulatory Commission (FERC) hold periodic sessions, providing opportunities to suggest improvements in regulation, new utility programs or new assessment standards to be applied to the performance of a concessionaire (RAP, 2011).

As quoted by (Holliday, 2018) "society's participation provides effective monitoring and control of local affairs, even when participants are not managed by committees, subcommittees and even elected councils - public bodies that generally produce opaque processes, non-binding agreements and poorly marketed advertisements and meeting."

It is possible to find several Public Hearings on subjects ranging from the conception of laws to the internal organization of US regulatory agencies. The objective is always to guarantee the participation of society in improving regulation (National Democratic Institute for International Affairs, 2000).

In the United States there is the National Association of Regulatory Utility Commissioners (NARUC), a non-profit organization, founded in 1889, dedicated to representing the members of state public service commissions that regulate utilities that provide essential services such as energy, telecommunications, energy, water and transport (NARUC, 2020). NARUC provides a venue to define and influence public policy, share best practices and promote solutions to improve regulation. It created a system of commissions so that each US state has representatives who will defend the best interests of regulation.

As an example, in the electricity sector there is the electricity committee that develops and promotes the supply of reliable, adequate and affordable electricity. Through strong collaboration with FERC and related federal agencies, the Committee also seeks ways to improve the quality and effectiveness of regulation through the provision of knowledge to any citizen, cooperation and information exchange (NARUC, 2020).

As an association whose objective is to improve regulation, NARUC uses public hearings to improve regulation independently.

The federative and participatory history of society in the United States is a very important factor that has contributed to the development of public policies and services that offer quality and improve conditions for the population.

## 5.2 PUBLIC HEARINGS IN THE UNITED KINGDOM

As previously mentioned, the PHs had their experimentation started in the United Kingdom in the 18th and 19th centuries to carry out the process of delimiting public land. Commissions were formed to listen to society's considerations on land delimitation. It was one of the first examples of a public hearing and emphasizes how most public hearings are used today when dealing with public land and private property (Kemp, 1988).

From 1948 onwards, the UK began a series of regulations in various sectors. Among other topics, it can be exemplified with equal remuneration and sex discrimination (1970), the industrial relations law that introduced the concept of unfair dismissal in 1971 and the legislation related to health and safety at work in 1974.

In 1983, with the conservative party winning the elections, a deregulation process was initiated. Several documents recommended anti-regulatory processes, from the preparation of a structured analysis of the impact of the proposed legislation, to the costs and benefits, on companies (Deregulation 1948-2006, 2020).

As an initiative to improve the English regulatory process, the Better Regulation Task Force (BRTF) was created in 1997, whose basic principles were:

Proportionality - Regulators should intervene only when necessary. Remedies must be appropriate to the risk and costs identified and minimized;

Accountability - Regulators must be able to justify decisions and be subject to public scrutiny;

Consistency - Government rules and standards must be united and fairly implemented while maintaining the stability of regulation over the years;

Transparency - Regulators need to provide clear, consistent, comparable and accessible information, publicize regulatory proposals, impacts and contributions received to all who wish;

Objective (focus) - Regulation should focus on the problem and minimize side effects.

Considering the above principles, BRTF started to propose public hearings, resulting in a significant improvement in the quality of regulation.

As a result of the results obtained, in 2006 the Law on Legislative and Regulatory Reform was approved, establishing statutory principles of good regulation based on the work of the task force.

BRTF was replaced in 2008 by a permanent department called Better Regulation. This division comprises the Department for Business, Energy and Industrial Strategy (British Department for Business, Energy and Industrial Strategy). Better Regulation aims to improve accountability to society, in addition to providing transparency to the regulatory process. A report is issued annually with the public hearings, their results and the savings or efficiency generated for the various sectors of activity, including the electricity sector (United Kingdom Government, 2020).

In Great Britain, the Office of Gas and Electricity Markets (OFGEM), the government's regulatory body for the electricity and natural gas markets, was created. It was formed by the union of the Office of Electricity Regulation (OFFER) and the Office of Gas Supply (OFGAS).

From its creation in 1998 to 2019, OFGEM carried out 2,405 public consultations, and as one of the principles of transparency established by the BRTF, in OFGEM's annual reports there is a description of the financial impacts of the consultations on the British economy (OFGEM, 2020).

OFGEM also proposes regulatory measures for the energy and gas market, and an example is the "RIIO<sup>2</sup>" policy. The objective, with its implementation, is to limit the maximum amount that can be charged as a tariff by the user of the electricity and gas distribution system. The first phase of the implementation of the "RIIO-1" price policy will be completed in 2021, for this reason OFGEM plans its continuity with the "RIIO-2" for the following year.

For this, the PH was proposed with the objective of collecting the greatest amount of information from the users of the distribution network and thus individually defining the pricing policies in the distribution system tariff with the local concessionaires (OFGEM, 2020).

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<sup>2</sup> It is a program used by the regulator with the objective of ensuring that companies provide a safe and reliable service, at a fair value, maximize performance, operate efficiently, innovate and guarantee the operation of their service networks for current and future customers.

### 5.3 PUBLIC HEARINGS IN BRAZIL

In Brazil, Public Hearings emerged in 1986 through the National Council for the Environment (CONAMA), which allows the use of a public hearing to discuss the Environmental Impact Report (RIMA) and to provide information on the report and on the environmental impact (Silva, Santos, & Paulino, 2003).

In 1987, the Bylaws of the National Constituent Assembly provided, in its art. 14, the holding of a public hearing in the thematic subcommittees, with the objective of hearing "entities representing segments of society". In this case, these audiences are merely informative (Silva, Santos, & Paulino, 2003).

Other laws during the 1990s and early 2000s also contained in their regulations the possibility of holding a public hearing to discuss issues involving the common good.

The figure of audiences gained greater evidence in the second half of the nineties after the privatization process developed in that decade.

With the privatization process, the role of regulatory agencies gained relevance, contributing to the growth of public hearings and consultations as a way to involve society in the preparation of the regulatory legal system.

It was at that time the beginning of the creation of several federal regulatory agencies, inaugurated by ANEEL.

In 1999, a law was published that regulates the administrative process in the scope of the Federal Public Administration, providing for the figure of the public hearing in the Brazilian administrative process (Soares, 2002), thus enabling regulatory agencies to use this tool in order to get closer of society and develop the themes necessary for the improvement of regulation.

The last major change in the legal system took place in 2019, in which Law No. 13,848 brought, among other advances, the obligation of the Regulator to prepare the Regulatory Impact Analysis (RIA), in addition to the preparation of a document describing the regulatory impacts of contributions received by the participants.

### 5.4 ASSOCIATIONS EXPERIENCE REGULATORY AND PHs - THE CASE OF ABAR AND NARUC PUBLIC HEARINGS IN BRAZIL

The Brazilian Association of Regulatory Agencies (ABAR) was founded on April 8, 1999. It is an entity governed by private law, created in the form of a non-profit, non-partisan civil association. Its objective is to promote mutual collaboration between associates and public authorities, in the pursuit of improving regulation

and technical capacity, contributing to the advancement and consolidation of regulatory activity throughout Brazil. It brings together a large number of Regulatory Agencies in the three spheres, federal, state and (ABAR, 2020).

The total number of ABAR members is 59 considering federal, state, municipal and inter-municipal regulatory agencies (ABAR, 2020). Making a comparison with NARUC in which there are representatives in the entity from all 50 American states in addition to the District of Columbia, Puerto Rico and the Virgin Islands (NARUC, 2020).

The conceptual difference between ABAR and NARUC lies in the fact that the former is an association of regulatory agencies. The second is an entity that has representatives of regulators from various areas of regulation in the US.

This difference in the methodology of participation increases representation, and the decisions taken by NARUC are respected and often accepted by its more than 50 members.

NARUC has services such as advocacy, educational, communication, research and international programs (NARUC, 2020). ABAR, on the other hand, offers an agenda of regulatory discussions and its consequences with the parliamentary chambers, mediation of solutions, courses and training, in addition to various initiatives in the area of basic sanitation, whose initial objective is improve regulatory instruments related to urban solid waste in the country (ABAR, 2020).

## VI. PHs IN THE BRAZILIAN ELECTRIC SECTOR - QUANTITATIVE AND QUALITATIVE ANALYSIS

The work carried out a quantitative and qualitative analysis of the PAs carried out by ANEEL in the ten years between 2010 and 2019.

ANEEL, since its creation, has as a principle the transparency in decision-making with the objective of improving SEB policies. The participation of society, with the objective of improving the regulation of the sector and the inspection of the activities carried out by the Agency, shows the commitment assumed by ANEEL with the best practices when communicating with society (ANEEL, 2020).

During the past decade, ANEEL carried out, in absolute numbers, a total of 1,077 PHs. The distribution over the years is detailed in Table 1.

Table 1 - Total PHs carried out by ANEEL between 2010 to 2019

Year	Total
2010	144
2011	90
2012	124
2013	149
2014	93
2015	96
2016	111
2017	99
2018	84
2019	87
<b>Total</b>	<b>1.077</b>

In Table 2, the work considered only the PHs promoted by ANEEL during the period from 2010 to 2019. Performing a percentage distribution during the aforementioned period, it is possible to identify which were the years with the highest volume of Public Hearings.

Table 2 - Distributions of PHs by percentage

Year	%
2010	13,37
2011	8,36
2012	11,51
2013	13,83
2014	8,64
2015	8,91
2016	10,31
2017	9,19
2018	7,80
2019	8,08
<b>Total</b>	<b>100</b>

Fig. 3, in turn, shows the percentage distribution of PHs carried out in the last decade.

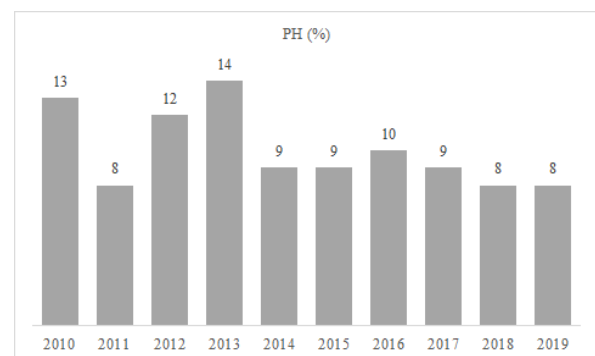


Fig. 3 - Percentage distribution of PHs



In the years 2010, 2012 and 2013, there was a greater number of PHs due to the need to establish or revise the values of Equivalent Outage Duration per Consumer Unit (DEC) and Equivalent Outage Frequency per Consumer Unit (FEC) of the distributors, in addition to a tariff review for both distributors and energy cooperatives. For each of them, an independent AP was opened.

**5.5 ENTITIES THAT CONTRIBUTE TO PHs**

For this work, a standardization of the typology of entities or representative groups that contribute to PAs was carried out. The following are qualified as:

**Distributor:** Concessionaire of public service for the distribution of electric energy, and company designated to provide the public service for the distribution of electric energy;

**Association:** Non-profit organization characterized by the union of individuals or legal entities with the objective of achieving mutual benefits and development for the segment they represent;

**Power Generator:** Holder of concession for electricity generation;

**Transmitter:** Concessionaire of public electricity transmission service or equivalent to public transmission service concessionaire;

**Energy Trader:** Entrepreneur that sells electricity without necessarily owning it;

**Consulting:** specialized companies or professionals capable of diagnosing or formulating solutions on a subject or specialty for the business environment;

**Private company:** Consumers who use electricity for their activities;

**Individuals:** individual representatives interested in the topic - citizens;

**Government:** Governing authority of a nation or political unit, whose purpose is to regulate and organize society. It covers the federal, state, district and municipal spheres;

A research challenge, during the survey of information, was how to differentiate the classification of generator and private company since there are public and private generators working in the SEB.

As a solution, the work considered any private or public company that produces energy as a generator, leaving companies that do not generate energy within the concept of private companies.

Technically, contributing to PAs would be the opportunity that Brazilian society has to improve the regulatory framework. However, this scenario is not

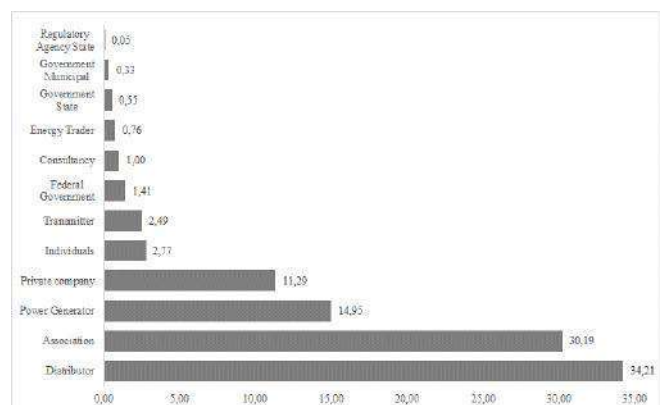
exactly what happens in practice. Participation in PAs, except for those that have a strong popular appeal, are restricted to groups directly impacted by the suggestion of change and/or that defend their own interests, such as associations.

Table 3 shows the percentage of participation of the groups defined above, making it possible to analyze the participation of each one in the SEB PHs.

*Table 3 - Percentage of participation of society in PHs*

Entity Type	Total (%)
Distributor	34,21
Association	30,19
Power Generator	14,95
Private company	11,29
Individuals	2,77
Transmitter	2,49
Federal Government	1,41
Consultancy	1,00
Energy Trader	0,76
Government State	0,55
Government Municipal	0,33
Regulatory Agency State	0,05
<b>Total</b>	<b>100</b>

Fig.4 shows the percentage distribution of contributions made by PHs.



*Fig. 4 - Distribution of contributions by PH entities*

Considering the analysis of the data collected, the distributor is undoubtedly the most present agent and, consequently, the most interested in monitoring and participating in the improvement of regulation. The reason is due to the fact that considering the energy chain as being

generation, transmission, distribution, commercialization and consumption of energy, distribution is where regulation can act more intensely.

The energy tariff also has a strong presence in regulation as a way to protect the end user. Due to the complexity of the definition process, the average citizen hardly understands the calculation methodology and its revisions. It is necessary for the regulatory authority to act in order to guarantee and maintain the economic balance of the concessionaires, in addition to maintaining the constant improvement of the network.

Another point to be highlighted is the need for awareness on the part of the population, since not everyone knows the role of the State as a Regulator and guider of public policies.

In the generation and commercialization segment, regulatory models in Brazil have opted for competition, and thus there are fewer standards under ANEEL's responsibility. The environmental, labor and other standards used as the basis for the installation of the projects end up being more impactful.

For transmission companies, regulation acts to ensure the quality of service and the economic-financial balance of the transmission lines.

In marketing, as discussed above, excessive regulation that could restrict the competitiveness of companies in the sector is less present than in other links in the production chain. The regulation is restricted to authorization to trade energy and operating limits according to the economic capacity of each company. There are also regulations defining entry barriers for free and special consumers.

Consumers act with direct contributions in PHs or through associations. Consultants, individuals and the government in its three spheres of power, participate in PHs with less intensity, acting in a timely manner according to their interests.

In the survey, the percentage of private companies is behind the contributions of distributors, associations and generators. Examples of companies in the segment are: engineering, law firm, construction companies, input suppliers, among others, who also act on a timely basis to improve regulation.

The scenario of low participation by society or participation only by certain groups is also not a Brazilian phenomenon. In the United States, even with the creation of the portal <https://www.regulations.gov> during the Clinton administration in the 1990s, contributions made by society could be sent using not only physical correspondence, but also the digital means of the Internet. epoch as e-mail and online forms (Coglianês, 2006).

Despite the offer of new mechanisms for the participation of the population, the amount of contributions was not enough to change the scenario of low social adhesion when called upon to collaborate in popular participation in the process of regulating the public (Coglianês, 2006).

The participation between two and three percent shows the low participation of individuals in direct participation in the improvement of regulation. Brazilians make little use of this mechanism, leaving other entities the possibility of intervening in the change.

Table 4 shows the amount of contributions made by individuals, the conclusion of low adherence happens when comparing with the total contributions received in each year of the survey.

Occasionally a particular event can lead to more pronounced contributions. In 2013, PH No. 15/2013 proposed improvement of Normative Resolution No. 414/2010 when the distributor carries out a project or work on private property, attracting greater participation. In REN No. 414/2010, in Chapter III, it is stipulated that the distributor must inform the interested party about the list of works and services required and the schedule, with the deadline for the beginning and completion of the works. As this is an issue that impacts the private property of individuals, the number of contributions was higher this year.

Table 4 - Quantity of contributions in PHs made by individuals

Year	Total contributions received	Total contributions to PHs by individuals
2010	2.862	18
2011	5.464	49
2012	4.766	35
2013	3.891	57
2014	6.088	24
2015	7.049	76
2016	4.873	21
2017	5.251	16
2018	3.845	8
2019	5.019	2
<b>Total</b>	<b>49.108</b>	<b>306</b>

## VII. APPLICATION OF DESIGN THINKING IN PHs

Tim Brown defined Design Thinking in 2008 as: "a discipline that uses the designer's sensitivity and innovation methods to match people's needs with what is

technically possible and financially viable for the organization and thus create value for the customer” (Brown, 2008).

Vijay Kumar defined that the DT process consists of a continuous loop, the first step being to observe and learn from reality, and then seek to reach a greater understanding through abstractions and identification of conceptual models that allow us to reframe the problem situation of new ones. shapes (Kumar, 2013).

Fig. 5 exemplifies the schematic conceptualization of the process developed by Kumar.

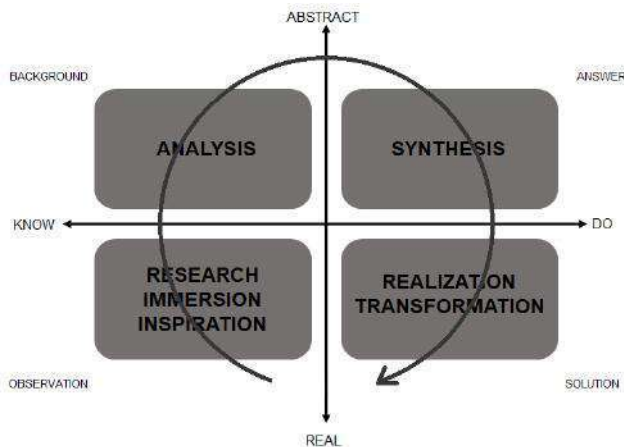


Fig. 5 - Sequence in the elaboration of ideas using DT

Kumar divides the DT process into four logical and sequential steps exemplified in Figure 3, namely:

- 1) Research: process of immersion in reality in search of observations, inspirations and with the help of people involved and the contexts of the problem situation;
- 2) Analysis: activity in which what was collected from the real is abstractly worked, seeking to propose new points of view for the problem situation. These new ways of understanding the problem will give a new direction to the process and structure a new knowledge of the plan for its resolution initially in the field of ideas (abstract);
- 3) Synthesis: step in which, based on the analysis of the previous step, creative approaches are used to generate ideas and new possibilities for solutions, starting the abstract process of doing;
- 4) Realization: possible identified and schematized solutions are transformed into concrete testable experiences for the main problem in addition to solutions for any problems considered secondary raised in conjunction with the discussion of the main theme.

The process of preparing the DT suggested by Kumar, when applied together Public Hearings, would bring as an

innovation a central theme which would be related to other regulatory matters, thus favoring integration.

Fig 6 shows a scheme of how to integrate the DT in the process of elaborating public hearings.

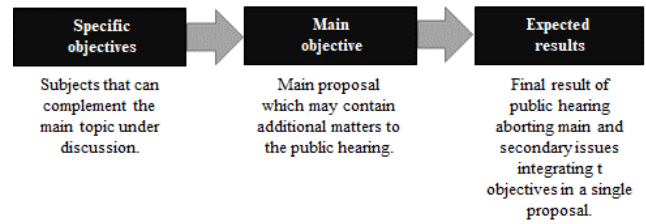


Fig. 6 - How to use the DT concepts in the preparation of proposals for Public Hearings

The initial proposal which has the main objective is defined by the Regulator and placed in a public hearing, it is at this time, as indicated in Fig.1, the definition of the strategy for discussing the ideas.

Afterwards, interested in contributing to the Public Hearing, they would form discussion groups and using the flow elaborated by Kumar and shown in Fig.5, which themes related to PA would be considered as the main objective, which would be specific objectives and the expectation of results.

Once the classification is defined, the Regulator starts receiving contributions from interested parties.

The penultimate step is the compilation by the Regulator, which must prepare a final report analyzing the contributions, justifying whether each one was accepted or not, and another with the regulatory impacts.

Finally, the final step is the elaboration of regulatory improvements based on the expected results on the main topic and on the topics considered specific.

The adoption of the DT as a mechanism can reduce the amount of PA proposed by the Regulator, as in the process, a Public Hearing has unfolding in several sectors through specific objectives.

The concept of “advocacy” can be part of the DT's methodology as the improvement in regulation is discussed in an interdisciplinary way and integrates all representatives of electrical sector segments (generation, distribution, commercialization and consumption).

The problem of low adherence by individuals, as already mentioned, lies in the complexity and understanding of regulation by civil society, but advertising together with a simple, structured, and multidisciplinary methodology allows people to start becoming familiar and start contributing to the PHs.

Along with applying the DT, a planning methodology used by the Office of Gas and Electricity Markets (OFGEM), a UK regulatory agency, displays the status of Public Hearings.

Among the available statuses there are: “Soon”, “Open”, “Closed (awaiting decision)” and “Closed (with decision)”. Statuses help to signal the planning of a given contribution, in addition to demonstrating that if the decision has not yet been published, there is a pending issue on the part of OFGEM.

In Brazil, there is no planning similar to that of OFGEM, and the addition of PHs that will still start the contribution period would be a point of improvement in the process, in addition to the inclusion of their status, especially after the end of the period for receiving contributions.

Regarding the experiences of applying the DT in other countries, there are still few, due to the pioneering spirit and unification of public policies with the DT.

Australia and New Zealand conducted a study of how Design Thinking is integrated into improving public policy. The conclusion was that there is still little evidence that the DT has in its methods and analysis the possibility of application in any sector of public policy. During the first, second and third phases (research, analysis and synthesis) the participation of citizens to understand the problems with the government is of great importance, with Public Consultation being used more frequently (Lewis, McGann, & Blomkamp, 2019).

On the other hand, a final realization that depends on the government does not always find synergy with the government's interests, forcing a change in the concept of public administration to take advantage of the results of the DT. A longer-term study is needed before conclusions about Design Thinking and its impact on policy-making become more evident, but there is a bright future (Lewis, McGann, & Blomkamp, 2019).

In 2016, in Estonia, a study on changes in the process of providing services and benefits to citizens was carried out using the main tools of the DT, in conjunction with popular participation. The result was the creation of a conceptual model for granting benefits that allowed its use by both the public sector and the private sector, stipulating deadlines, skills and improvements (Sirendi & Taveter, 2016).

For these authors, the process of granting benefits has become a product to be offered to the population, with all those involved, public and private agents, performing their functions defined in the conceptual model for efficient care at a low cost to the participants. Also, as a conclusion, the

study highlights the importance of future research to define DT as an integrated solution for continuous improvement (Sirendi & Taveter, 2016).

## VIII. CONCLUSION

Even with few studies integrating the DT to the public sector and more effectively to the SEB, the example mentioned indicates that the interaction in the DT methodology together with the performance of PHs can create an environment in which regulation is improved more effectively, creating the opportunity for creative solutions to emerge that might otherwise not be considered.

The DT utilization process applied to Brazilian regulation can be expanded and used in any nation. The objective of the work was to suggest a methodology for universal integration so that it can contribute to the evolution of regulation through the participation of the population in the themes that the government wishes to discuss.

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# Hydrokinetic Power Generation System coupled to the Axial-Flow Generator

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**Keywords**— *low speeds, Converter, Axial Flow, Generator.*

**Abstract**— *Decentralized power generation is an option to serve communities that survive in places without electricity or isolated from urban centers or in areas with intermittent electricity coming from gasoline or diesel generator sets. This article presents an alternative energy generation with low environmental and financial impact, a floating hydroelectric generation system using an axial flow electric generator combined with a cross-flow hydrokinetic converter that works from water flows in rivers' sections floating structure allows for performance even at low speeds.*

## I. INTRODUCTION

Electricity is needed to develop isolated regions of the country, as access to this service is vital in economic and social development, impacting people's communication, productive use, and a direct relationship to improving the quality of life [4].

The high costs of transmission lines can be caused by the large distances between homes to the network due to the low population density in the Amazon region [4].

Alternative decentralized service solutions have been encouraged by the federal government through social programs. These programs aim to bring electricity to rural regions, isolated through micro and mini hydroelectric plants, thermoelectric plants powered by biofuels or

natural gas, solar photovoltaic plants, wind turbines, hybrid systems [3], [4].

The proposed Hydrokinetic Power Generation System coupled to the Axial-Flow Generator may be a viable option for communities close to rivers with specific hydrological characteristics, including a frequent and constant water flow. This generation system is robust, easy to maintain, and with low financial investment and no environmental impact, as it does not use large, flooded areas.

## II. MODELING OF THE HYDROKINETIC GENERATION SYSTEM COUPLED TO THE AXIAL FLOW GENERATOR

Michell-Banki-type cross-flow turbines use a drum-type rotor equipped with blades. The water flow is directed by a hydraulic profile and meets the rotor blades, driving it. This type of turbine is used in hydraulic projects with smaller waterfalls and a greater volume of excellent water, which usually occurs in flatter regions. [1], [3].

The various types of couplings used between the converter and the generator result in problems ranging from balancing the axes, exposure of the parts to weather, more significant space used, and even maintenance [3].

The construction of unique equipment, which combines a cross-flow hydro converter with a permanent magnet generator or squirrel cage induction motor in an axial flow machine, allows for space and maintenance gains and greater power [3]. The proposed system works submerged or in line with pipes where there are flows of any type [3], [5].

In [3] presents the mathematical modeling of the axial flow generator and the dimensioning of the permanent magnets.

The prototype will be installed on the Madeira River. One of the largest rivers in the world in terms of water volume. It has a total drainage area of 1,420,000 km<sup>2</sup>, or about 1/5 of the entire Amazon basin.

The surveys were carried out with the National Water Agency (known in Brazil by its Portuguese acronym - ANA), in its database, and with the Mineral Resources Research Company (known in Brazil by its Portuguese acronym - CPRM) in Rondônia, where there is historical data on flow, flow velocity, and depth, were made available for consultation, enabling modeling and simulation for the elaboration of the construction project of the floating hydroelectric system in realist scale.

Fig.1 shows the installation location of the Hydrokinetic Power Generation System coupled to the floating Axial Flow Generator.



Fig.1: The Installation location of the proposed system.

The Madeira River is known for transporting a large amount of suspended material and, in the rainy season, its flow goes from 5,000 m<sup>3</sup>/s to 50,000 m<sup>3</sup>/s. Understanding the dynamics of the river, given this seasonality, is essential for determining the parameters of the floating hydroelectric system.

A large amount of sediments in the river increases the fluid density and, in a direct ratio, the available hydraulic power. However, the corrosion problems are more evident.

An important input parameter for the design of a hydrokinetic converter is the river flow velocity since the available hydraulic power is directly proportional to the section area and the cube of the flow velocity. This data over time becomes even more relevant in a river with significant variation in its regime, as is the case of the Madeira River, as shown in Fig. 2.

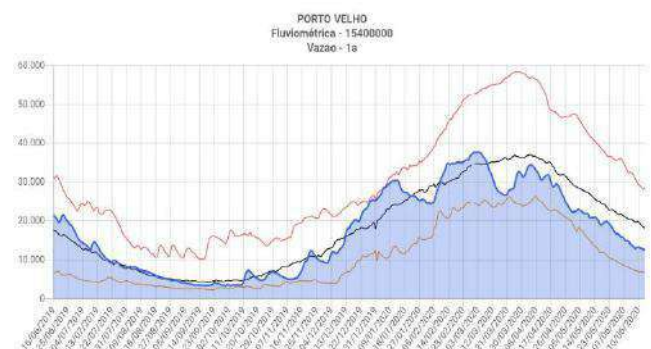


Fig.2: In red is a historical maximum, in orange historical minimum, and in blue the flow value of the last 12 months.

An ADCP - Acoustic Doppler Current Profiler is used to raise the current profile, a hydro-acoustic current profiler that measures the velocity of particles in the water column using a physical principle of propagation of sound waves (Doppler effect). This type of equipment is shown in Fig. 3.

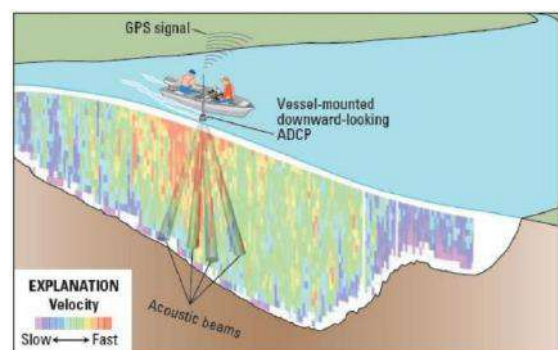


Fig.3: Functioning Acoustic Doppler Current Profiler [6].

The collected flow velocity historical data are simulated in the WinRiver II software, where it is possible

to observe the current velocity profile and the bed trace as shown in Figures. 4 and 5.

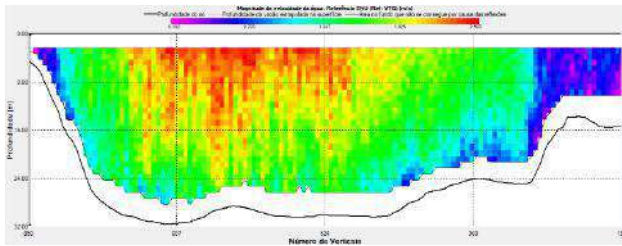


Fig.4: Typical measurement in the flood period (February 2020).

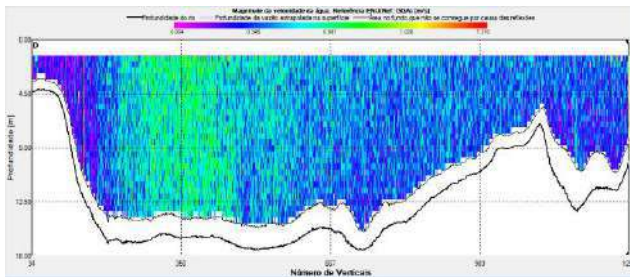


Fig.5: Typical measurement in the dry period (September 2016).

As shown in figures 4 and 5, the average velocity at 200 meters from the right bank of the Madeira River varies from 0.7 m / s in the dry period to 2.5 m / s in flood. With this data, it is possible to develop simulations of the river flow, including the floating system where the turbine will be located. Fig. 6 shows the flow simulation of a natural flow channel with the floating turbine housing system.

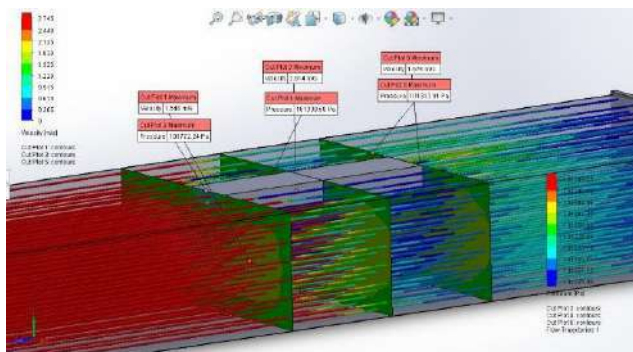


Fig.6: One-channel flow simulations.

A simulation of a diffuser to determine the energy available for a generation was presented in [3]. The results presented demonstrate an extensive recirculation below the diffuser. This recirculation is a hydraulic loss. A new diffuser geometry is proposed to solve this problem, according to the simulations presented in Figures 7, 8, 9, and 10.

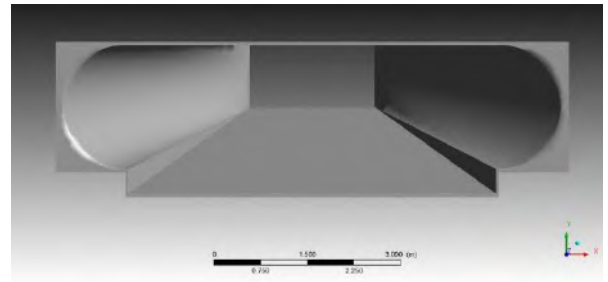


Fig.7: Front view of the diffuser.

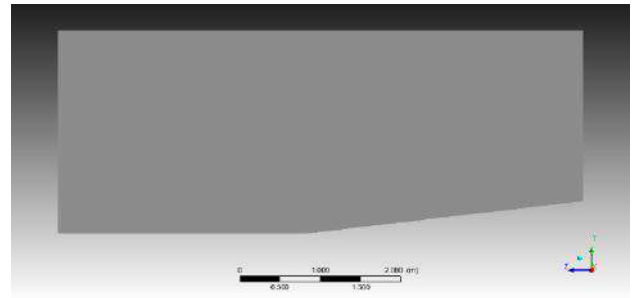


Fig.8: Side view of the diffuser.

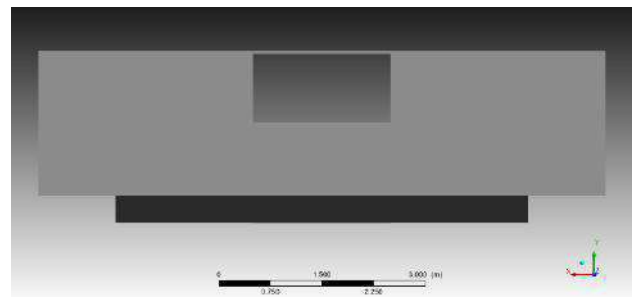


Fig.9: Rear view of the diffuser with exit window (rotor position).

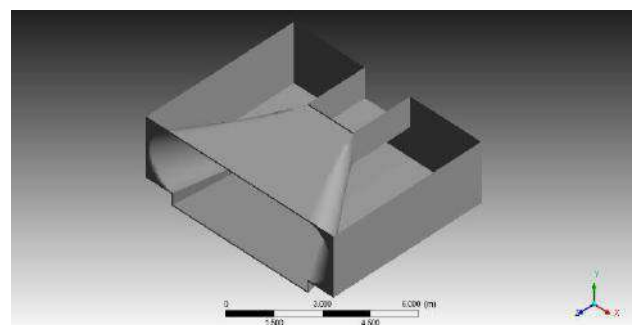


Fig.10: Isometric view of the diffuser.

The computational model used for simulation is shown in Fig. 11. The inflow (upstream), Fig. 12, was based on historical measurements of the speed of the Madeira River in Porto Velho – Rondônia. The geometry was worked on



the SpaceClaim software, Ansys Inc. 2017, and the Meshing software generated the mesh.

In the dry period, the average speed is around 0.7 m/s, and in the flood period, it is 2.5 m/s. Based on this history, the input speed was simulated from 0.5 to 3.0 m/s with an increment of 0.5 m/s.

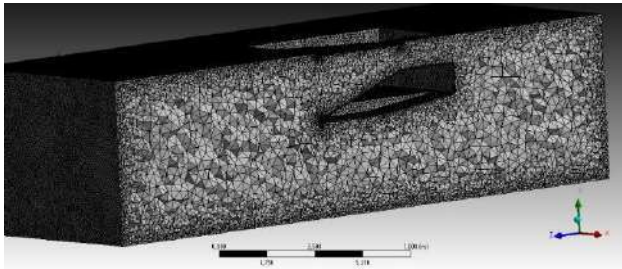


Fig.11: Computational model used for simulations.

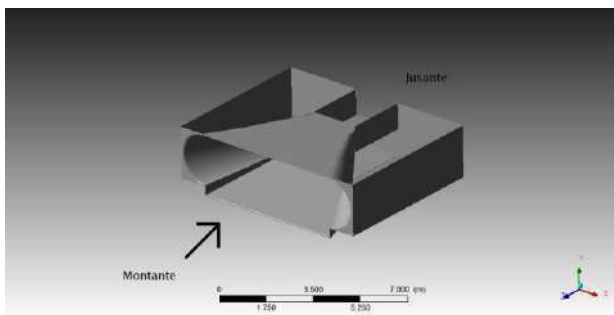


Fig.12: Computational model boundary conditions.

For numerical simulation, used the CFX software Ansys Inc. 2017. The parallel processing resource was used.

In Fig.12, the input boundary conditions (upstream) are presented along with the average speed obtained near the diffuser inlet and the average diffuser output speed.

In Table 1, the input boundary conditions (upstream) are presented along with the average velocity obtained near the diffuser inlet and the average diffuser exit velocity.

Table 1 - Speeds Obtained in the Computational Model

Input	Average input speed	Average output speed
3,0	2,880090	2,998580
2,5	2,400370	2,497730
2,0	1,920250	1,997130
1,5	1,440110	1,496750
1,0	0,959991	0,996668
0,5	0,479909	0,497159

The input velocity is the boundary condition imposed on the computational model, which, in turn, represents the historical average velocity measured in the Madeira River. Due to the flow pressure drop and viscous and kinetic effects, the speed decreases along the way. An average speed near the diffuser inlet (blue plane) was calculated, Fig. 13, which shows the details of the regions to obtain the average velocities.

The hydraulic potential across the diffuser is obtained by an average speed calculated at the outlet (yellow plane).

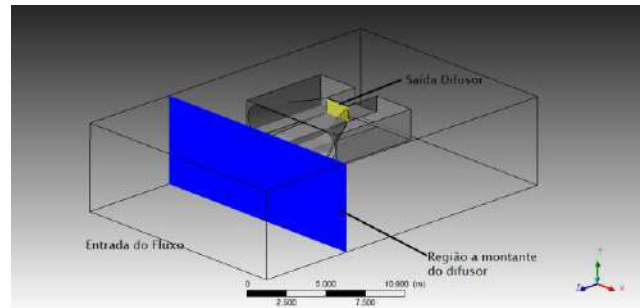


Fig.13: Details of regions to obtain average speeds.

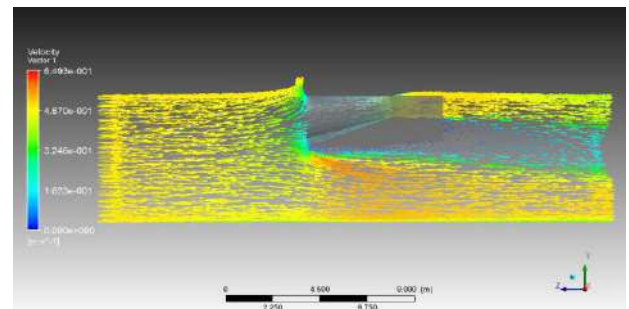


Fig.14: Velocity vectors for input flow of 0.5 m/s

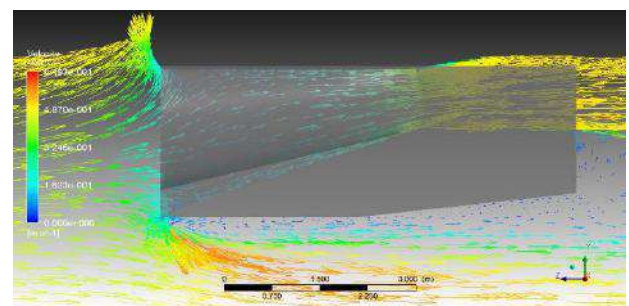


Fig.15: Velocity vector field detail for 0.5 m/s flow.

Figures 14, 15, and 16 show a significant reduction in recirculation below the diffuser.

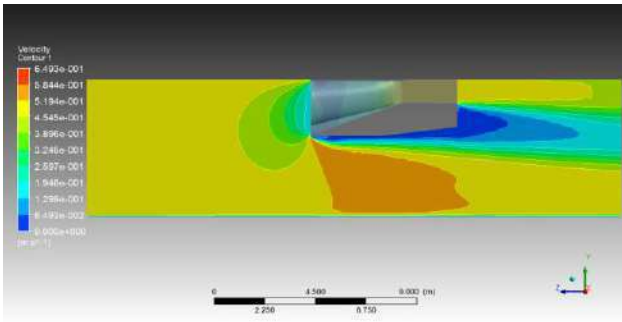


Fig.16: Velocity field for 0.5 m / s flow.

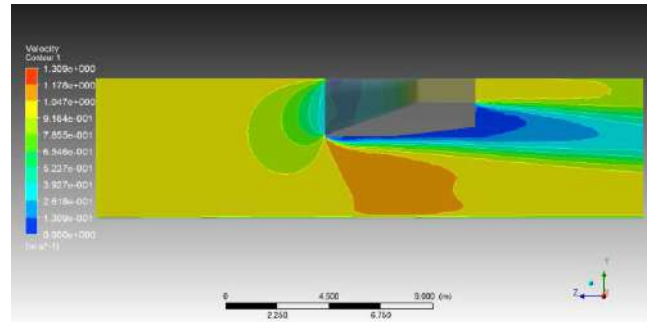


Fig.19: Velocity field for 1.0 m/s flow.

As can be seen, there is a high-velocity region below the diffuser. By the principle of mass conservation, the tendency is for the flow to pass through regions with less obstruction. Nevertheless, we observed a loss of speed along the path (Fig.16); however, we observed that the diffuser played its role, increasing the rate at its exit. The figures below show different velocity profiles in the equipment as a function of different initial flow velocities.

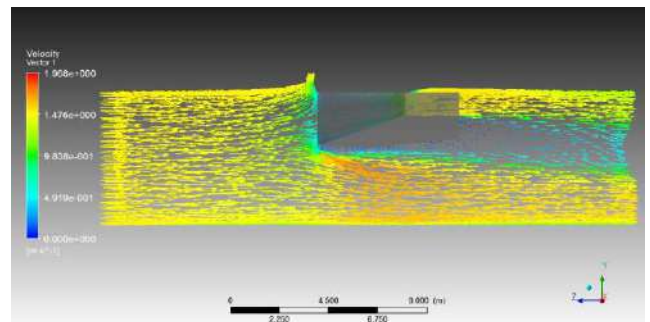


Fig.20: Velocity vectors for the input flow of 1.5 m/s.

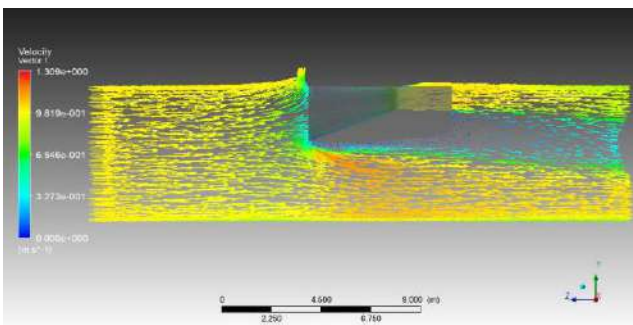


Fig.17: Velocity vectors for input flow of 1.0 m/s.

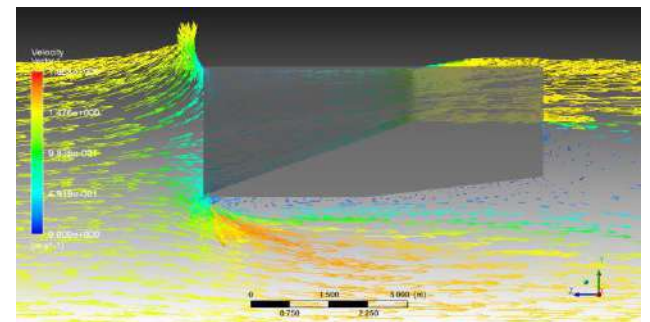


Fig.21: Velocity vector field detail for 1.5 m/s flow.

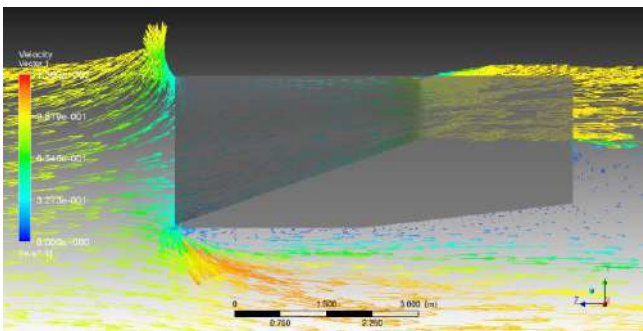


Fig.18: Velocity vectors for input flow of 1.0 m/s.

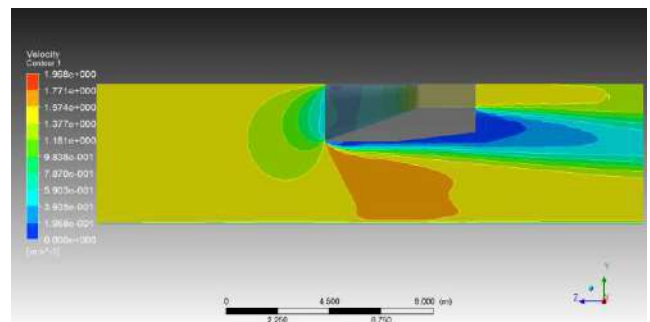


Fig.22: Velocity field for 1.5 m/s flow.

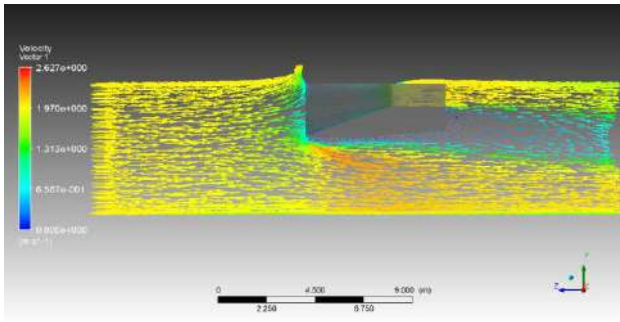


Fig.23: Velocity vectors for the 2.0 m/s input flow.

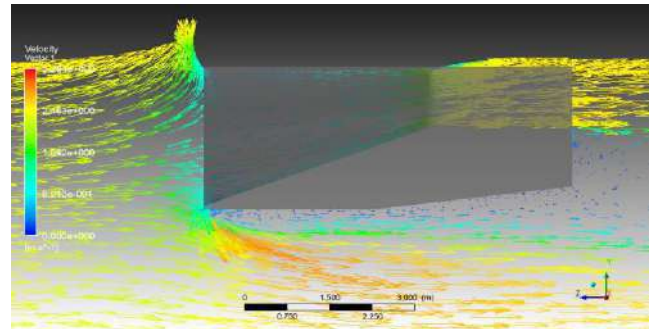


Fig.27: Velocity vector field detail for 2.5 m/s input flow.

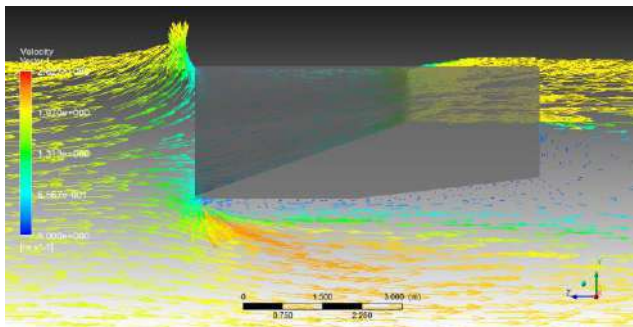


Fig.24: Velocity vector field detail for 2.0 m/s input flow.

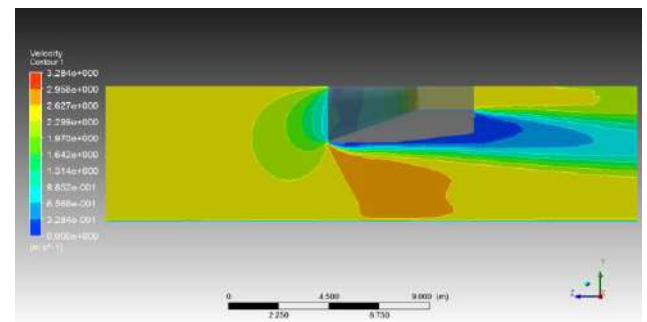


Fig.28: Velocity field for 2.5 m/s flow.

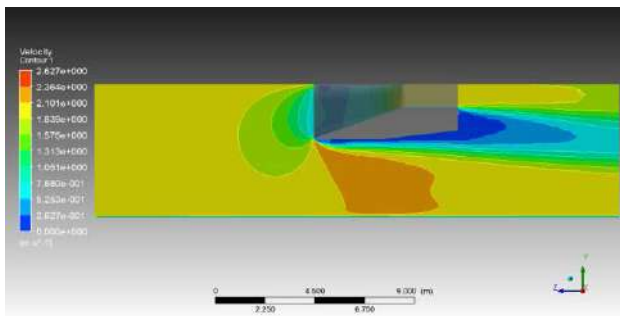


Fig.25: Velocity field for 2.0 m/s flow.

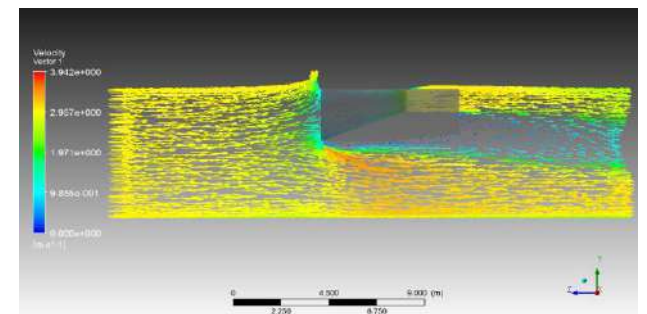


Fig.29: Velocity vectors for input flow of 3.0 m/s.

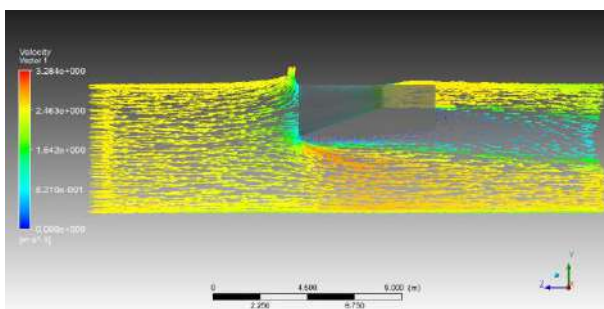


Fig.26: Velocity vectors for input flow 2.5 m/s.

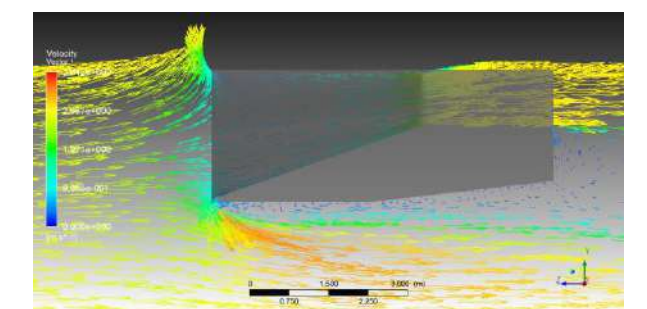


Fig.30: Velocity vector field detail for 3.0 m/s input flow.

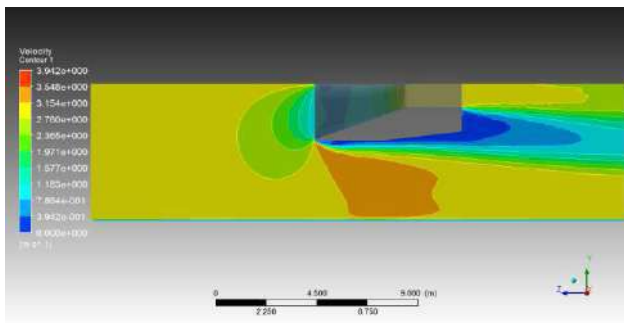


Fig.31: Velocity field for 3.0 m/s flow.

The model presented will be printed (3D printer) in reduced scale for testing in the Control and Automation laboratory channel to validate numerical results. As only the flow of the Madeira River is known, through the simulation, an average rotation that would be produced by the flow passing through the diffuser was estimated. We will use this rotation to simulate both the electrical and mechanical parts of the rotor to obtain the shaft torque produced in the turbine.

It determined an average rotation of the average speed at the diffuser output. Considering that the rotor blade is 1 m long and the linear velocity is proportional to the angular velocity:

$$V = \omega R \tag{1.0}$$

Table 2 presents the values of the theoretical average rotation obtained from the average output speed of the rotor.

Table 2: Theoretical average rotation obtained at the diffuser output

Input	Average Rotation (r.p.m.)
3,0	57,26865951
2,5	47,70312912
2,0	38,14237338
1,5	28,58581933
1,0	19,03495666
0,5	9,495037482

This average rotation will be used in the modeling of the electrical part and the simulation of the rotating part of the turbine (rotor).

The generator's electrical machine can either be built with permanent magnets or a squirrel-cage induction motor, and the voltage generated varies according to the installation's water flow. A proprietary conversion system,

built into the system body, synthesizes frequency and voltage to desired values. This generation system will be made with permanent magnets.

Considering the movement of the permanent magnet rotor, the distance traveled by a pair of magnets induces a voltage cycle at the terminals of a stator coil taken as a reference. Thus, adopting thirty magnets on the concentric segment of magnetizable material, adjacent to the face with fixed magnets, spaced by a few millimeters, there will be another concentric segment for the mechanical support of the nine stator units, generating different phases of electrical voltage.

Due to the initial perspective of adopting three concentric stators in the full-scale design, there would be different tangential speeds for the same rotor speed. A fact that inevitably conditions the design of the coils to three distinct types. In the smaller-scale design, each of these three stator coil designs is on a single circle. There should be different assessment criteria, adopting three speeds for each test.

The rotation speeds in the reduced-scale prototype will be such that they must induce voltage at the frequencies of 35.2 Hz, 29.4 Hz, and 25.2 Hz, respectively, those observed in the full-scale model design, from the most external stator to the more internal.

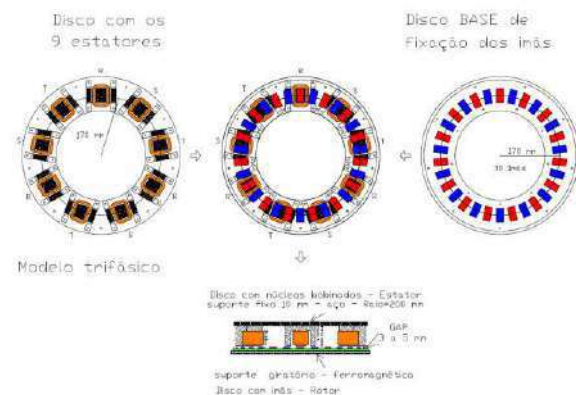


Fig.32: Small-scale prototype stator and rotor.

Considering that the passage of a pair of magnets from different magnetic poles induces an electrical voltage cycle at the unit stator terminals taken as a reference, considering the rotor with 30 magnets, for those steady-state frequencies, follows the proportion below:

$$\begin{matrix} \left( \begin{matrix} 35,2 \text{ Hz} \\ 29,4 \text{ Hz} \\ 25,2 \text{ Hz} \end{matrix} \right) & \text{-----} & (X) \text{ magnets} \\ 1 \text{ Hz} & \text{-----} & 2 \text{ magnets} \end{matrix} \tag{2.0}$$

Therefore:

$$X = \begin{pmatrix} 70,4 \\ 58,8 \\ 50,4 \end{pmatrix} \text{ magnets/s} \tag{3.0}$$

Thus, the steady-state will be reached from the outermost to the innermost stator in the full-scale model. There are displacement rates of 70.4, 58.8, and 50.4 magnets per second.

Considering the model at a minimum scale with one circular path that containing the thirty magnets, the necessary velocities for each of the three different stator units to reach the steady-state will be obtained with the proportion below:

$$\begin{pmatrix} 70,4 \\ 58,8 \\ 50,4 \end{pmatrix} \text{ magnets/s} \xrightarrow{\hspace{10em}} 1 \text{ rev/s}$$

$$30 \text{ magnets/s} \xrightarrow{\hspace{10em}} \begin{pmatrix} 2,35 \text{ rev/s} = \frac{2,35 \text{ RPM}}{60^{-1}} \cong 141,0 \text{ RPM} \\ 1,96 \text{ rev/s} = \frac{1,96 \text{ RPM}}{60^{-1}} \cong 117,6 \text{ RPM} \\ 1,68 \text{ rev/s} = \frac{1,68 \text{ RPM}}{60^{-1}} \cong 100,8 \text{ RPM} \end{pmatrix} \tag{4.0}$$

The rotations calculated for the model in minimum scale are intended to validate the theoretical and practical arrangement, leading to the refinement of the electrical design of the machine in full scale.

For the best understanding of the study, each of the three stator unit designs will be fixed side by side in a single path of excitation by the rotor. They will be identified as R-phase, S-phase, and T-phase. The values for phases R, S, and T represent the stator rotation on a minimum scale with the same speed of passage of the magnets provided in the full-scale model.

**Phase R**

- Rotation in steady-state 141.0 r.p.m.;
- Number of turns per stator unit 85 (15 AWG);
- Maximum electrical current in conductors (450 A/cm<sup>2</sup>) 7,427 A;
- Theoretical value (per stator unit) at 16.0 V steady state rotation.

**Phase S**

- Rotation in permanent regime 117,6 r.p.m.;
- Number of turns per stator unit 109 (15/16 AWG);
- Maximum electrical current in conductors (450 A/cm<sup>2</sup>) 5,890 A ;
- Theoretical value (per stator unit) at 17.2 V steady state rotation.

**Phase T**

- Rotation in steady-state 100.8 r.p.m.;

- Number of turns per stator unit 136 (17 AWG);
- Maximum electrical current of conductors (450 A/cm<sup>2</sup>) 4,671 A ;
- Theoretical value (per stator unit) at 18.5 V steady-state rotation.

**III. PROTOTYPE OF THE HYDROKINETIC GENERATION SYSTEM COUPLED TO THE AXIAL FLOW GENERATOR**

The model was printed on a reduced-scale 3D printer for testing in the channel belonging to the Control and Automation laboratory to validate the results presented in the simulation.



Fig.33: Hydrokinetic Power Generation System coupled to the Axial-Flow Generator.



Fig.34: Turbine and diffuser overview.

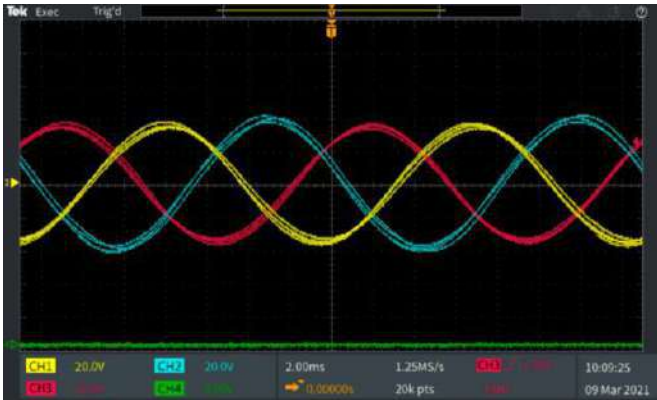


Fig.35: The three-phase voltage generated in loads of  $1 \Omega$  of 30 W.

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#### IV. CONCLUSION

The new diffuser geometry proposed in this article increased its output speed as predicted in the simulations and the test channel.

The built prototype can generate energy for isolated communities and can be used in various economic activities with rivers, canals, or small watercourses, with low flow speeds.

The proposed system is relevant for its low manufacturing and installation cost. Furthermore, it contributes to the preservation of the environment, as there is no need for dams.

#### ACKNOWLEDGEMENTS

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# Design Thinking as an Approach to Guide a More Humanized Learning Process in Engineering Teaching

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**Keywords—** *Challenge-Based Learning, Design thinking, engineering teaching, learning practices, learning outcomes.*

**Abstract—** *Changes in digital transformation have been increasingly accelerated. Consequently, educational institutions face a significant challenge in preparing individuals for the current and future job market. These institutions must support students in developing transversal skills that can meet the demands for work and social life. Thus, the objective of this study is to present a learning model that combines the challenge-based learning methodology with the design thinking approach as a strategy to conduct a more humanized learning process and promote the development of transversal skills. This study was conducted with 23 students pursuing mechanical engineering. The learning model was well-rated by the students, and the development of transversal competencies were evaluated.*

## I. INTRODUCTION

According to (Mendonça, de Andrade, & Neto, 2018), digital transformation has been breaking paradigms in companies, business models, education, and society, owing to the considerable innovation in information and communication technologies such as cloud computing, Internet of Things, and artificial intelligence.

According to (Borgatti Neto, 2007), we are experiencing a transition from a mechanistic paradigm to a different paradigm of complexity. According to (Snowden & Boone, 2007), complex contexts are disordered, no apparent cause-and-effect relationship exists, and the path forward is determined based on the integration of emerging patterns. In this scenario, a comprehensive understanding of the context is a condition for establishing changes in an environment of growing uncertainty. Thus, owing to the technological revolution, which imposes a significant cognitive challenge, the transformation of thinking from a mechanistic, linear, and fragmented pattern to a more complex, integrative, and collaborative pattern in a network is crucial.

An important consideration by (Noweski et al., 2012) is that scientific, business, and social organizations lack skills and competencies for the 21<sup>st</sup> century; however, the educational system is still focused on cognitive skills, despite recognizing the need to develop new values and social attitudes that can meet the demands of work and social life.

This condition allows a student to move with greater security from their academic life to work life, both in relation to their first work and future experiences.

Educational institutions need to maintain pace with the changes in the world, evolve quickly to be more relevant, and ensure that everyone learns competently. Consequently, it is necessary to rethink the curriculum, methodologies, role of the teacher, and connection with society and organizations, awaken students' autonomy, interest, and an empathetic and reflective look at the context, and stimulate the development of transversal and attitudinal skills through the connection of students with different learning experiences.

Learning models must be applied to make the process more contextualized, experimental, and reflective, to contribute to the development of transversal skills.

The aim of this study is to present a learning model that combines the challenge-based learning (CBL) methodology with the design thinking (DT) approach and shows how this can strategically guide the learning process.

The concepts adopted for transversal competencies, DT approach, and CBL methodology are shown. The proposed learning model, its application, and the results achieved are described.

## II. TRANSVERSAL SKILLS

In the case in which the definitions of competencies have multiple characteristics and no general established consensus exists, as observed in relation to transversal competencies, in this study, we will refer to the model of (Silva & Teixeira, 2012), which is supported by the reference de (Moreno, 2006) define transversal work competencies as attitudes, capacities, and skills of the individual that contribute to effective performance in different work situations, being transferable from one context to another throughout life.

Based on the models of (Moreno, 2006) and (Silva & Teixeira, 2012), the following transversal competencies were included in this study: empathy, collaboration and teamwork, written communication, oral communication, problem-solving, organization of the work, creativity, and autonomy. However, it is worth noting that, as discussed by (Moreno, 2006), it is difficult to know the extent to which soft skills can be developed. In this work, the premise is that using learning practices that contribute to the exercise of transversal skills is a way to generate awareness and enhance the development of those skills.

## III. DT APPROACH

DT is a process of investigation and development of a solution, the result of critical and creative thinking, centered on the needs of the user, which integrates a holistic and innovative look, based on a new approach to problems in obtaining information, analysis, and, consequently, solutions based on knowledge generated from an integrative perspective. Therefore, this approach occurs in the stages of designing a solution, which contributes importantly to the educational context. (Brown, 2008; Dunne & Martin, 2006).

According to (Buchanan, 1992), the DT process is divided into two distinct phases: The understanding and

definition of the problem and the solution to the problem. The understanding and definition of the problem is an analytical sequence that determines all elements of the problem and specifies all the requirements of a successful solution. The solution to the problem is a synthetic sequence in which the various requirements are combined and balanced against each other, generating the concept and proposal of a solution that meets the expectations of users. The DT approach must be made broadly, understanding, at first, the problem and the context in which it is inserted and later, reflecting on the solution.

It is possible to find in the literature different terminologies for the DT, such as a process, an approach, a method, a system, and a way of thinking. In this work, we consider DT as an approach. To meet the DT approach, the solution to a problem must meet and balance the following criteria: being desirable by the user, economically and environmentally viable, and technologically feasible. In addition, it must meet the following principles: centered on the man, with a collaborative, interactive, and iterative approach (Aranha & SANTOS, 2016; Buchanan, 1992; Dunne & Martin, 2006; Martins Filho, Gerges, & Fialho, 2015; Razzouk & Shute, 2012).

As regards problem-solving, it is important to emphasize that the DT approach originates from the DT that flourished in the 1960s and finds a fertile field to solve the perverse problems, as addressed by (Dorst, 2015; Rittel & Webber, 1973).

According to (Rittel & Webber, 1973) DT is an adequate approach for dealing with perverse problems. Perverse problems are a class of social system problems that are poorly formulated, where information is misunderstood, many customers and decision-makers have conflicting values, and the ramifications of the system are completely misunderstood. Moreover, it highlights that most of the problems addressed by designers are perverse problems, as well as many contemporary problems and challenges. In summary, it is observed that the investigative and reflective look at perverse and open problems demands the competence of empathy, understanding the context and the user, which is facilitated by the ability to ask the correct questions, which is essential for the training of reflective professionals who will act in the 21<sup>st</sup> century.

DT has diversified and evolved in recent decades. It was first introduced by Richard Buchanan in 1992, and is no longer an approach used only by a designer but is equally being used in the business environment, education, etc. (Buchanan, 1992) highlights that DT works as a mental model of how a problem is approached. It shifts the focus of how a problem is approached, from the focus of



the creator to the focus of the user, as a process that focuses on the user and their needs, seeking to understand, empathetically, what generates value. Empathy and full understanding of the context are the greatest strengths of the DT approach.

The DT approach is divided into cycles or stages, with different authors adopting different nomenclatures to name these stages. In this work, the following nomenclatures and stages are used: empathy, definition, ideation, experimentation, and evaluation (Charosky et al., 2018; Marin, Hargis, & Cavanaugh, 2013). Fig. 1 shows the major steps of this approach.

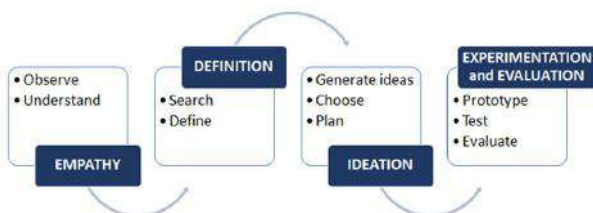


Fig. 1: DT approach. Source: Author (2020)

In the empathy stage, the objective is to generate an understanding of the problem (formulate the problem) and qualify the challenge to be overcome, based on the needs of the user. At the definition stage, the objective is to research and define the requirements and characteristics that need to be met and functions that need to be performed by the solution. The ideation stage aims to generate ideas about possible solutions that will be used for the development of a prototype and solution construction. Finally, the experimentation stage aims to test the prototype, obtain feedback, evaluate the learning process, develop the solution, and publish the results obtained.

Finally, the DT provides a process of reflecting on an action, contributing to structuring the teaching-learning process that involves everyone, students, teachers, and target audience (users of the solution), in a high-level process of understanding the context (problems and challenges), and development of adequate solutions that adhere to the reality under study (realistic solutions), guided by deductive, inductive, and CBL (Dunne & Martin, 2006).

#### IV. CBL METHODOLOGY

The first efforts to build a CBL methodology were published in 2008 through the initiative called Apple Classrooms of Tomorrow (ACOT). This initiative was an effort that collaborated with the education community and aimed to identify the basic principles for 21<sup>st</sup> century schools, as well as helping schools move closer to creating

a more appropriate type of learning environment to increase the engagement of new generations with schools (M Nichols & Cator, 2008).

According to (Santos, 2016), CBL was built on the practice of problem-based learning (PBL), a model where students work with real-world problems in collaborative teams. CBL, however, goes further, as it encompasses the PBL concepts and the need to develop and test a prototype, which requires students to materialize the solution, thus developing their entrepreneurial capacity.

CBL is a multidisciplinary educational approach that encourages students to collaborate with other students and teachers to seek solutions to real-world problems. To work with CBL, students need a clear understanding of the problem, those involved and the challenge, they study the subject, research, debate, develop solutions, and put them into practice (Ferreira, Flório, & Iaralham, 2016). CBL advocates those students must learn with intense support and participation from teachers and experts, confronting students with a relevant and open problematic situation, where a real solution is required; Consequently, the student must develop a deeper knowledge of the topics they are studying to apply them to the solution of the problem.

CBL is a pedagogic approach that actively involves the student in a real situation, a challenge from society, related to the context where the student belongs; therefore, this student is emotionally involved, which implies understanding the problem and the implementation of an innovative solution (de Monterrey, 2015).

CBL takes advantage of the interest of the students in giving practical meaning to education, the development of transversal skills that are extremely significant to the context, such as collaborative and multidisciplinary work, decision-making, advanced communication, ethics, and leadership (Malmqvist, Rådberg, & Lundqvist, 2015).

According to (Johnson & Brown, 2011; Santos, 2016), CBL helps to improve several areas of knowledge. Ninety percent of teachers reported significant improvements in areas such as leadership, collaboration, flexibility, creativity, problem-solving, and innovation. Furthermore, 75% of teachers cited an increase in student engagement.

The authors (M Nichols & Cator, 2008) describe the CBL methodology in components, which we describe in this paper as steps, which are key to the CBL process. It starts with a big idea and moves on to the following steps: definition of the essential question, the definition of the challenge, reflecting on the guiding questions, definition of the guiding activities, identification of the necessary resources, development of the solution, implementation and evaluation of the solution, and finally, reflection and

documentation of the results achieved, and the solution development process. According to (Mark Nichols, Cator, & Torres, 2016) the challenges can be of different types: nano challenge, mini challenge, challenge, and strategic challenge, and this depends on the time, focus, and intensity of the intended learning experience, as well as the scope of use of the CBL, that is, if all the stages of the CBL will be used or only parts. In fig. 2, based on the proposal of (M Nichols & Cator, 2008), a scheme that represents the framework of the CBL methodology is illustrated.



Fig. 2: framework of the CBL methodology. Source: Author (2020)

In the learning model proposed in this work, which is the result of a doctoral research, the definition of the challenge is associated with assistive technologies and works as a strategy to engage the student in the learning process and develop a solution that aims to address real pain, where the performance of a student can make a difference. According to (Nichols et al., 2016) challenges create a sense of urgency and stimulate action; thus, the selection of challenges is strategic to generate meaning in the learning process.

**V. LEARNING MODEL (APRENDESIGN)**

The proposed model, called APRENDESIGN, seeks to conduct the learning experience to stimulate the interaction of the students with the environment through a reflective process, guided by pragmatic reasoning.

The proposition of APRENDESIGN is based on assumptions, which are described as follows:

- Assumption 1 – Solving real challenges requires the enhancement of collaboration between the different actors involved in the learning process: students, teachers, experts, problem-solving users, and other stakeholders (Calvo Centeno, Galván Vallina, Gutierrez Duarte, & Rodríguez Gómez, 2019; Malmqvist et al., 2015; Membrillo-Hernández et al., 2019; Pathak, 2018).
- Assumption 2: The development team must devote time to understand the challenge before embarking on a solution through an interactive and iterative process, as recommended by DT (Buchanan, 1992; Noel & Liub, 2017).
- Assumption 3 – Working with real challenges contextualized with the reality of the student increases engagement and improves the learning process, according to (Johnson & Brown, 2011; Santos, 2016).
- Assumption 4 – The learning experience must promote an investigative process based on reflection and pragmatic reasoning, according to (Dewey, 1933; Schön, 2000).

Based on these assumptions, a learning model that combines the CBL methodology with the DT approach is proposed, as illustrated in Fig. 3.

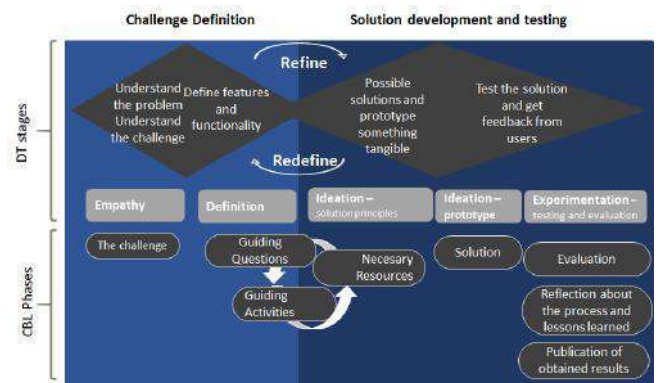


Fig. 3: APRENDESIGN - framework of the proposed learning model that combines CBL with the DT approach. Source: Author (2020)

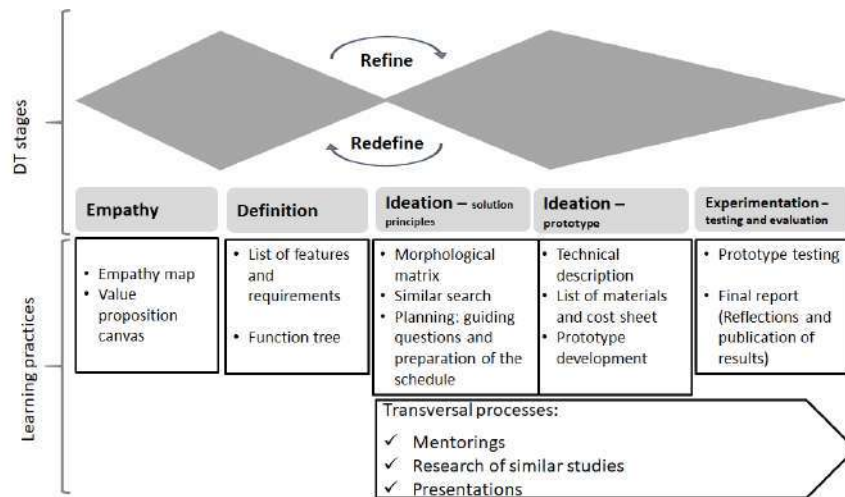


Fig. 4: details of the learning practices used to develop the solution (projects). Source: Author (2021)

The model is organized at the top with DT stages and the bottom with CBL stages. On the left side, a space for the understanding and definition of the challenge (empathy and definition) exists and on the right side, the solution development and testing (Ideation, Experimentation, and Evaluation), having as relevant points, the solution to be developed from the perspective of the user, contributing to the humanization of the learning process. Furthermore, it is worth noting that the DT approach helps to provoke different perspectives to build a more plural and complete process, adequate to the challenges imposed by the complex environment we are living in today. Model description based on DT stages.

- Empathy stage: it aims to generate an understanding of the problem (formulate the problem) and define the challenges to be overcome, as well as generate meaning and student engagement with the project development process and learning.
- Definition stage: seeks to understand the requirements, features, and functionalities that the solution (prototype) should meet. The most important aspects of this stage are questions, not the search for a solution, and this deserves a lot of attention from the teachers, as it is common for students to go to the solution without properly understanding the problem to be solved.
- Ideation stage – solution principles: it aims to generate ideas about solution principles to provide a solid foundation for the development of a technically viable, user-desirable, and executable solution.
- Ideation stage – prototype: It aims at building a solution that meets the expectations of the users, that is, the construction of the prototype.
- Experimentation stage – testing and evaluation: The objective is to test the prototype, obtain feedback, and

then evaluate the learning process and the development of the presented solution. It is also part of the result publication stage.

At the end of this process, a prototype must be developed, tested, and evaluated as a solution to the problem presented.

In APRENDESIGN, the DT organizes and guides the learning process, as a guiding thread, in stages (empathy, definition, ideation, experimentation, and evaluation), whereas the CBL methodology instrumentalizes the process through stages (challenge, guiding questions, guiding activities, necessary resources, solution, evaluation, and publication of the results obtained and reflection on the learning process), supported by the use of learning practices, which guide, from the understanding of the challenge, development, and solution testing to fulfill all stages of DT.

As a gap in the DT approach, a need to use methods and tools to instrumentalize each stage of the approach exists, as the DT presents the concept of what to do, through its stages but does not detail how to do it and this led to the birth of CBL. In addition, through CBL, the learning process is oriented toward solving a real challenge and through the stage of the definition of the guiding questions, as the students define what is necessary to learn to solve the challenge, generating meaning in the learning process.

The operationalization of the learning model is supported using learning practices, which guide the understanding of the challenge and development of the solution, to fulfill all stages of DT, as shown in Fig. 4.

The Fig. 4 describes the learning practices used in each stage of the CBL to perform the stages of DT, as well as the strategies to monitor and guide the teams as regards the

development of the project and prototype, through mentorships and presentations, which occur after the definition stage.

The learning practices are presented and exercised through workshops, which are structured as teamwork, assisted by teachers, lasting 2-3 hours for discussion, understanding, and structuring of relevant information for the development of the project. Mentorships are the moments where teachers guide the teams as regards the deliveries of each workshop, prototype development, and support of the structuring of the presentations. Here, it is also important to work on the engagement of students with the learning process and project development.

The presentations are moments where the teams formally present, to a group of guiding professors, the results achieved so far. Presentations are thermometers for students and teams to critically assess the progress and

quality of projects under development, in a high-level process of reflection on the project development process and the quality of deliverables. Similar studies have also been conducted, which is a benchmarking process aimed at seeking references and inspiration for the development of the solution.

### VI. EVALUATION SYSTEM

To assess the impact of the proposed learning model on the development of the project and the development of the transversal skills of students, an evaluation system comprising student and teacher assessments was developed. A graphical representation of the evaluation system is shown in Fig. 5.

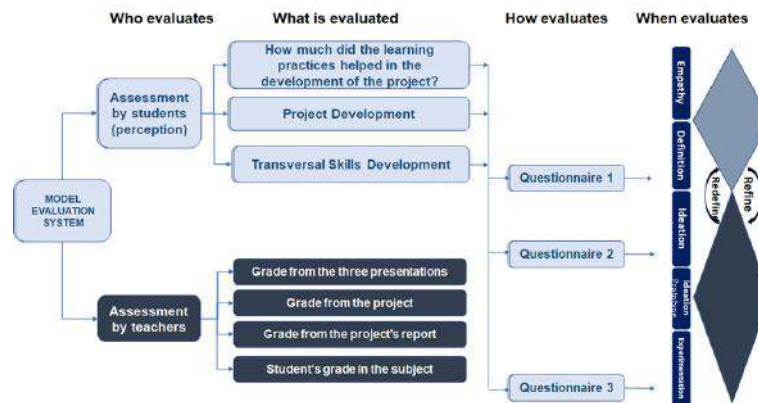


Fig. 5: representation of the APRENDESIGN evaluation system.

Source: Author (2021)

<b>Learning practices</b> – Used to conduct the project in the context of mechanical engineering.	<b>Learning Outcomes</b> - Results (impacts) achieved in the perception of students and evaluation of teachers, during the development of the project.
<ul style="list-style-type: none"> <li>• Value Proposition Canvas</li> <li>• List of features and requirements</li> <li>• Function tree</li> <li>• Mentorship</li> <li>• Initial presentation</li> <li>• Morphological matrix</li> <li>• Planning: guiding questions and preparation of the schedule</li> <li>• Research of similar studies</li> <li>• Intermediate presentation of the project</li> <li>• Technical description</li> <li>• List of materials and cost sheet</li> </ul>	<ul style="list-style-type: none"> <li>• Level of problem understanding and solution definition</li> <li>• Level of the solution conceived by the team</li> <li>• Quality of time and resource management by the team</li> <li>• Level of interest in using the learning model in other subjects</li> <li>• Level of satisfaction with project delivery</li> <li>• Initial presentation grade</li> <li>• Intermediate presentation grade</li> <li>• Final presentation grade</li> <li>• Grade of the final project report</li> <li>• Grade of the project “Mechanical Engineering Challenge”</li> <li>• Grade of the introductory mechanical engineering subject</li> </ul>

<ul style="list-style-type: none"> <li>• Prototype development</li> <li>• Final presentation of the project</li> </ul>	
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Fig. 6: learning Practices versus Learning Outcomes

Student assessment was performed using three self-assessment questionnaires. The evaluation of the professors was a set of grades attributed to the three presentations given during the semester, the project developed, the final report of the project, and the grade referring to the subject of Introduction to Mechanical Engineering.

The questionnaires used to assess learning practices, project development, and the development of transversal skills were applied thrice per semester using the Google Forms tool; it always occurs after the presentations of projects, which are represented in Fig. 6. A Likert scale was used to assess the questionnaires, in which scale 1 corresponds to the lowest score and scale 5 corresponds to the highest.

To structure the data analysis and evaluation model, a comparative framework is presented between the learning practices used and the impact of the use of these practices in the project development and in the development of transversal skills by students. Fig. 6 shows a proposed structure in a way that describes on the left side the questions contained in the questionnaires relating to the learning practices used during the development of the project, and on the right side, the questions contained in the questionnaires and other evaluation items relating to the intended learning outcomes.

It is noteworthy that, through the data analysis based on learning practices versus learning outcomes, when it comes to correlation, the scenarios that may occur are:

- Positive correlation: the higher the learning practice scores, the higher the learning outcomes.
- Negative correlation—an indication that the practices are not adequate or the way these practices are applied should be reviewed, as the intended results are not being achieved. It is important to emphasize that the opposite also deserves attention, as it may indicate that, independently of the practices, the learning results occur, and this demands an analysis of the process.

Further, it should be noted that the performance of this assessment from the perspective of teachers, with the active participation of students as subjects impacted by the learning process, is relevant because it allows us to evaluate whether the intended learning objectives, from the perspective of teachers and students, are being met.

## VII. APPLICATION AND RESULTS OF THE APRENDESIGN

APRENDESIGN was applied in the discipline “Mechanical Engineering Challenge,” which was formed by Mechanical Engineering students from SENAI CIMATEC, mostly students in the 1st semester. SENAI CIMATEC is one of the major technologies and innovation complexes in Brazil that currently comprises a technical school, university center, and a technological center.

The subject project, “Mechanical Engineering Challenge,” which focused on solving real challenges of assistive technologies, was developed in partnership with the *Centro de Reabilitação das Obras Sociais Irmã Dulce* (CER/OSID), a psychomotor rehabilitation center, reference in Salvador-Bahia.

At the beginning of the semester, CER/OSID representatives presented several demands for assistive technologies that contributed to the independence and inclusion of patients. Based on these challenges, students organize themselves into teams, with an average of five participants, and then begin the development of the project. Each team refined their essential questions and defined the challenges they would work with. In the proposed model, the qualifications of the essential questions and challenges are performed by the teams with the support of the professors and proponents of the challenge. After the challenge definition, the teams proceed with the definition of the requirements, features, and functionalities that should be presented as a solution. Subsequently, the principles of solutions that will be adopted are defined, and the preparation of technical description and the development of the prototype.

Fig. 7 shows an image that represents solutions developed by the teams in 2019. Owing to the COVID-19 pandemic in 2020, the prototype test could not be performed. As previously mentioned, this work is part of doctoral research, and the application and evaluation of APRENDESIGN has been done since 2018.

The survey data refer to the application of the proposed learning model in the “Mechanical Engineering Challenge” project class, held in the 2nd semester of 2020. The class comprised 25 students, 23 of whom responded to the survey. In addition to testing the proposed learning model, the objective of this evaluation was to evaluate the

impact of the model on the development of projects and transversal skills.



Fig. 7: assistive technology solutions developed by students participating in the project that adopted APRENDESIGN as a strategy to guide the learning process.

Source: Author (2019).

Based on the research, it is worth noting that all learning practices that constitute APRENDESIGN were well-evaluated by students, with an overall average grade of 4.50, on a scale from 1 to 5, where:

- Grade 1 means the learning practice helped very little.
- Grade 2 means the learning practice helped a little.
- Grade 3 means the learning practice helped
- Grade 4 means the learning practice helped reasonably well.
- Grade 5 indicates the learning practice helped very well.

Table 1 Represents the statistical evaluation of each learning practice evaluated, with the value proposition canvas, technical description, presentations, and function tree being the best-evaluated learning practices.

Table 1: Description of the average grade, median, mode, and standard deviation of learning practices evaluated by students

Learning practice evaluated	Average Grade	Mode	Median	Standard Deviation
Value proposition canvas	4.74	5	5	0.45
List of features and requirements	4.52	5	5	0.51
Function tree	4.57	5	5	0.59
Morphological matrix	4.48	5	5	1.12
Planning: guiding questions and preparation of the schedule	4.22	4	4	1.30
Research of similar studies	4.39	5	5	1.22
Technical description	4.65	5	5	1.28
List of materials and cost sheet	4.39	5	5	1.28
Mentorship	4.46	5	5	1.04
Presentations	4.58	5	5	1.03

When the students were asked why the learning practices helped in the understanding of the challenge and development of the project, they responded as follows:

- The learning practices helped us to understand the challenge as they helped us to reorder our thoughts.
- All learning practices used by the team helped in the progress of the project. In view of the relationship difficulties owing to the pandemic, the practices served as a communication guide.
- The learning practices facilitated the visualization and understanding of the project, such as where we should start, how to do it, what are the goals, and how to develop a quality project, aiming at an improvement of the quality of life of patients.
- They helped us to better see the problem and the needs of users, which was important in the precise development of the project.

- The learning practices used in the “Mechanical Engineering Challenge” helped us to understand the challenge and the need for the project; from these practices, we had to have more empathy with the project and the beneficiaries of the project.
- The learning practices gave an even greater immersion to our project, migrating our theoretical knowledge to a more practical area; thus, we could get an idea of how our walkway will help in the daily lives of patients.

In the case of the project development, the evaluation was generally satisfactory, and on average, the grade given by the students for the understanding of the problem by the team and the definition of the solution was 4.08 (clearly identified the need and reasonably understands the characteristics and requirements demanded by the solution); the quality of the solution designed by the team was 3.35 (the team has already identified the solution principles; however, we still need to better understand how the entire project will work), the ability to plan and organize the work for the development of the project was 3.39, (the team knows what they have to do and can better plan what they need to learn to develop the project and the principles of chosen solutions), the degree of satisfaction with the delivery of the project was 4.09, with high satisfaction, it was considered that they met the expectations of the user. When students were asked about their interest in using the learning model in other subjects, the average score was 3.96 (a vast majority of students expressed their interest in using the learning model in other subjects); these data are represented in Fig. 8. Therefore, it can be said that APRENDESIGN helped in the development of the project and was well-evaluated by the impacted students.

In addition, when the students were asked if they would use the learning model in other subjects and their reasons, they responded as follows:

- Helps in the matter of interest, students have more fun and seek to learn more about the subject.
- It would be used in certain disciplines for greater engagement and understanding of the content present in the discipline.
- This is a more dynamic way of learning.
- Learning is more interesting when it is dynamic.
- Because, in this way, we have a follow-up that helps us to achieve our objectives, principally through mentorship.

From the testimonies of students during project presentation, the importance of connecting the project with the real challenge presented by CER/OSID is observed,

which involves and engages students as it represents demand from the society where the role of engineering can make the difference. It is often highlighted by students that social projects (assistive technologies) mobilize teams and encourage students to get involved, both in understanding the needs of users and in the search for solutions that can make a difference in the lives of people; this process has been very relevant to humanize engineering education, as well as providing an approach that highlights the need for a more attentive and curious look to broadly understand the role of engineering in the search for solutions to social challenges.

In addition to the assessment of learning practices and project development, the students assessed the development of transversal skills, and the assessment was very positive. The development of all transversal skills that make up the learning model was well-rated by students on a scale of 1 to 5, where.

- Grade 1 means the transversal competence has not been developed.
- Grade 2 means the transversal competence has been poorly developed.
- Grade 3 means the transversal competence has been satisfactorily developed.
- Grade 4 means the transversal competence has been well-developed; and
- Grade 5 means the transversal competence was well-developed with a positive emphasis.

The three transversal skills that obtained the best scores, on average, were respectively empathy (average grade 4.46), oral communication (average grade 4.39), and problem-solving (average grade 4.34). The competencies with the lowest grades, given by the students, were respectively time organization (average grade 3.93), written communication (average grade 3.94), and autonomy (average grade 4.08). It is observed that even the competencies less highlighted by the students obtained a very expressive score, all above 3.93, that is, 78.6% of the maximum score. Fig. 9 shows the notes described earlier.

In addition, the deepening of the analysis of the results and with the aim of correlational analysis, based on figure 8, is presented in Table 2. The left side comprises the grades given by the students, referring to how much the learning practices used helped in the development of the project. The right side comprises learning results based on the perception of the students and the evaluation of the professors. It is noteworthy that the items vary at each stage of the project because different learning practices are used, and the learning outcomes also vary. Through this

analysis, it is possible to establish a correlation between how much learning practices contribute to the

development of the project.

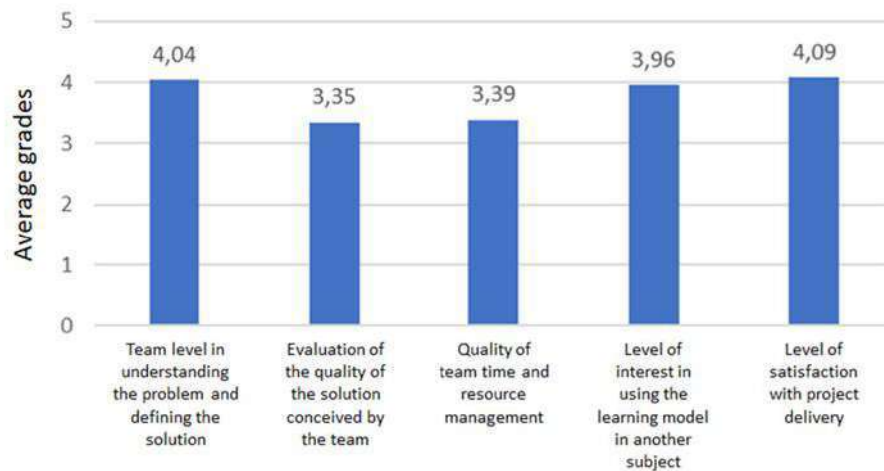


Fig. 8: Students evaluation regarding the project development

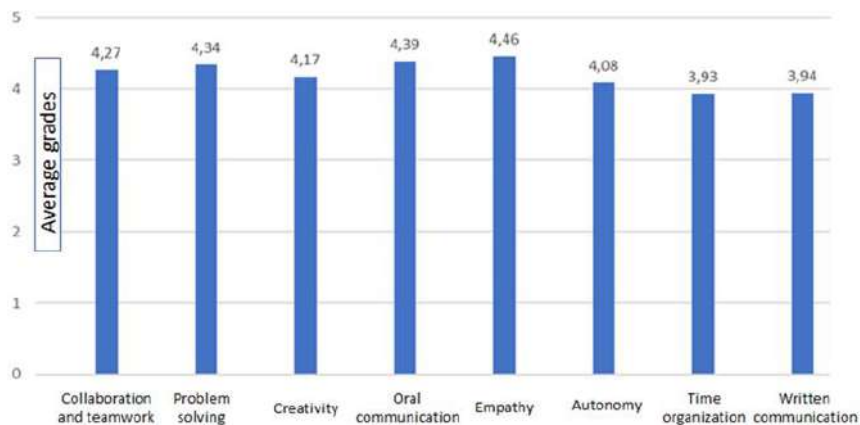


Fig. 9: Average grades based on the perception of the transversal skills development of students

This analysis of the values (subtotal) of each column contributes to a reflection on the part of teachers, to verify whether the use of learning practices should be reconsidered in terms of content or the way it has been applied, making it possible to identify which practices or learning outcomes are more in need of attention, becoming a reference to direct the necessary efforts.

To structure an evaluation proposal to assist in the analysis of the results in Table 2, on the next page, the following level of correlation between learning practices and the learning outcomes achieved by students was adopted:

- If the difference between the subtotal value of learning practices and learning outcomes is less than or equal to 10%, a good correlation exists between the practices and the results achieved; that is, it is considered that the practices lead to results.

- If the difference between the subtotal value of learning practices compared to learning outcomes is greater than 10% and less than 20%, a medium correlation exists; that is, it is considered that a promising result exists in terms of practice that leads to learning outcomes.
- If the difference between the result of the subtotal of learning practices compared to the learning results is greater than 20%, this result is of low correlation; that is, it is considered that the result is vulnerable and lacks attention on the part of the teacher to analyze what should be adjusted in practice or in the method to achieve a greater correlation.

Note that the aforementioned values are an indication and may vary based on the class profile in terms of knowledge and experience.

Based on the results presented in Table 2, it is possible to verify the alignment between the learning practices



used, in comparison with the quality of project development, in the perception of students and teachers. The correlational analysis of the intermediate stage draws attention; the difference between the subtotal of practices and results is 0.78 or 17.7%, and the difference in the other stages is smaller. In the first stage, it was 0.45 or 9.8%, in the final stage it was 0.49 or 10.8%, and the difference in the consolidated result was 0.58 or 12.9%, driven by the result of the intermediate stage.

This result may indicate that the intermediate stage lacks a more refined analysis; to identify the reasons that led to this difference, when compared with the other two stages, as mentioned earlier, it should be evaluated whether the practices were not adequate or if they were applied inappropriately to achieve the intended result.

For the result in question, the reflection pointed to the need to improve the application of the morphological matrix and planning: guiding questions and elaboration of the schedule; consequently, workshops 3 and 4 were

remodeled and the conduct was adjusted to improve the articulation between workshops, using the morphological matrix as input for the planning of the guiding questions and preparation of the schedule.

Finally, through the evaluation system, it was possible to verify that the learning practices used by the proposed model were well-evaluated by the students, all with a grade higher than 4.22, out of a maximum of 5, contributing significantly to the development of the project. It was also possible to verify that, according to the students, during the development of the project, all the transversal competencies evaluated were well-developed, with the lowest average score of 3.93, out of a maximum of 5. Another highlight is the high interest of students in using the proposed model in other disciplines.

Table 2: Correlational analysis between how much the learning practices used helped in the project development compared to the quality of project development

2020S2 – Initial Stage			
Learning practices	Grades	Learning outcomes (Project development)	Grades
<b>Q3: Value proposition canvas</b> <b>Q4: List of features and requirements</b> <b>Q5: Function tree</b> <b>Q6: Mentorship</b> <b>Q7: Presentation</b>	4.74	<b>Q9: Team level in understanding the problem and defining the solution</b> <ul style="list-style-type: none"> <li>Initial presentation grades average</li> </ul>	4.04
	4.52		4.22
	4.57		
	4.44		
	4.61		
<b>Subtotal</b>	4.58	Subtotal	4.13
2020S2 - Intermediate Stage			
<b>Q2: Morphological matrix</b> <b>Q3: Planning: guiding questions and preparation of the schedule</b> <b>Q4: Technical description</b> <b>Q5: Research of similar studies</b> <b>Q7: Presentation</b>	4.48	<b>Q9: Level of the solution conceived by the team</b> <b>Q10: Quality of time and resource management by the team</b> <ul style="list-style-type: none"> <li>Intermediate presentation grades average</li> </ul>	3.35
	4.22		3.39
	4,44		
	4.39		
	4.48		
<b>Subtotal</b>	4.40	Subtotal	3.62

2020S2 – Final Stage			
<b>Q2: Technical description</b> <b>Q3: List of materials and cost sheet</b> <b>Q5: Mentorship</b> <b>Q6: Presentation</b>	4.65	<b>Q7: Level of interest in using the learning model in other subjects</b> <b>Q9: Level of satisfaction with project delivery</b> <ul style="list-style-type: none"> <li>• Final presentation grades average</li> <li>• Final report grades average</li> <li>• Project grades average</li> <li>• Average student grades in the introductory mechanical engineering discipline</li> </ul>	3.96
	4.39		4.09
	4.48		4.38
	4.65		3.90
			3.96
			4.00
<b>Subtotal</b>	4.54	Subtotal	4.05
<b>Semester average</b>	4.51	Semester average	3.93

### VIII. CONCLUSION

A learning approach that promotes a more contextualized, experimental process, guided by pragmatic reasoning and a real challenge, presents better conditions to contribute to the learning process and the development of transversal skills. In this context, the DT combined with the CBL methodology has an important approach to contribute to the development of relevant competencies for 21<sup>st</sup> century actors. In addition, it is worth noting that working with socially appealing challenges has considerable potentials to engage and involve students in the process, as well as generate a special motivation that contributes to the improvement of empathy and consequently humanizing the process of project development. The evidence of the presented approach can be seen in the results of this research, which shows, in the perception of the students, how much the proposed model helped in the development of the project and contributed to the development of transversal skills. Based on the teachers, it shows the positive evaluations of the quality of deliveries and maturity of the projects during the semester.

The contribution of the evaluation system, based on learning practices used compared to the learning results achieved allows the teacher, during and at the end of the process, to evaluate and reflect on the impact of each practice used, subsidizing information to improve the learning process.

In the management of the learning process, teachers can identify and develop learning practices that lead to more successful futures for all students, which is possible through continuous assessment and with the effective participation of students, active subjects of the process, on the pertinence and adherence of the learning practices used

and how much these have supported the development of projects and transversal skills, which can help the teacher to identify which practices and approaches should be reviewed such that the intended learning objectives can be achieved.

It is also worth noting that the model was designed to be applied under normal conditions of social relationships; however, owing to the pandemic, the test was performed under adverse conditions owing to social isolation, which occurred because of the Covid-19 pandemic, and some reflections are presented. The lack of eye contact makes it difficult for students to emotionally engage with the challenge, reducing the bond created between students and potential users of the solution, which makes it difficult for the students to understand the problem and the context.

To date, the study has been performed with a limited sample; thus, new applications are indicated, with different groups, to improve reflections and records on the proposed learning model and its use. The correlation between learning practices and learning outcomes should be considered, that is, what difference between practices and results may indicate that the correlation is strong, medium, or weak.

Finally, the proposed learning model can be applied in different learning contexts, different types of projects with different student profiles, and consequently, it is necessary to assess which learning practices are the most appropriate to instrumentalize the process and support in reaching the intended learning objectives. Based on this statement, it is highly recommended to use this model in other contexts to improve the understanding of the impact on project development and on the development of transversal skills.

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## Camu-Camu (*Myrciaria dubia*) from the Amazon

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**Keywords**— Antioxidant capacity, Fruits  
of the Amazon, Vitamin C.

**Abstract**— Camu-camu (*Myrciaria dubia*) H.B.K.) Mc Vaugh fruits are promising sources of various bioactive compounds such as vitamin C. Camu-camu is a fruit native to the Amazon region and is considered the greatest natural source of vitamin C worldwide are also good sources of minerals. The objective of this study was to analyze pulp camu-camu throughout the Amazon region using the methodology Vitamin C content was measured by high-performance liquid chromatography (HPLC). Analyzes have shown that camu-camu powder had the highest content of antioxidants capacity, 51,567  $\mu\text{mol TE/g}$  and anthocyanins 9548 GAE mg/100g compared to açaí, blueberry, apple and orange pulp. In conclusion, camu-camu can be used to introduce bioactive compounds into food products and to delay or prevent many human diseases.

### I. INTRODUCTION

Camu-camu (*Myrciaria dubia* (HBK) McVaugh), is an exotic tropical fruit native fruit of the Amazon region and it is one of the few Amazon fruits that have been explored for commercial purposes, has numerous different behaviors from other species known to date, concerning ecology, morphology, agronomy, physiology and nutrition, with great potential for future uses in agribusiness and agroforestry systems.

Ecologically, camu-camu develops very well in pH ranges between 4 and 7, regardless of soil types, that is, soils poor or not in nutrients. It normally grows in full sun, with very high luminous intensity, as it originates from the banks of rivers and lakes where there is direct sunlight and the reflection of light on water and/or on the white sand beach. In its natural habitat, it is normally influenced by floods and ebbs. During floods the plants are partially or totally covered, for a period of two to four months a year and another stress is the dry period coinciding with the ebb of the rivers.

Morphologically, there may be a very different architecture, depending on the population density of the area, with greater or lesser ramification, and light intensity

seems to be one of the variables that directly interferes in fruit production. During the seedling stage, there may be greater differentiation in terms of morphology in the arrangement of leaves, which are usually simple, paired and crossed leaves, with trifoliate leaves (< 5%) and less than 0.5% with only one single leaf, which disappear over time making the sheets simple and opposite. Agronomically, plants normally grow in poor and acidic soils (with a pH between 4 and 4.5), but fruit production can be compromised depending on the nutrient content present in the soil. In areas corrected with liming and gradual fertilization on dry land, production reaches two or more crops per year. Heavy fertilization is not recommended at once, due to the sensitivity of the plants or seedlings, but the practice of fertilization or gradual correction. Plants that are well adapted on terra firme, with balanced fertilization, can start production after two years and some plants can produce 22 kg of fruit/crop. Some genotypes with 3 500 mg/100 g of ascorbic acid pulp have already been selected from the INPA Germplasm Bank, which can be vegetatively multiplied and distributed to producers.

Table 1. Result of vitamin C content, obtained in different locations, in relation to the visual maturation of Camu-Camu fruit throughout the Amazon region.

Collection location Rio/Municipality/State	Vitamin C (mg/100g of pulp)	Ascorbic acid (mg/100g of pulp)	Maturation of the fruit
Rio Urubu, Bonfim-RR	6100 a	268,48	Red/Ripe
Rio Candéias, Porto Velho-RO	2304 b	507,33	Red/Ripe
Rio Pirara, Normandia-RR	2163 bc	1185,69	Once / mature
Rio Tocantins, Marabá-PA	2128 bcd	74,03	Red/Ripe
Faz. Yurucum, Rio Preto da Eva-AM	2065 bcd	155,99	Red/Ripe
Rio Jaru, Jaru-RR	1694 bcde	514,78	Red/Ripe
Rio Janí, Laranjal do Jari-AP	1653 cde	152,29	Red/Ripe
Rio Uatumã, São Sebastião do Uatumã-AM	1629 cde	203,93	Red/Ripe
Rio Negro, Manaus-AM	1563 cdef	55,17	Red/Ripe
Rio Urubu 2, Bonfim-RR	1555 cdef	124,46	once/green
Rio Negro, Barcelos-AM	1529 cdef	93,58	verymature
Rio Urubu, Bonfim-RR	1517 cdef	109,93	once/green
Rio Madeira, Porto Velho-RO	1499 cdef	402,49	once/green
Rio Branco, Aruanjã-RR	1494 cdef	303,72	once/green
Rio Arraia, Bonfim-RR	1466 def	134,47	once/green
Rio Urupá, Ji-Paraná-RO	1459 def	230,76	verymature
Rio Urubu, Bonfim-RR	1420 ef	274,35	once/green
Rio Javari, Benjamin Constant-AM	1390 ef	127,29	Once / mature
Rio Cauama, Boa Vista-RR	1238 ef	197,72	Once / mature
Rio Araci, Barcelos-AM	1234 ef	140,25	verymature
Rio Jamari, Ariquemes-RO	1189 ef	274,61	past fruit
Rio Machado, Ji-Paraná-RO	939 f	240,99	past fruit

Nutritionally, camu-camu is known as the most vitamin C-rich fruit known today (Yuyama *et al.*, 2002), ranging from 800 to 6100 mg/100 g of pulp (Table 1) throughout the Amazon region using the methodology Vitamin C content was measured by high-performance liquid chromatography (HPLC) following the methodology described by the Association of official agricultural chemists (AOAC, 2011). The ascorbic acid content is normally higher when the fruit is red in color, unlike acerola which is higher when the fruit is green in color. Another very curious fact is the stability of ascorbic acid from camu-camu to storage (it kept its content after three years). After making jelly and ice cream there is still about 450 to 710 mg of ascorbic acid/100g of product. Vitamin C is important for the pharmaceutical and cosmetic industries and recently another component is becoming

very important in the pharmaceutical and food area which is natural antioxidants, which can prevent some types of cancer. With all the nutritional constituent of Camu-camu, in particular as a source of stable ascorbic acid, flavonoids, phenolic compounds and anthocyanins, it is suggested to use it not only in the composition of daily food, as it contributes to health protection and reduction of risk of chronic non-communicable diseases, but also with potential in the domestic and foreign market. Analyzes have shown that camu-camu powder had the highest content of antioxidants 51,567  $\mu\text{mol TE/g}$  and anthocyanins 9548 GAE mg/100g compared to açai, blueberry, apple and orange pulp.

Therefore, the expectation for the development of the crop is high, although farmers who believe in the crop are very small.

## II. CONCLUSION

Camu-camu fruits are excellent sources of different bioactive compounds, such as vitamin C and phenolic compounds. Camu-camu fruits show high antioxidant capacity as compared to other fruits. In conclusion, camu-camu fruits can be used to increase the amount of bioactive compounds in food products and to delay or prevent many human diseases.

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# Agroecological Community Garden of Plural Space: Food and Nutritional Security, Social Inclusion, and Income Generation

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**Keywords— Territorial Development,  
Social Inclusion, Family Income, Food  
and Nutrition Security.**

**Abstract—** The agriculture is also practiced in the cities and surrounding areas being known as urban and periurban agriculture, which is presented as backyards or Garden Community. This paper aims to discuss the extension project actions for work and income generation for social and economic fragile communities - Agroecological Community Garden of plural space, approaching its relation with food security, social inclusion and income generation, being justified by the importance of publicizing initiatives that have a high value impact, as the project dialogues with social, economic and health issues. The approach used in this study was an experience report lived during and after the implementation of the Community Garden project, located in the Malhada da Areia neighborhood in Juazeiro, Bahia. The Community Garden encourages that the food produced should be consumed by their own families, where this production is diversified, derived from a healthy, organic, and environmentally friendly mode of production. The leftovers of production are commercialized as a form of income generation, contributing to the empowerment and social participation of these people. This Garden is a social project that serves as a reference to farmers familiarized with the organic sustainable urban agriculture model, ensuring food security of families whose work and income come only from this activity, reducing malnutrition and valuing health and life.

## I. INTRODUCTION

Food production has always been associated to rural areas, with urban center only playing the role of major consumers of agricultural products. (Alves et al., 2019). However, lately, the emergence of urban spaces destined to agriculture is a real initiative in the largest and most

important cities around the world. It is noticed that, gradually, the urban spaces are being used for food, medicinal plants, ornamental flowers and other varieties (Serafim e Dias, 2013), among them the non-conventional food plants (PANC) providing opportunities for inclusive and sustainable spaces.

The practice of cultivating food in cities and the surrounding areas is called urban and periurban agriculture (AUP). Nevertheless, the sharp unfolding of agrarian-urban ideology is not limited only to the implementation of urban gardens, but also to a whole theme of discussions about the economy and social behavior. Among them social solidarity and health, assisting the recovery of the urban environment, stimulating participatory governance, territorial planning and strengthening food and nutritional security. Though, it is possible to conquer recognition as an important activity that produces food in natura and to create new job opportunities, recycling urban waste and promoting the emergence of green belts. (Azevedo et al., 2020). This idea is based on agroecology which has as its basic principle the rational use of natural resources, concerned not only with the production chain and income, but also with the connection between human and environment, seeking sustainable prototypes for the field (Gliessman, 2001; Altieri, 2002; Caporal et al., 2009). According to Petersen (2009), who has a scientific vision that grants a conceptual and methodological guideline, which serve as a guide for processes aimed at “refunding” agriculture in nature through the idealization of structural and functional analogies between natural ecosystems and agroecosystems.

Costa et al. (2015), also states that the urban and periurban gardens stimulate dietary patterns that help improve food security, nutrition and health in communities enabling different perspectives of research, including in the health area, especially with public policies that encourage the cultivation of these gardens, such as: National Health Promotion Policy (PNPS), National Policy of Medicinal Plants, National Policy of integrative and complementary practices (PNPIC) e National Policy of Health Education (PNEPS).

Serafim e Dias (2013) state that:

Such experiences in the implementation of agricultural urban spaces are supported by elements of social technology, such as the empowerment of users and garden workers, the use of traditional techniques and adaptations of methods and instruments to the urban reality, as well as the critical and transformative perspective on the established reality, which in this case are not the cities and its unsustainable growth patterns. (Serafim & Dias, 2013, p.135)

Azevedo et al., (2020) share the same opinion saying that:

Recognizing the relevance and importance of this phenomenon on an international scale and aiming, above all, to approach it within the scope

of some policies and programs, intending to address issues related to food security and the income of socially and environmentally vulnerable families and groups, the ONU has recently recognized the AUP as a multifunctional and diversified activity, including the production and/or processing of agricultural and livestock products in intra-urban and peri-urban areas for self-consumption and/or marketing purposes. It is about enjoying the resources and local supplies to respect the local knowledge, promote gender equality through the use and coexistence of appropriated technologies (such as social technologies), based on participative processes, collective and democratic for the best life quality of urban and periurban population. (Azevedo et al., 2020, p.12)

The AUP is a strategy that promotes a food self-sufficiency destined to self-consumption, exchanges, donations, or commercialization. The domestic and community gardens are examples of this practice that has been intensified besides the productive backyards (Santos e Machado, 2020).

The productive backyard exists since a very long time and they are not new, but they correspond to a variety of forest species, agricultural as fruit trees (acerola, guava, banana, papaya, lemon, Orange, mango, custard apple), medicinal herbs such as (mint, mastruz, lemongrass, arruda, rosemary, etc.), vegetables (onion, cilantro, peppers, tomato, lettuce, chicory, arugula, chives, parsley, etc.) and ornamental plants, associated to a small breeding of domestic animals, fundamental to food security and the development of sustainable family farming. It is also important to emphasize their ecological function and to conserve the diversity of plants in their composition, ensuring the genetic variability of many species. These backyards are traditional agricultural systems which the purpose is subsistence, a fact that contributes above all, to a healthy diet and to the supply of various products and services to local businesses improving Family income.

Just like the backyards, the Community gardens have a huge importance to Society, because families who live on the urban areas are able to consume the food they cultivate (Pereira e Arce, 2016), considering that these producers are, in most cases, financially needy people.

This paper aims to discuss the actions of the extension Project of income and work generation for socially and economically fragile communities – Agroecological Community Garden of the Plural Space, approaching its relationship with Food Security, social inclusion and income generation.

This is justified by the importance of publicizing initiatives that have a high value impact, because the project dialogues with social, economic and health issues, providing improvements in the living conditions of those who make the vegetable garden their livelihood, as well as improvements in the context of food and nutritional security for those who consume the food grown there.

This is an extension project developed with support of the Universidade Federal do Vale do São Francisco.

## II. MATERIALS AND METHODS

The place of study was the Agroecological Community Garden of Plural Space. This is an experience report lived during and after the implementation of the Project to generate work and income for socially and economically fragile communities - Agroecological Community Garden of Plural Space. Of the Universidade Federal do Vale do São Francisco – UNIVASF, located on the Malhada da Areia neighborhood, in Juazeiro, Bahia.

## III. RESULTS AND DISCUSSION

The agroecological Community Garden of Plural Space, belongs to the Universidade Federal do Vale do São Francisco (UNIVASF), located on Juazeiro city – Bahia, on Malhada da Areia neighborhood, covering 8.700 m<sup>2</sup> distributed in 31 lots with individual areas of 150 m<sup>2</sup>.

First, the Garden had the participation of 40 farmers and nowadays there are 20 families. All of them are part of the Association of Organic Producers of the São Francisco Valley (APROVASF) and they live in a condominium located next to the Garden, what contributes to the reduction of expenses with regard to the displacement of their homes to the vegetable garden to carry out their activities.

At the beginning of its implementation (in April 2013) the families were benefited with Ecological practices course that was held in partnership with the Universidade Estadual da Bahia (UNEB), campus Juazeiro, in addition to receive training on agroecological production over the years.

At this course several subjects were taught, such as: environment, the use of alternative sources of organic and natural mineral fertilizers, ecological management of the water and soil, water resources, the use of simplified irrigation system, stonemeal in agroecological agriculture, practices and use of green manure, formulation of natural pesticides, production of liquid biofertilizer, fundamentals agroecology and practical application and obtaining seedlings for the production of vegetables.

### - Relationship with Food and Nutritional Security.

The concept of food security was originated in the context of the needs caused by the second world war and was strengthened in the end of the 20th century, including discussions about the economic and physical access to food. It approaches the nutritional aspects, the quality of the food, as well as the cultural aspects related to diet (Aliaga et al., 2020).

Currently, Food and Nutritional Security is defined (SAN) as,

The realization of everyone's the right of the access to regular and permanent quality food, in sufficient quantity, without compromising access to other essential needs, based on health dietary practices, respecting cultural diversity and being environmentally, culturally, economically, and socially sustainable. (Lei nº 11.346, 2006, p.1).

This way, according to SAN's definition, it is not enough to have access to food, but this access must be in sufficient quantities to promote the nutritional contribution for each person.

One of the purposes of the garden's production is for the food to be consumed by the families themselves. This helps to improve the nutritional content of the meals they eat.

Another important observation is that when we talk about food and nutritional security and healthy diet, we also talk about the relevance of the access to food diversification.

At the mentioned Garden it is grown a great variety of organic foods, ranging from leafy vegetables (parsley, cilantro, chives, lettuce, arugula, spinach, kale), fruits (papaya, watermelon, melon), legumes (green beans), tuberous roots (beetroot, carrot), fruits (peppers, okra, tomato, cherry tomato), among others, ensuring that various types of food and nutrients reach the table of the beneficiaries.

Regarding the quality of the food, it has to be from a healthy mode of production that respects the environment, culture, the economy and socially sustainable, requirements also followed in the production standards of the mentioned garden.

Since its implementation, organic management practices are adopted, without the utilization of any agrochemicals. The methods adopted as fertilizers for the soil are: Application of manure and plant residues; crop rotation system; introduction of green fertilization, as a cocktail of legume species, grasses and compost; use of dead cover that may be grass and palm straw or residues from previous crops.



The seedlings are prepared with seeds. Part of them are acquired in trading houses certified as organic and others are produced in the vegetable garden. If any pest appears, alternatives solutions prepared with diluted neutral detergent, cassava peel, garlic, among others are applied. Always using techniques that are not harmful to people or environment.

All the species that constitute the Garden are regional foods, thus ensuring respect and encouragement for the consumption of local foods that are part of our food culture.

Another aspect of food and nutrition security concerns to the quality of the water used in the community gardens.

Regarding the available water for irrigation of the plants, it is stored in covered reservoirs, coming from the same pipeline that supplies the Plural Space and the unit receives periodic visits from the sanitary inspection of health agents.

The garbage is collected selectively and collected by the city's collection, contributing to the preservation of the environment.

Thus, it is noticed the size of the contribution that this Project has for the improvement of the food and nutritional security of the people who are involved, in addition the preservation of the environment.

#### **- Social inclusion and income generation.**

A paper published by Tedde et al., (2019) state that,

Another important aspect related to the implementation of the communitarian Garden is the promotion of the communities' empowerment, which aims the creation of solidarity and cooperation's bonds between individuals, potentializing social and productive inclusion strategies. (Tedde et al., 2019, p. 110).

The vegetable Garden, object of this study, contributes to the empowerment of those who are involved, both male and female. However, among the participants, most of them are female and this insertion in an activity promotes education and knowledge. There it is talked about entrepreneurship and it brings financial profit. It is an opportunity that women find to break social barriers, acquire a profession, increase self-esteem, and become empowered.

Some activities are developed in groups, providing opportunities for the strengthening of family and community bonds, such as: seed production, manure acquisition and preparation of organic compounds.

Another situation that benefited the relationships was the method used during the implementation of the

vegetable garden. During this period the transmission of knowledge occurred between each people involved. It still happens and the individuals build and rebuild their knowledge through educational actions, opening new doors for the dialogue about popular, theoretical, and technical/scientific knowledge. This makes the interaction between all those who are involved in the Project (technicians, advisors, producers, co-ordinators, and other participants).

This proposal of methodology values the knowledge of participants, raises dialogue and solidarity as ethical values derived from their lives.

Community Garden of plural space also encourages producers to sell the leftover food, generating income to improve their quality of life.

At the beginning, the production was sold by the producers in the garden. In 2014 an Organic Market was created, and it worked in front of the UNIVASF rectoria, at the Centro campus, in Petrolina – Pernambuco, as well as at the UNIVASF campus Juazeiro - Bahia, in front of the collegiate block. The street market used to work every Friday, from 8 am to 11 am, but during the COVID 19 pandemic, the activities were suspended, and it will return only when the health authorities release it. For now, the sale happens in the vegetable Garden and deliveries to trader of the street Market and to the producer Market in Juazeiro.

#### **IV. CONCLUSION**

The Agroecological Community Garden of Plural Space is an active social program, serving as a reference for Family farmers, because it practices a sustainable urban agriculture based on organic production dynamics that do not harm the environment. Above all, it ensures the food security for families whose work and income only come from this activity, reducing malnutrition and valuing health and life.

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# Analysis of physical therapy treatment in post-mastectomy sensitivity disorder

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**Keywords—** *Physiotherapy, Sensitivity and Breast Cancer.*

**Abstract—** *Breast cancer is a cellular anomaly that can occur due to several factors, both environmental and the body itself. Cancer is one of the most important diseases that are increasing each year and, among many types, breast cancer, especially, draws itself even more attention for its location in a part of the body that brings womanhood to femininity. Thus, entails a series of physical and mental problems. Most women opt for mastectomy when the cancer is in an advanced stage as it is one of the ways to remove the entire tumor at once. Physical therapy plays a very important role because it will be present at all stages of cancer, it will be in early treatment until postoperative where it will prevent complications, an adequate functional recovery, and a better quality of life. The aim of this study was to propose a significant improvement in the life of a patient with breast tenderness decrease after mastectomy using the physiotherapy protocol for sensitivity recovery. It was found that there was recovery of normal skin sensitivity, total pain reduction and quality of life gain.*

## I. INTRODUCTION

Breast cancer is a cellular anomaly that can occur due to several factors, whether environmental or the body itself. Gene mutations can occur and trigger transformation and malignant growth. Some risk factors for breast cancer are: age, skin color, race and ethnicity, family history, hereditary genetic lesions, medications (such as oral contraceptives, herbal medicines, pesticides), ionizing radiation, obesity and quality of life (CEZAR; NASCIMENTO, 2014).

Cancer is one of the diseases that has been increasing every year and, among several types, breast cancer, especially, draws more attention. It is located in a part of the body that brings femininity to women and, therefore, causes a series of physical and mental problems. Affecting several women over the years, breast cancer is the main malignant disease of the female sex, it has affected several age groups and the mortality of women has had a significant increase (SCHILITZ et al., 2019).

In many cases, surgery to remove the tumor is necessary. Among the main surgeries, we have the modified radical mastectomy and total mastectomy.

In a modified radical mastectomy, the surgeon removes the breast, the part above the pectoral muscles, and some of the lymph nodes in the armpit. In total (or simple) mastectomy, the surgeon removes the entire breast. Radical mastectomy is rarely performed today, which removes the breast, pectoral muscles, and most of the lower, middle, and upper lymph nodes (KOMEN, 2010).

Loss of breast sensitivity has been shown to be a common factor in women who have undergone mastectomy. The cold skin and scars, combined with the absence of sensitivity, cause some women the feeling that the graft looks like lifeless skin, which is not part of their body.

Women find it difficult to exercise their sexuality when breast sensitivity is compromised. A part of the body, which previously promoted the sensation of pleasure, becomes discomfort and other uncomfortable feelings, which may be associated with insensitivity to breast disease, each time they are touched (LORENZ; LOHMANN; PISSAIA, 2019).

Depieri (2005), report that desensitization is the sensitive stimulus performed at the distal end of the stump, which will lead to saturation of the receptors of the sensitive afferent pathways, with a view to normalizing local sensitivity. Because of this, there is a decrease in local hypersensitivity, so that adaptation to the prosthesis is bearable, through slow and gradual movements, starting from the finest to the harshest stimulus, being passed from one phase to another as the patient reports no be more of a nuisance the stimulus performed by the physiotherapist.

The improvement of the sensitivity disorder occurs through desensitization techniques. Physiotherapy plays a very important role because it will be present in all stages of cancer, whether in early treatment until the post-operative period, where it will prevent complications, adequate functional recovery, and a better quality of life. With desensitization in a patient with sensitivity disorder, it is expected to obtain a reduction in pain, improvement in tingling and paresthesia. Through the improvement of symptoms it is expected to increase the quality of life of patients and prevent possible future complications (MATHEUS; SILVA; FIGUEIREDO, 2018).

Most women opt for mastectomy when the cancer is at an advanced stage, as it is one of the ways to remove the entire tumor at once. Every surgery has its sequelae: in mastectomy she may have pain, swelling in the arm, seroma, hematoma, decreased ROM and also may present

sensitivity disorders, which is a clinical entity where the woman will feel pain, tingling and breast sensation gift. The sensations can be continuous and strong, they manifest themselves right after the surgery, in months and even years, it will depend on each body. Desensitization is one of the techniques to treat the syndrome (MATHEUS; SILVA; FIGUEIREDO, 2018).

Desensitization in patients with breast hypersensitivity and recovery of normal sensitivity aims to provide a reduction in heightened sensations and significant relaxation, not only in the breast, but also in other areas of the body. Thus, the objective of this study was to propose a significant improvement in the life of a patient diagnosed with decreased sensitivity after mastectomy through the use of a physical therapy protocol.

## II. METHODS

### TYPE OF RESEARCH

Nature and type of research

#### As the goals

Based on the objectives, this work is classified as explanatory research, in which it explains why, reason, deepens the knowledge of reality (GIL, 2002).

These researches are mainly concerned with identifying the factors that determine or contribute to the occurrence of the phenomena. This is the type of research that deepens the knowledge of reality, because it explains the reason, the reason for things (GIL, 2002).

#### As for technical procedures

Bibliographic research is based on a set of sources such as books, articles published in scientific journals, dissertations and theses, printed materials or materials available in electronic media (BALENA, 2013).

Case study is a research modality widely used in biomedical and social sciences. It consists of the in-depth and exhaustive study of one or a few objects, in a way that allows for their broad and detailed knowledge (GIL, 2002).

#### As for the approach

This is a qualitative work. It is the type of research suitable for those seeking to understand specific complex phenomena, in depth, of a social and cultural nature, through descriptions, interpretations and comparisons, without considering their numerical aspects in terms of mathematical and statistical rules (FONTELLES et al., 2009).

#### Population

Female patient with sensitivity disorder.

## Sample

Patients who were diagnosed with breast cancer between 2008 and 2018, who underwent the surgical process with the radical mastectomy technique, living in the city of Caçador, Videira, Fraiburgo and Joaçaba - SC, aged between 40 and 60 years.

## Ethical procedures

The project was submitted to the Ethics Committee of the Alto Vale University of Rio do Peixe - UNIARP and will follow all the ethical procedures provided for by Resolution No. 466/12, of the National Health Council, on research involving human beings and approved under opinion 3.775.682.

## Procedures for data collection

The sample was selected through the dissemination of the research development at UNIARP Caçador-SC in partnership with the Women's Network for Fighting Cancer Hunter, with participants being volunteers who fit the inclusion factors.

Clarifications were made about the study and the signature of the Free and Informed Consent Term was collected for those who agreed to participate.

The research patient was then submitted to evaluation using the Evaluation form, which contains sociodemographic data, information about the pathology and treatment procedures already carried out, as well as physical and functional examinations to detect the phantom breast. After the evaluation, the patients underwent 15 physical therapy sessions using a breast sensitivity enhancement protocol. At the end of the 15 sessions, the patient was reassessed. The procedures took place at Uniarp Caçador's School of Physiotherapy Clinic.

## Assessment

The patient was submitted to evaluation using the Evaluation form, which contains sociodemographic data, information about the pathology and treatment procedures already performed, as well as physical and functional examinations to detect the sensitivity disorder. After the evaluation, an esthesiometer test was performed to measure breast sensitivity.

## Protocol application

The techniques applied in the sessions were massager with two different heads, one with bristles and

the other with a sponge, clove ball, and paraffin with two applications.

The sessions lasted for one hour, the massage with the clove ball was done in circular motions for 20 minutes, with the massager also performing circular movements lasting 10 minutes with each head. And finally the paraffin with two applications for 10 minutes each.

## Reevaluation

Reassessment took place in the last session using the esthesiometer, which confirmed the results of gain in sensitivity and the patient's report was of total absence of pain.

## III. RESULTS AND DISCUSSION

The patient participating in the research was a woman who is currently 54 years old. The patient had been following up for fibroadenoma and cysts in the right breast since 2003. Five years ago, in 2014, at the age of 49, she was diagnosed with Invasive Breast Cancer with Stage 3 and Luminal Molecular Classification B, for complement. For diagnosis, lymphadenectomy was performed using Sentinel Lymph Node products and right axillary parasentinel. She underwent neoadjuvant treatment receiving 06 cycles of chemotherapy. After completion of neoadjuvant chemotherapy, the patient underwent modified radical mastectomy surgery (2015). Material sent for post-surgical pathological study verified lack of response to neoadjuvant chemotherapy and voluminous disease with invasion of the nipple.

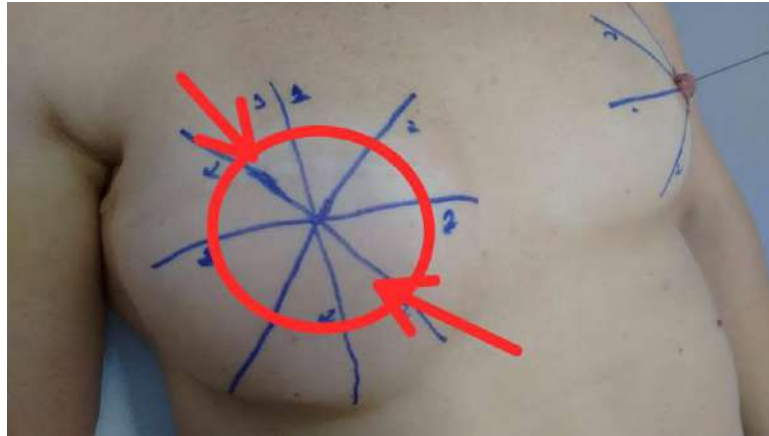
During physical therapy evaluation, the main complaints were pain in the upper part of the breast and absence of periareolar sensitivity.

After performing 15 physiotherapy sessions to recover the local sensitivity of the right breast, the following results were observed:

### Test with esthesiometer

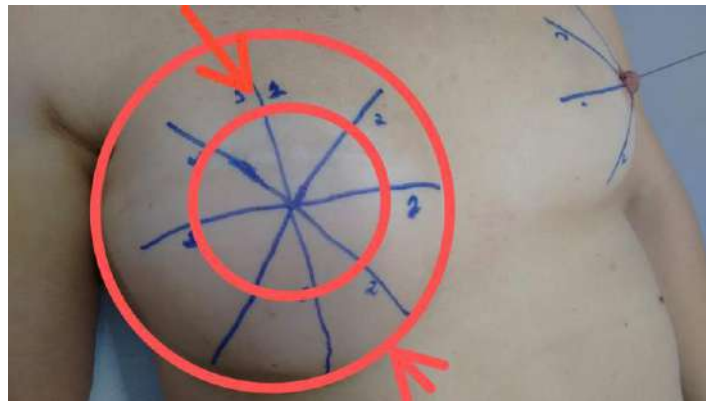
The figures below show the regions where the esthesiometer was applied for the sensitivity and pain test, as well as the regions where the techniques for increasing sensitivity and decreasing them were applied.

Figure 1 demonstrates the locations around the red circle where the patient had normal sensitivity.



*Fig.1: Normal sensitivity*  
**Source:** The Author (2019).

Figure 2 demonstrates that the peri-areolar region indicated in the circle did not present any sensitivity.



*Fig.2: Lack of sensitivity*  
**Source:** The Author (2019).

With the applied physiotherapeutic techniques, the patient had a significant increase in sensitivity. The applied techniques were massager with two different heads, one with bristles and the other with a sponge, clove ball, and paraffin with two applications.

Figure 3 shows the location (marked by the circle) where the patient had pain to touch.



*Fig.3: Pain area.*  
**Source:** The Author (2019).

The techniques for reassessment were the same used during the assessment. It was observed that after the 6th of the 15th sessions, the patient no longer had any pain and that skin sensitivity had recovered.

According to a study by Rocha et al. (2007), sensory stimulation and kinesiotherapy provide greater recruitment of muscle fibers during the treatment, which may increase efferents in the system and promote a reduction in the threshold of sensory nerve fibers, facilitating the triggering of afferents, thus, an improvement in the thermal sensitivity.

Protopathic sensitivity is the most primitive and diffuse, and represents all painful cutaneous stimuli, to heat and cold. When the transected sensory-cutaneous nerve regeneration occurs, the individual does not accurately locate the stimulus site. In specific sensitivity, discrimination is finer, with precise location, appears later in cases of nerve regeneration and comprises tactile and thermal sensitivities and temperature changes, with localization and discrimination power (FERNANDES; FREITAS; SPERLI, 2012).

The use of paraffin as a thermotherapy technique to restore normal sensitivity and decrease pain is proven by the study of Robertson et al. (2009) which states that thermotherapy, which consists of the application or removal of body heat for therapeutic purposes. Superficial thermotherapy is used to relieve pain in patients undergoing palliative care. The goal is to promote muscle spasm relief, muscle relaxation in individuals with tumors (ROBERTSON et al., 2009).

Sampaio's study, Moura and Resende (2005) corroborates this when it states that physiotherapy offers resources to reduce the characteristic pain that was verified with the patient after using the protocols. These procedures are used in the treatment of acute and chronic pain. It is of fundamental importance to provide the patient with greater well-being, functional improvement and better quality of life. Some objectives are transcutaneous electrical nerve stimulation, application of heat and cold (thermotherapy and cryotherapy), massage, among others.

It was also found that physiotherapy is of fundamental importance for the full recovery of mastectomized patients, a characteristic observed by Gugelmin (2018) which reports physical therapy has an important role in mastectomized patients as they help to reduce pain, movement, preserving and restoring the kinetic-functional integrity of the organs.

#### IV. FINAL CONSIDERATIONS

Breast cancer has been growing every year, and affecting many women, early cancer detection aims at a better prognosis and less morbidity associated with treatment, so studies to develop better treatment protocols are needed to address all stages of cancer.

Physiotherapy plays a very important role in this new stage in the life of the operated woman, it is present from pre to post-operative period, and its indications are for posture, adhesions, changes in sensitivity, among others, the sooner you undergo physiotherapy, the better the recovery with faster return to activities of daily living, contributing to their reintegration into society without functional limitations.

The diagnosis of the disease is experienced by both the patient and the family, it is a moment of anguish, fear of death, denial, anger, sadness. During the treatment, the woman will go through very painful periods, for the loss of the breast makes the woman no longer feel feminine attractive, and a period of denial begins where she does not accept some treatments out of shame or even fear that the condition will become aggravated.

This study demonstrated that Physiotherapy can significantly contribute to improving the quality of life of patients undergoing mastectomy. It is suggested to continue the research investigating more cases of breast sensitivity disorders with a larger number of patients.

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# Comparative Analyses of Honey Production Chains on the edge of Sobradinho Lake-Ba and Serra of Capivara-Pi using the Strategic Management Tool Matrix Swot 3.0

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**Keywords**—*Comparative analysis; SWOT 3.0 MATRIX, Management.*

**Abstract**—*The territory of the Brazilian semi-arid region has historically been the scene of great challenges and adversities, with the capacity for survival and resistance of the people living in it being represented. Within this same territory, there are also several potentialities that should be studied, developed and encouraged, one of which is the bee honey production chain with *Apis mellifera* type stingers for economic purposes, also known as European bee, which must be worked towards complementing income, as well as the diversification of the subsistence activity of the populations of these territories. The study in question intends to compare the honey production chain in two regions of the Semi-Arid Region of the Northeast. The first chain is located on the edge of the Sobradinho lake in the State of Bahia, and the second is located in Serra da Capivara, which belongs to the state of Piauí. The present study is of a qualitative-quantitative, bibliographic and documentary nature, since studies already carried out will be analyzed, starting from secondary data for a comparative analysis of the two chains, using the system called MATRIX SWOT 3.0.*

## I. INTRODUCTION

The Brazilian semi-arid region is occupied by 22 million inhabitants, being the largest rural population in the country. With an area corresponding to 18.2% of the national territory, it is the most densely populated and most biodiverse semi-arid region on the planet (Baptista & Campos, 2014).

Although climatic factors cause some limitations, this region has many potentialities that must be studied and

eventually implemented with the aim of contributing to its sustainable development. Like the study of the honey production chain, which may have its economic viability assessed, to ascertain the prospects for job and income generation for populations in the Northeastern semi-arid. Thus, for this work, honey production chains were compared in two areas of this region that present the same climatic conditions, fauna and flora, showing how much

this agricultural activity can bring benefits to communities, corroborating the development of the areas surveyed.

In this sense, activities such as honey production with the western honeybee (*Apis mellifera*) have significant economic potential (Soares, Araújo and Araújo, 2019).

Apiculture represents a productive and sustainable, low-cost activity that could supplement the incomes of smallholder farmers and reduce emigration from the area (Sachs, 2009). It is also ecologically correct since it does not deforest. To the contrary, it encourages reforestation.

The active rural population in the Northeastern Semi-arid Region is currently focused primarily on raising sheep and goats. Successful honey production presents a strong potential to supplement their incomes.

For this study, we analyzed the honey production chains of two regions of the semi-arid northeast, each with similar climatic conditions, fauna and flora. The study analyzes the honey production chains in two territories. The first called Edge of lake of Sobradinho, no State of Bahia (hereinafter referred to as “Bahia case”) and Serra of Capivara in the State of Piauí (hereinafter referred to as “Piauí case”).

## II. THEORETICAL REFERENCES

### 2.1 Production Chains

Observations of systemic and integrated steps of each production chain, can identify system shortfalls. It is essential to study every stage of each production chain. Mello and Brum (2020, p.4) state that,

[...] the study of production chains makes it possible to monitor each product, from its initial conception until it reaches the final consumer, whether in the domestic or foreign markets. It is also noted that there are different production chains around the same product, according to their organization in different regions and countries. Thus, the production chains compete in the general market for their specific product.

For a producer, any improvement in efficiency – energy, production processes and steps, or use of new materials – is innovation directly correlated to infrastructure investment. Any narrowing of the production chain can reduce costs, increase production, and consequently profitability.

In the development of a production chain, attention should also be given to economic, environmental, and social impacts (both positive and negative) arising from the exploitation of natural resources. The image and promotion of any enterprise, operated by a legal entity or

by an individual, will benefit from value-added economic, social, and environmental attributes.

To achieve sustainability, the activity must maintain a balance with the environment (Kramer, 2020). Production will be compromised without harmony with the surrounding environment.

### 2.2 Honey Production Chains

A production chain is understood as the set of actions that transforms raw materials into products. The various transformation processes are chosen by individual producers, organizations and institutions (Assad et al., 2018). The sales marketing of Brazilian honey has grown both nationally and internationally since the beginning of the 21st century. Analyses of production chains are vital to ensure continued market competitiveness and growth (Rego et al., 2017).

Castro et al., conceptualize production chains as follows:

“[...] production chains are sets of interactive components, such as agricultural and agroforestry production systems, service and input suppliers, processing and transformation, distribution and marketing industries, as well as final consumers of the product and by-products of the chain” (Castro et al., 1995, p. 12).

The raw material of the production chains under study are the supply of queen bees and larvae, production boxes and their various components, beehives, wax and reserve combs, food supplements, centrifuge equipment and services (Assad et al., 2018). Forage is provided by pastures of endemic and cultivated plants.

In the chains under study, marketing is carried out in four ways:

- Through regional intermediaries who purchase the honey from bulk beekeepers in buckets, cans, or drums. The intermediaries consolidate the honey into metal drums suitable for transportation. The drums are stacked and stored until the date of shipment to processing industries who in turn package the honey for domestic and international distribution and sale to wholesalers (Araújo, 2014).
- A broker is hired by the retail [JM2] entities. They broker contacts the beekeepers and makes direct purchases of the product on behalf of the retail entities (Araújo et al., 2016).
- Through direct sale by beekeepers to their community associations – usually involving smaller quantities (Araújo et al., 2016).
- Informal marketing where beekeepers sell a portion of their honey directly on the open markets to local consumers (Araújo et al., 2016).

### III. THE MATRIX SWOT

In the competitive contemporary business world, it is essential that organizations be able to analyze the real market in which they operate. For this, managers/administrators use various resources and/or tools to assist in the interpretation of quantitative and qualitative information to predict uncertainties and unforeseen events (Saraiva et al., 2007; Rodrigues et al., 2015; and Massukado, 2004).

SWOT is an acronym for **S**trengths/**W**eaknesses, **O**pportunities/**T**hreats. The MATRIX SWOT, developed by Albert Humphrey between the 1960s and 1970s (Gürel; Tat, 2017), is an important methodological tool that helps the manager/administrator deepen their strategic analysis of a process so that they may optimize business decisions (Kotler; Armstrong, 2008). It is widely used by companies regardless of the level of development of their commercial size (Qehaja; Kutllovci; Pula, 2017).

In the MATRIX SWOT, **S**trengths refer to what a company does well internally, **W**eaknesses refer to what the company does not do very well, both considering the internal environment. On the hand, **O**pportunities are potential avenues to achieve greater growth and profitability, and **T**hreats are factors that can have the ability to negatively impact the company on the external environment (Martins et al., 2013; Paliwal, 2006).

### IV. METHODOLOGY

To answer the research question, initially a literature review was conducted. The descriptor keywords used were “production chain”, “honey”, “apiculture”, and “semi-arid.” *Comparative analysis; SWOT 3.0 MATRIX, Management.*

In this study, a team of Master's students in the discipline called Analysis of Production Chains in the Graduate Program in Dynamics of Development of the Semi-arid - PPGDiDeS of the Federal University of Vale do São Francisco - UNIVASF, used the strategic management tool MATRIX SWOT 3.0 to analyze data gleaned from a meagre body of existing bibliographic documentation. To analyze data for two cases:

- 1) “The Bahia case” is based on “Honey production chain in the territory of the Sobradinho lake border in the State of Bahia”, published in Revista Sodebras in 2016, identified as Article 1 in Analysis 1 (AA1).
- 2) “The Piauí case” is based on “Honeybee production chain from Piauí”, presented at the 6th Piauiense Beekeeping Seminar, identified as Article under Analysis 2 (AA2).

The MATRIX SWOT 3.0 tool is based on the analysis of the internal and external factors of AA1 and AA2, where data were extracted and generated qualitative and quantitative variables, using the Likert Scale with a score from 0 to 10. The Likert Scale values in the MATRIX SWOT 3.0 are: 0 - totally unimportant, 2.5 - little importance, 5 - important, 7.5 - very important and 10 - totally important. In addition, for internal factors, the rating scale (qualitative) refers to the variables strength and weakness and for external factors, opportunities and threats.

### V. RESULTS AND DISCUSSIONS

5.1 Comparative analysis between the productive chains of honey on the edge of the lake of Sobradinho-BA and Serra da Capivara-PI using the strategic management tool MATRIX SWOT 3.0

The study of the productive chains in certain regions can determine their viability or lack of viability, generating future perspectives of development, employment and income for the local populations that live in these regions of the Northeastern Semi-arid.

Castro et al (1995) conceptualize production chains as follows:

“[...] production chains are sets of interactive components, such as agricultural and agroforestry production systems, service and input suppliers, processing and transformation, distribution and marketing industries, as well as final consumers of the product and by-products of the chain” (CASTRO et al, 1995, p. 12).

In this sense, the honey production chains on the edge of Sobradinho Lake in Bahia and Serra da Capivara in the State of Piauí, object of this study, are inserted in an environment of diversity and multiplicity, in which interrelationships are each increasingly complex between man and nature. Therefore, the integration of these two actors can provide local development, increase producers' income, diversifying business within rural properties.

On the other hand, within a historical context, for Soares, Araújo and Araújo (2019), the State of Piauí started beekeeping from the year 1976 with the arrival of the Wenzel and Bendel families, in the municipality of Picos. According to the authors, the Piauí state has been developing professionally in a sustained manner in the beekeeping sector.

After inserting the variables (strengths and weaknesses) registered in the scientific article called “Honey production chain on the edge of the Sobradinho lake in the state of Bahia” and launching the strategic management tool called

MATRIX SWOT 3.0, we performed the first analysis filter based on the Likert scale method.

It is evidenced in the analysis 1.1 Internal Factors (of the honey chain on the edge of the lake of Sobradinho-BA) that within the internal structure of the chain itself, there are a number of gaps (weaknesses) that should be better addressed by beekeepers (Table 1). These are: a) The lack of health inspection (essential for the product quality process); b) Low technical qualification of beekeepers - which significantly impairs the management, in particular during periods of drought; c) Inadequate and inefficient infrastructure that impacts both quality and hygiene; d) Health inspection standards are not being met. This creates a production and quality problem, as well as a health problem for consumers; e) Quality values remain recognized. There is inadequate effort in the marketing network to improve commercialization; f) Associative or cooperative organization is lacking. This weighs on production and marketing; g) Poor or underutilized honey extraction equipment; h) Inadequate technical assistance from government agencies resulting in a culture of non-scientific “empiricism”; i) Low capitalization resulting in depreciation of equipment.

Table 1: Honey chain on the edge of the lake of Sobradinho-BA

<b>STRENGTHS</b>	<b>68</b>
Sales Marketing the product on the market	10
Beekeeping Flora	10
Production cost	10
Production outflow	10
Research and Development	10
Economic, social and environmental impacts	10
Honey sales warehouse in Remanso-BA	7,5
<b>WEAKNESSES</b>	<b>85</b>
The lack of HEALTH INSPECTION	10
Low technical qualification of beekeepers	10
INADEQUATE / INEFFICIENT production infrastructure	10
Do not meet the current sanitary standards	10
The product has low market quality for	10

consumption	
Low membership in association and/or cooperatives	10
Lack of honey extraction equipment	10
Lack of technical assistance from Government Agencies	10
Low CAPITALIZATION of beekeepers	5

Source: Prepared by the authors (2020), based on the MATRIX SWOT 3.0 tool

It is evident that the territory offers significant opportunities. One of the main challenges to further development is the lack of coordination and organization among competing honey producers.

In the analysis 1.1 Internal Factors (from the Serra da Capivara-PI honey chain), it is quite evident that the forces undoubtedly overcome the weaknesses of the chain under review (Table 2). However, it is necessary to list the weaknesses of the chain with some observations, namely:

a) Lack of state and municipal support and specialized technical assistance programs (in the article it is clear that there is a strong partnership between SEBRAE-PI and EMATER, in addition to other non-profit entities that help the chain. However, it is very incipient given the potential production of the territory and the chain as a whole). Without the partnership of government agencies (State and Municipalities) to make public policies, qualification, training and specialized and continuous technical monitoring possible, the chain may lose strength and new entrants in this market seize the opportunity to enter this market; b) Few beekeepers feed the swarms during the dry season, which leads to the loss of swarms and productivity (although the qualifications of beekeepers in the chain have access to technical assistance, handling in times of drought needs to be better worked in the supply chain. Piauí can generate an increase in productivity during the dry season); c) Lack of an organized and articulated network for the marketing of honey (this may be one of the major obstacles in the Piauí chain), as the creation of an integrated network could generate knowledge through exchanges between producers, as well as the search for new partners and new buyers of the product in the national and international honey market; d) Lack of knowledge and management tools by beekeepers and cooperatives (the lack of basic knowledge in management represents 65% of the death of micro and small companies in Brazil according to SEBRAE NACIONAL). Beekeepers in the

Piauí chain need to urgently seek this qualification within the management processes, establishing training and consulting partnerships with SEBRAE-PI to try as soon as possible to eliminate this great weakness of this chain in question.

Table 2: Honey chain from Serra of Capivara-PI

STRENGTHS	110
Quality of honey produced (competitive differential)	10
Performance of COOPARN and COOPASC cooperatives	10
Training of most beekeepers	10
Good cost / benefit ratio in honey production	10
Performance of the PVSA of the state government	10
Income generation for families through beekeeping	10
Access to beekeeping financing by BNB and BB	10
Diversity of flowering bee	10
Presence of middlemen (purchase in cash)	7,5
Existence of support entities for beekeepers such as: EMATER, CaritasDiocesana, Dom Hélder Project, Coota	7,5
Existence of technicians and private technical assistance companies specialized in beekeeping	7,5
Sufficient space for installation of future apiaries	7,5
WEAKNESSES	37,5
Lack of state and municipal development programs and specialized technical assistance	10
Few beekeepers feed the swarms during the dry season, which causes the loss of swarm and productivity	10
Lack of an organized and articulated network for the marketing of honey	10
Lack of knowledge and management tools, by beekeepers and cooperatives	7,5

Source: Prepared by the authors (2020), based on the MATRIX SWOT 3.0 system

After inserting the variables (strengths and weaknesses) registered in the scientific article called “Study of the beekeeping productive chain of the Serra ofCapivara territory in the state of Piauí” and launching in the strategic management tool called MATRIX SWOT 3.0, we performed the first filter of the analysis based on the Likert scale method.

In the analysis 1.2 External Factors (of the honey chain on the edge of the lake of Sobradinho-BA), it is clear that the opportunities in the chain under review are immense (Table 3). However, the main threat is the existence of many competitors of honey in the market and this threat is already quite worrying and should serve as an incentive to implement several improvements that have already been signaled so that the honey chain in this territory can develop further.

Table 3: External factors of the honey chain on the edge of the lake of Sobradinho-BA

OPPORTUNITIES	115
Potential for growth in honey production	10
Potential for income diversification	10
Competitive market price of honey	10
Cooperation among producers	10
Training and capacity building	10
Availability of supplementary food for dry seasons	10
New technologies for honey production	7,5
Creation of Cooperative or Association	7,5
Preservation of CAATINGA's flora	7,5
New generations to manage the chain	7,5
New beneficial public policies	5
Rural extension activities for the chain	5
Research and publication on the subject	5
Create a specific regional event (promote products)	5
Reinvestment in production equipment	5
THREATS	10

Competing of honey producers	10
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**Source:** Prepared by the authors (2020), based on the MATRIX SWOT 3.0 system

Regarding the analysis 1.2 External Factors (from the Serra ofCativara-PI honey chain), it is clear that, as it is better structured and positioned in the market, it generates a larger commercial relationship with suppliers, buyers and, consequently, attracts the possibility of new entrants in this market. It is extremely promising given the consumption of honey, due to the growing concern with a search for quality of life and well-being of the world population.

Table 4 presents data analysis of Piauı’s case. It indicates that the main threats to this chain are:

- a) Prolonged drought. In order to try to minimize this threat, it is necessary to establish strong partnership with technical governmental bodies that will provide specific training and new options for the management;
- b) Low price of honey compared to previous years. Without a consolidated and well-articulated commercial network, beekeepers will permanently succumb to unfair demands from middlemen and buyers;
- c) Importation of competitively-priced honey from other countries. Following market trends and diversifying could minimize this threat;
- d) Reduction of flowering during periods of drought. Irrigation options from Serra ofCativara - PI should be considered to try to mitigate loss of flora and allow bee pollination;
- e) Lack of cooperative spirit by the majority of beekeepers who are members of cooperatives. A more collaborative culture needs to be nurtured with an emphasis on the importance of joint and cooperative work;
- f) Some beekeepers do not yet have modern beekeeping skills. Governmental and non-governmental bodies need to provide specialized technical assistance.

Table 4: External factors of the honey chain of Serra da Capivara-PI

<b>OPPORTUNITIES</b>	<b>70</b>
Increasing awareness of healthy diets	10
Marketing of honey to government agencies: Small holder Farms Food and National Supply Company (CONAB)	10

Marketing of honey for school lunches through PNAE, in municipal and state schools	10
Production of other beehive products, such as: pollen, propolis, royal jelly, and apitoxin	10
Adding value to honey by the cooperatives: Improvement and fractionation of honey for the market	7,5
Conditions for setting up agricultural companies producing honey in the territory	7,5
Honey is seen to be an important dietary supplement.	7,5
Lack of access to market channels such as the National School Feeding Program (PNAE) and Education Program	7,5
<b>THREATS</b>	<b>68</b>
Prolonged droughts in the study territory	10
Imported honey from other countries at more competitive prices	10
Low flowering during droughts	10
Lack of cooperative spirit by cooperative members	10
Low market price compared to previous years	7,5
Inadequate technical proficiency	7,5
Non-acceptance of best practices (BPA)	7,5
Weak purchasing power of cooperatives: COO	5

**Source:** Prepared by the authors (2020), based on the MATRIX SWOT 3.0 system

In this way, the success of the managers of the honey production chains in the two studied territories, depends on the actions that should be implemented based on the various variables available contained in the internal and external factors of the MATRIX SWOT3.0 presented here.

Therefore, the analyzes are correlated with a very well-structured action plan that should allow the continuous improvement of the production process aiming at better results for all those involved in the chains.

Based on the study of honey chains in the territories of the Sobradinho lake border in the State of Bahia, as well as Serra da Capivara in the State of Piauı, it is evident that the

two chains represent a fraction, albeit a small part of the economy in agricultural products that provide these chains within their territories for products produced from bee honey.

Table 5: General analysis of the internal and external factors of the honey chain on the edge of the lake of Sobradinho-BA

Forces	67,5
Weaknesses	85
Opportunities	115
Threats	10

Source: Prepared by the authors (2020), based on the MATRIX SWOT 3.0 system

The general analysis of internal and external factors presented in MATRIX SWOT 3.0 of the “Production chain of honey in the territory of the edge of the lake of Sobradinho in the state of Bahia”, signals the following path: Producers must first take advantage of the countless opportunities for improvement existing in the chain, optimizing its forces. Weaknesses must be addressed as a matter of urgency and duly corrected, given that at the moment the threats are much smaller.

Table 6: General analysis of the internal and external factors of the honey chain of Serra ofCativara-PI

Forces	110
Weaknesses	37,5
Opportunities	70
Threats	67,5

Source: Prepared by the authors (2020), based on the MATRIX SWOT 3.0 system

The general analysis of internal and external factors presented in MATRIX SWOT 3.0 of the “Honey production chain in the Serra of Capivara territory in the state of Piauí”, signals the following path: The producers of this chain must first maintain their strength, trying to improve each day. It is important to take advantage of the countless market opportunities in this chain. The threats are quite significant, which is clear from the analysis. Although this chain has few weaknesses revealed by SWOT 3.0, it is necessary to minimize them so that they can be transformed into fortresses.

Finally, after analyzing the honey chains of the territories on the edge of the Sobradinho lake in the state of Bahia and Serra da Capivara in the state of Piauí, based on the MATRIX SWOT 3.0, the results obtained for the two chains were the following:

Table 7: Favorability index of SWOT analysis in the honey chain on the edge of the lake of Sobradinho-BA



Source: Prepared by the authors (2020), based on the MATRIX SWOT 3.0 system

Based on the analysis of MATRIX SWOT 3.0 of the “Honey production chain in the territory of the edge of the Sobradinho lake in the state of Bahia” (emphasis added), the favorability index of this chain is 55%, a course for the continuity of the business, obviously without forgetting the factors that must be developed and improved.

Table 8: Favorability index of SWOT analysis in the honey chain of Serra of Capivara-PI



Source: Prepared by the authors (2020), based on the MATRIX SWOT 3.0 system

Based on the analysis of MATRIX SWOT 3.0 of the “Honey production chain in the Serra ofCapivara territory in the state of Piauí” (emphasis added), this chain's favorability index is 47%, pointing to the path of business continuity, obviously without forgetting the factors that must be developed and improved.

Thus, in the perspective of developing the honey production chains in the territories of the Sobradinho lake border in the state of Bahia and Serra of Capivara in the state of Piauí, they need to develop several factors (internal and external) as pointed out in MATRIX SWOT 3.0, which infer the competitive advantages of this segment, aiming at obtaining a better performance in production and in meeting the increasing demands of the consumer market. To this end, considering that the entire production chain must work in a joint effort, both by the producers and the stakeholders (partners) that are around the chain, such as research institutions and public bodies, with the

perspective of raising the level of competitiveness of this company every day. productive chain in the territories where they are located. Thus, these data suggest new studies, as the remaining links in this chain are being developed.

Through this study, there was a scarcity of scientific articles that deal with the theme here under comment, within the analyzed territories, thus punctuating the relevance of this work.

In this sense, the importance of the theme for science is perceived in the perspective of having new studies on the honey production chain in the Brazilian Northeastern Semi-Arid.

## VI. CONCLUSION

The development of a given region is a cumulative process, with macro, micro-regional and micro-economic needs (Elias; Rathmann; Azevedo; Dutra; Silva, 2009). Hence the importance of understanding the diversity of products produced and the components of the production processes.

In the context of the Brazilian Semiarid, the territory surrounding Lake of Sobradinho emerges as a favorable region for the development of beekeeping, since, in addition to an abundant bee pasture, a favorable climate for the development of this activity and an abundance of water (one of the largest water mirrors in the world), located within the area of influence of the largest beekeeping pole in the Northeast, which is the mesoregion of the Southwest Piauiense (ARAÚJO; CORREIA and SILVA, 2016).

The proposed objectives of this study were achieved. Using the strategic SWOT MATRIX 3.0 management tool, it was possible to analyze two productive chains of honey production, one in the State of Bahia and the other in the State of Piauí, both located in the northeastern semi-arid region of Brazil. The study identified areas needing process improvement.

Despite the growth in honey production in Brazil, beekeepers are still organized around their own associations and cooperatives, and these organizations are still relatively underdeveloped (Araújo et al., 2016). However, in both the Bahia case and the Piauí case found that the honey chains could be transformative for future development of local communities.

In both the Bahia and the Piauí regions, beekeeping represents a small fraction of the agro-industrial economy. But both the Bahia study and the Piauí studies indicate that well-structured action plans would improve the honey

production processes and make apiculture a more significant supplementary income.

Successful outcome will require strong partnerships with state and municipal government agencies to provide public policies and low-level investment, together with the nurture of awareness and provision of appropriate technical/vocational training and monitoring.

In the perspective of developing the honey production chains, both regions would benefit from measures aimed at improving production to meet market demand. To raise competitive levels, producers and partners/stakeholders, research institutions, and public bodies must work together. Areas that need to be addressed include provision of technical assistance, quality controls to honey producers, and developing a more robust marketing network.

This study also demonstrated the value of a management tool to analyze and diagnose variables in a clear and concise way.

Currently there is only a meagre body of relevant scientific articles concerning honey production in Brazil's semi-arid northeast. New studies will be required as improved production chains are developed. It is hoped that new research will follow this study and provide more insight into new strategies.

Using the strategic management tool called MATRIX SWOT 3.0, it was possible to analyze two productive chains of honey, one in the State of Bahia and the other in the State of Piauí, both located in the Brazilian Northeast Semi-arid. We suggested based on data analysis, training of producers, development of a wide network of marketing of the main products in diversified markets, improvement of product quality control. The study was based on the possibility of optimizing the information generated by the MATRIX SWOT 3.0 of the two honey chains, to improve the process of future decision making by managers. This work demonstrated the possibility of applying a management tool, more specifically to elaborate analysis and diagnosis, in a clear and concise way. The great contribution of the SWOT 3.0 MATRIX lies in the possibility of establishing connections between the various factors identified (Strengths, Weaknesses, Threats and Opportunities) in order to bring improvements in the organizational processes. It is expected that, based on our results, new studies will emerge that will deepen this theme more and more, giving continuity through the proposition of new strategies or even the application of other management tools. To analyze two production chains of honey in two territories located in the Northeastern Semi-arid. However, the research bibliographic, and, finally, the data analyses demonstrated that the tool used



provides the systematization and integration of information dispersed in a simple way, being applicable to the honey production chain in the studied territories, greatly facilitating the processes in the administration area.

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# Comparison between Quantitative and Qualitative Theme-Feature Forest Biomass Estimation Models built over SAR Data

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**Keywords**— Amazon Forest, Biomass,  
Machine Learning, Remote Sensing, SAR.

**Abstract**— International organizations are still in need for methodologies that accurately measures forests above ground biomass (AGB). Among the remote sensing technologies, those of Synthetic Aperture Radar (SAR) stands out in the modeling of forest biomass due to their ability to characterize the geometry of the imaged region. The semantic representation, through thematic maps, is one of the main means for the geospatial situational understanding. However, there is a gap of knowledge for models that are built by the analysis of quantitative and qualitative theme-feature in a complementary way. This article aims to develop and compare forest biomass estimation models, through an innovative methodology, over quantitative and qualitative theme-features. To this end, extracted SAR data and specific machine learning (ML) and feature selection techniques are applied for each case. The models developed are based into forest inventories with 128 plots located in two different Brazilian Amazon Forest areas and were built over 231 extracted independent variables. The methodology applied used techniques to categorize numeric data and, afterwards, comparatively evaluate numeric quantitative and categorized qualitative results. The constructions of the models were based on ML algorithms such as Multilayer Perceptron, Support Vector Machine and Random Forest. The results showed that the different study areas had very different vegetation characteristics, significantly impacting the feature selection and ML algorithms. The different biomes of the Amazon Forest and their respective characteristics demanded specific models and techniques, not fitting into a single pattern. importance.

## I. INTRODUCTION

In 2016 more than 190 countries participated in the 21<sup>st</sup> United Nations Conference of the Parties on Climate Change (COP-21), held in Paris. This conference aimed to continue the Kyoto Protocol, expired in 2012, and, consequently, to define goals regarding the emission of polluting gases into the atmosphere. Despite the intense

work, a legally binding treaty, capable of compelling the international community to cut greenhouse gas emissions, has not been signed. Among the reasons for this failure, one of the highlights was the lack of methodologies that accurately measures these cuts and establishes mechanisms for this reduction [1,2].

According to the United Nations Framework Convention on Climate Change – UNFCCC [3] the Article 3.4 of the Kyoto Protocol requires countries to report annually on changes in carbon stocks associated with forest biomass. The Intergovernmental Panel for Climate Change [4] and [5] states that reports with this information must follow a methodology based on the principles of transparency, consistency, comparability, completeness and accuracy.

However, [2,6-7] states that studies quantifying the carbon cycle between the atmosphere and forests are still needed. [2] points out that 53 to 58% of the carbon cycle comes from forests, therefore, accurate data on forest biomass are essential for many purposes, including subsidizing projects for environmental monitoring and Reducing Emissions from Deforestation and Forest Degradation (REDD +). [1,8] also states that forest biomass should be considered as a source of renewable energy and can be a source of income for national economies when used as carbon credit.

Among the remote sensing technologies, those of Synthetic Aperture Radar (SAR) stands out in the modeling of forest biomass due to their ability to characterize the geometry of the imaged region [1,2,6,8-12]. It also allows the monitoring and the verification of the type, direction, intensity and extent of the degradation in different areas, caused by human influence or by natural forest fires [6,13-16]. Due to the good results obtained by researchers, new projects that aims to use SAR data to estimate biomass are under execution or planning [6]. The Japan Aerospace Exploration Agency (JAXA) project, ALOS PALSAR 2, has been underway since 2014 and is a source of significant data for recent researches [14,17-20].

In Brazil, among the projects that aims to generate SAR images and that can be used in biomass estimation, the Amazon Radiography Project developed by the Geographic Service of the Army (DSG) stands out. By 2022, a total area of 1,800,000 km<sup>2</sup> of the Amazon region will be covered with airborne sensors in the X and P bands [21]. In addition to the 1:50,000 scale mapping, the project also has the potential to generate data to support infrastructure projects and sustainable exploitation of natural resources in the region [22-24].

Due to the large amount of data that can be originated from available SAR sensors, it is necessary to apply techniques that aims to organize and analyze quantitative and qualitative features in an intelligent and automated way [20,25-27]. Machine Learning – ML techniques are able to model knowledge and make associations between

different types of quantitative or qualitative information [28-29]. According to [30], the main advantages of ML are accuracy, since the optimal algorithm is selected from the characteristics of the data and the problem to be solved; automation in learning, which adjusts the models according to the success or failure of the results; processing speed; customization, being suitable in any type of problem; and scalability, as they are processes that adapt to data growth.

One of the possible applications in ML is the development of models involving thematic issues and those resulting in qualitative theme-attributes [28-29]. In these cases, the theme-attribute is commonly used for the construction of thematic maps that includes different areas of human geography, from the spatial representation of health and social geography [31-33], to characteristics related to forest biomass stocks [2,12-13, 16-18]. The semantic representation, through thematic maps, grows in importance, being one of the main means for the geospatial situational understanding and, consequently, the implementation of public administrations [34-35].

Recent published researches referring to biomass estimation presents ML originated models which output results are quantitative theme-attribute, that is, numerical [1,16,18-19]. However, studies that builds and analyzes simultaneously quantitative and qualitative theme-attributes models were not observed. Therefore, it is necessary researches that seeks to cover this gap of knowledge and that aims at building thematic maps models using, in a complementary way, quantitative and qualitative theme-attributes.

This article aims to develop and compare forest biomass estimation models built over quantitative and qualitative theme-feature based on extracted SAR data. To this end, machine learning and feature selection techniques are specifically selected and applied for each case.

## II. METHOD

### 2.1 Study Area and data

The study areas are located in different geographical regions of the Brazilian Amazon rain forest: São Gabriel da Cachoeira (SGC), a municipality located on the banks of the Rio Negro, in the northwest of the state of Amazonas; and the Unini River Extractive Reserve (Unini River ExRes) located in the Unini River basin, in the municipality of Barcelos. The areas, in white, are highlighted in Figure 1, together with the location of some of the inventoried plots, in green.

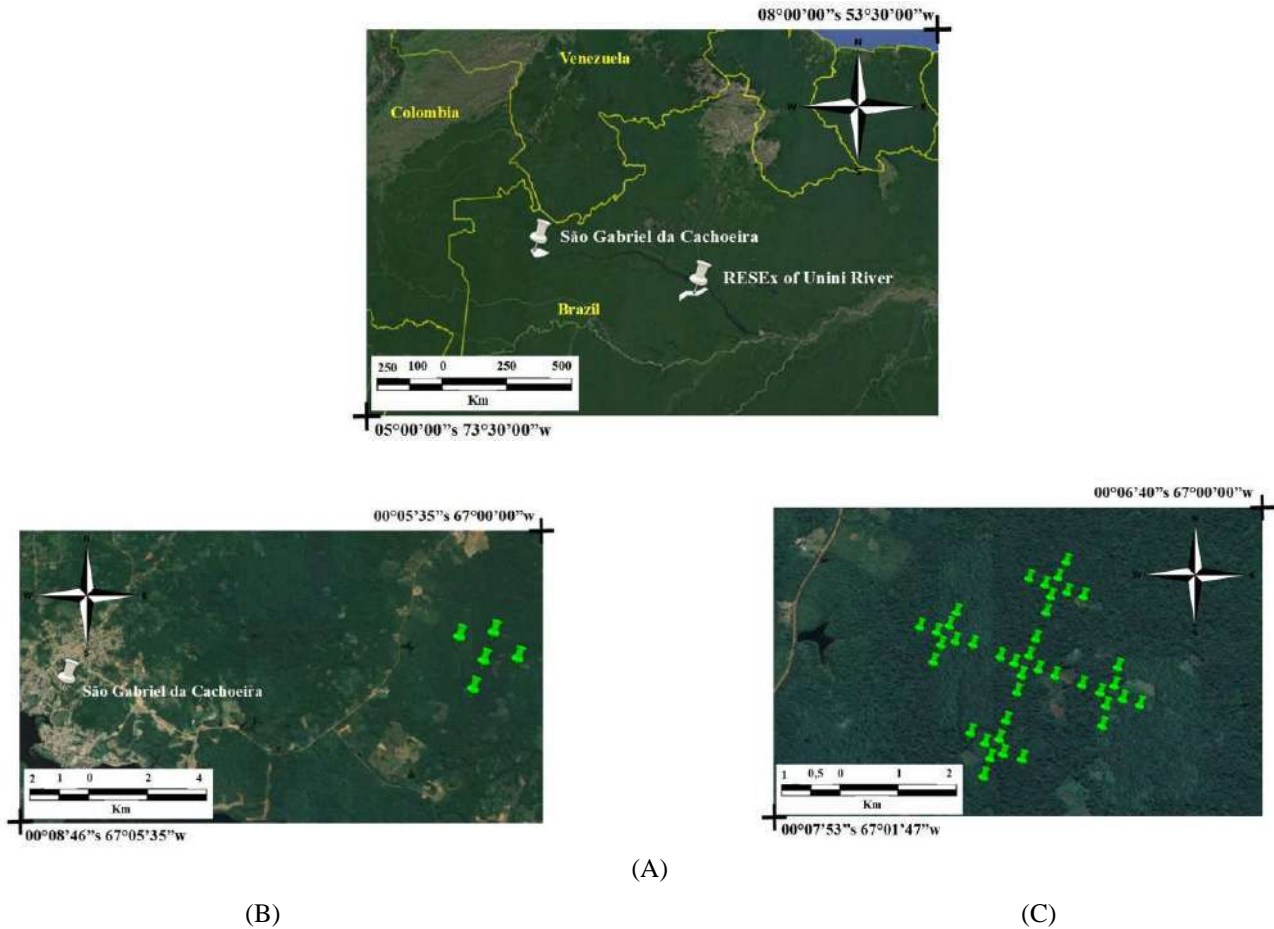


Fig.1:(a) Study areas, highlighted in white; (b) São Gabriel da Cachoeira region; (c) Location of a subset of plots inventoried and arranged in the shape of Maltese Cross.

The areas were selected for two reasons: the distinct phytoecological and land use and occupation situations and the availability of data. The SGC area has hybrid characteristics, composed of anthropized regions together with dense vegetation. In contrast, the Unini River ExRes area is composed only of primary virgin forest vegetation.

According to [31], the vegetation found in the study areas is of forest formation. More specifically, [32] indicates that the vegetation found in the São Gabriel da Cachoeira area is composed by phytoecological forest contact / edaphic formations regions (*campinaranas*). These regions are characterized in three ways:

- (1) dense, submontane forests with dissected relief. [32] states that the average AGB volume in the area is 107.4 m<sup>3</sup>/ha;
- (2) dense, submontane and undulating forests; and
- (3) dense forests, lowlands and relief with the presence of plateaus.

The Unini River ExRes, in its turn, is an extractive conservation unit with about 833 hectares in length and characterized in [32] as:

- (1) dense tropical forest, referring to the sub-region of the low plateaus of the Amazon; and
- (2) areas of ecological tension with dense alluvial presence.

The remote sensing data was obtained from the ALOS PALSAR 2 sensor and the Amazon Radiography Project. The working areas are comprised between 0° and 1° south latitudes and 67° and 68° west longitudes, for the region of São Gabriel da Cachoeira; and between 1° and 2° south latitudes and 62° and 63 ° west longitudes, for the Unini River ExRes.

The data from ALOS PALSAR 2 were provided by IBAMA and are Level 1.1 – Single Look Complex (SLC) processing images in the quadri-polarized strip-map imaging mode.

The Amazon Radiography Project data were provided by the [21] with the following characteristics:

- (1) amplitude orthoimages in X band HH polarization and P band quadri-polarized, all with 16 bits radiometric resolution and 5 meters spatial resolution;
- (2) digital surface models (DSM) and digital terrain models (DTM) generated, respectively, from the interferometric processing of X and P data, with 32 bits radiometric resolution and 5 meters spatial resolution.

The AGB data were provided by the National Institute of Amazon Researches – INPA, and follow the methods developed by [33] and described by [34]. In addition to the exact same geographical position as the images, the proximity to the region's imaging date was also important as it aims to avoid major changes in the analyzed vegetation.

The given biomass data provided was composed of 128 inventoried plots, 58 plots of São Gabriel da Cachoeira and 70 of Unini River ExRes, presenting the AGB values (ton/ha) and the UTM coordinates of the start and end points of each plot. As pointed out by [35-36], different allometric equations were used to calculate the inventoried plots due to the characteristics of the region. Figure 2 illustrates the format, the start (P1) and end (P2) points and the arbitrary coordinates of each arboreal individual within the plot.

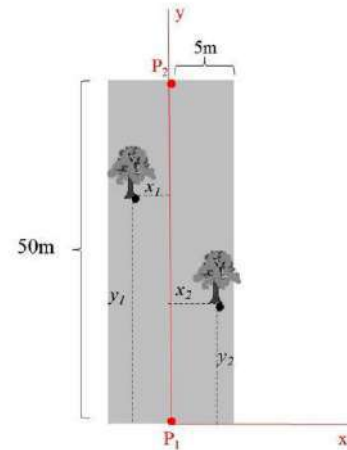


Fig.2:Plot of forest inventory.

Fig.2:Plot of forest inventory.

**2.2 Methodological approach**

The research was structured according to the flowchart shown in Figure 3. Each step is described in the following subitems.

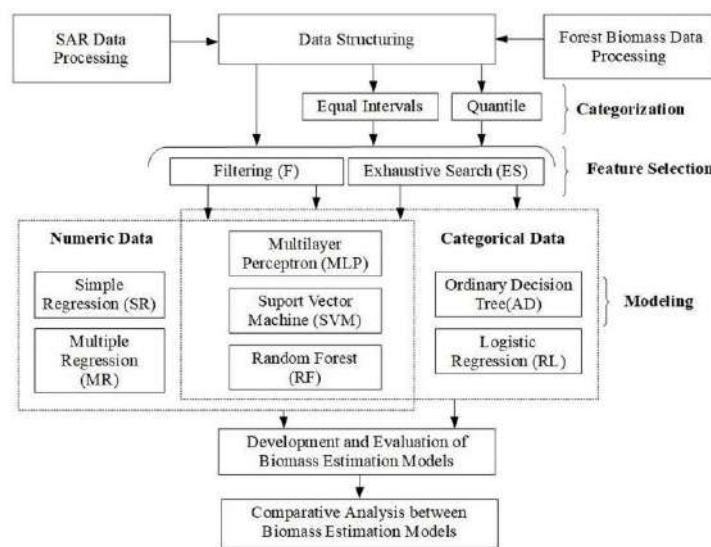


Fig.3: Methodological Flowchart.

**2.2.1 Forest Biomass Data Processing**

Using analytical geometry techniques, the UTM coordinates of each 4 corners of the inventoried plots were calculated and the respective vector files for each region of interest (ROI) were generated.

**2.2.2 SAR Data Processing**

In this stage, the ALOS PARSAR 2 images, obtained in SLC format, were processed and the features on the available X, L and P bands were extracted. All processing steps were performed using the Polarimetric SAR Data Processing and Educational Tool (PolSARpro), version 6.0

(Biomass Edition), from the European Space Agency (ESA).

The ALOS PALSAR 2 images were processed according to the flowchart shown in Figure 4. The following parameters were used:

- multilook processing with 2 looks for the rows and 1 look for the columns, as suggested by [19];
- Lee Refined speckle filter with 2 looks and 7x7 size window;
- calculation of the covariance [C] and coherence [T] matrices images, both 3x3;
- geocoding of the coherence matrix image [T], performing the correction of the Range-doppler terrain and the respective georeferencing using the digital elevation model automatically extracted from the Shuttle Radar Topography Mission (SRTM), with 90m spatial resolution;
- polarimetric calibration and conversion to sigma-nought ( $\sigma^0$ ) using Equation 1, where the DN is the Digital Number, in amplitude, and CF is the calibration factor in dB for the channels [37]. The value applied for the CF was -83; and
- application of target decomposition techniques.

$$\sigma_0 = 10 * \log_{10} \langle DN^2 \rangle + CF \quad (1)$$

At the end of the SAR data processing, the interferometric, incoherent and coherent features were extracted according to Table 1.

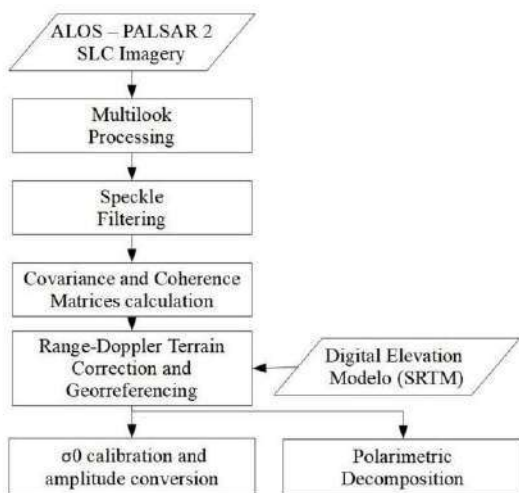


Fig.4: ALOS PALSAR 2 image processing. Adapted from [19]

Table.1: Extracted Features from SAR Data

Symbol	Description
<b>SAR Interferometric Features</b>	
$H_{int}$	Interferometric height – It is the difference in altitude between the Digital Surface Model (MDS), obtained with the X band, and the Digital Terrain Model (MDT), obtained with the P band. It represents the height of the vegetation.
Decliv	Declivity – It is the slope of the land surface in relation to the horizontal, obtained through the MDT.
<b>Incoherent SAR Features</b>	
Xhh	Amplitude image of the X band in the HH polarization – The backscatter of the forest canopy.
Lhh, Lhv, Lvv	Amplitude image of the L band in the polarizations HH, HV or VV – Represents the main geometric characteristics of arboreal individuals.
Phh, Phv, Pvv	Amplitude image of the P band in the polarizations HH, HV or VV – Associated with the main geometric characteristics of the terrain.
Lhh-Lhv, Lhh-Lvv, Lvv-Lhv	Subtraction between amplitude images in the L band polarizations.
Phh-Phv, Phh-Pvv, Pvv-Phv	Subtraction between amplitude images in the P band polarizations.
PC1L, PC2L, PC3L	Principal Components of the amplitude images in the L bands polarizations.
PC1P, PC2P, PC3P	Principal Components of the amplitude images in the P bands polarizations.
<b>Henderson and Lewis Polarimetric Decomposition Features [38]</b>	
PR_L, PR_P	Ratio between parallel polarizations (Parallel Ratio – PR) in the L or P bands ( $PR_{Band} = Band_{vv} / Band_{hh}$ ) – Associated with the orientation and shape of the backscatter elements in the forest.

CR_L, CR_P	Ratio between crossed polarizations ( <i>Crossed Ratio – CR</i> ) in the L or P bands ( $CR_{Band} = Band_{hv} / Band_{hh}$ ) – Referring to the volumetric backscatter of the target.
TotPow_L, TotPow_P	Total power of the L or P bands ( $TotPow_{Band} = Band_{hh} + Band_{vv} + 2 * Band_{hv}$ ) – They represent the sum of all backscatter mechanisms occurring in the forest.
<b>Pope Polarimetric Decomposition Features [39]</b>	
BMI_L, BMI_P	Biomass index in bands L or P ( $BMI_{Band} = (Band_{hh} + Band_{vv}) / 2$ ) – Indicator of the amount of woody structure in the forest.
CSI_L, CSI_P	Canopy structure index in the L or P bands ( $CSI_{Band} = Band_{vv} / (Band_{vv} + Band_{hh})$ ) – Compares the vertical structure with the horizontal vegetation.
VSI_L, VSI_P	Volumetric scattering index in the L or P bands ( $VSI_{Band} = Band_{hv} / (Band_{hv} + BMI_{Band})$ ) – Related to the density of the canopy, being directly proportional to the amount of elements that cause multiple type scattering.
<b>Kim and Zyl Polarimetric Decomposition Features [40]</b>	
RVI_L, RVI_P	Radar vegetation index ( $RVI_{Band} = 8 * Band_{hv} / (Band_{hh} + Band_{vv} + 2 * Band_{hv})$ ) – Associated with the proportion of vegetation in the soil.
<b>Haralick Textural Features [41]</b>	
The co-occurrence texture features analyzes the relationship between pixel pairs values within a window and constructs a Grey Level Co-occurrence Matrix (GLCM). In the texture equations, $P(i, j)$ is the co-occurrence probability of each pixel value in column $i$ and row $j$ ; $N_g$ is the number of distinct grey levels in the quantized image; $\mu$ is the average value of $P$ ; $\sigma$ is the x or y deviation pattern of the image.	
J_Me_Band	Mean ( $Me = \sum_{i=1}^{N_g} \sum_{j=1}^{N_g} i * P(i,j)$ ) value within the GLCM.

J_Va_Band	Variance ( $Va = \sum_{i=1}^{N_g} \sum_{j=1}^{N_g} (i - \mu)^2 P(i,j)$ ) value within the GLCM.
J_Ho_Band	Homogeneity ( $Ho = \sum_{i=1}^{N_g} \sum_{j=1}^{N_g} P(i,j) \frac{1}{1 + (i - j)^2}$ ) is the spatial correlation measurement in the GLCM.
J_Con_Band	Contrast ( $Con = \sum_{i=1}^{N_g} \sum_{j=1}^{N_g} P(i,j)(i - j)^2$ ) is the intensity difference between the reference pixels and its neighbors in the GLCM.
J_Di_Band	Dissimilarity ( $Di = \sum_{i=1}^{N_g} \sum_{j=1}^{N_g} P(i,j) i - j $ ) is the amplitude difference between the reference pixels and its neighbors in the GLCM.
J_En_Band	Entropy ( $En = - \sum_{i=1}^{N_g} \sum_{j=1}^{N_g} P(i,j) \log(P(i,j))$ ) value represents the randomness between the elements of the GLCM
J_Se_Band	Second Moment ( $Se = \sum_{i=1}^{N_g} \sum_{j=1}^{N_g} P(i,j)^2$ ) is the second angular moment between the elements of the GLCM.
J_Cor_Band	Correlation ( $Cor = \frac{\sum_{i=1}^{N_g} \sum_{j=1}^{N_g} (i,j) P(i,j) - \mu_x \mu_y}{\sigma_x \sigma_y}$ ) is the statistical difference between the reference pixels and its neighbors in the GLCM.
<b>Coherent SAR Features</b>	

<b>Cloude and Pottier Polarimetric Decomposition Features [42]</b>	
Alpha	$\alpha$ angle – Dominant type of scattering.
H	Entropy – Proportion in the importance of the dominant type of scattering.
A	Anisotropy – Proportion in the importance of the secondary and tertiary types of scattering.
<b>Freeman and Durden Polarimetric Decomposition Features [43]</b>	
FD_Vol	Volumetric – Contribution of the type of volumetric scattering, simulating the forest canopy.
FD_Dbl	Double Bounce – Result of a set of dihedral corner reflectors.
FD_Odd	Superficial – Contribution of the type of surface scattering.
<b>Touzi Polarimetric Decomposition Features [44]</b>	
TAlfa_S1, TAlfa_S2, TAlfa_S1, TAlfa_Sm	Magnitude ( $\alpha$ ) - Provides the type of symmetry related to the type of scattering of the target.
TPhi_S1, TPhi_S2, TPhi_S1, TPhi_Sm	Phase ( $\phi$ ) - Represents a more complete characterization of the target's scattering type.
TTau_S1, TTau_S2, TTau_S1, TTau_Sm	Helical angle ( $\tau$ ) - Allows the measurement of the target's degree of symmetry, distinguishing symmetric and asymmetric scattering.
TPsi_S1, TPsi_S2, TPsi_S1, TPsi_Sm	Orientation angle ( $\psi$ ) - Associated with the target's angle of inclination.
<b>Van Zyl Polarimetric Decomposition Features [45]</b>	
VanZ_Vol	Volumetric Scattering – Volumetric scattering proportion.
VanZ_Dbl	Double Bounce Scattering – Double

	bounce scattering proportion.
VanZ_Odd	Odd Scattering – Surface (odd) scattering proportion.
<b>Yamaguchi Polarimetric Decomposition Features [46]</b>	
Yam_Vol	Volumetric Scattering – Volumetric scattering proportion.
Yam_Dbl	Double Bounce Scattering – Double bounce scattering proportion.
Yam_Odd	Odd Scattering – Surface (odd) scattering proportion.

### 2.2.3 Data Structuring

The data extracted from SAR and the AGB data were organized in a single structured spreadsheet, having the features represented in columns and the instances, referring to each inventoried forest biomass plot, as rows. The AGB feature was defined as the theme-feature (or “result” or “output” feature) of the structured spreadsheet.

For each of the extracted features, the arithmetic mean of the pixels’ value corresponding to the areas of the inventoried AGB plots was calculated.

The numerical data was used in two different ways. First, using the original values of the explanatory feature set  $x = (x_1, x_2, \dots, x_p)^T$ , so that the multiple regression model would be as shown in Equation 2. Second, with the logarithmic of the original value, as Equation 3. In all cases  $p$  is the number of variables,  $\beta = (\beta_0, \beta_1, \dots, \beta_p)^T$  is the parameter set,  $y$  is the dependent AGB variable and  $\varepsilon$  is the random error.

$$y = \beta_0 + \beta_1x_1 + \dots + \beta_px_2 + \varepsilon \quad (2)$$

$$\ln(y) = \ln(\beta_0) + \beta_1\ln(x_1) + \dots + \beta_p\ln(x_p) + \varepsilon \quad (3)$$

### 2.2.4 Categorization

The numerical data of the AGB quantitative feature were categorized and associated with one of the 5 (five) categories of biomass: "Low", "Medium-Low", "Medium", "Medium-High" and "High". The categorization methods, used to transform quantitative to qualitative features, were of the equal intervals and of the quantile.

According to [47], the method of equal intervals is performed by dividing the theme-feature values in the domain range by the number of categories of interest. In Equation 4,  $K$  is the number of categories defined by the user,  $x_{\min}$  and  $x_{\max}$ , respectively, the minimum and



maximum values observed in the theme-feature and  $\delta$  the value of the widths for each category interval.

$$\delta = (x_{max} - x_{min}) / K \quad (4)$$

In the quantile method, categorization is performed by dividing the total number of instances  $N$  by the number of categories of interest  $K$ . Therefore, at the end of this method each category will have the same number of objects.

At the end of the categorization stage, the theme-feature was classified in one of three possibilities: numeric (NumThFe), categorical by the “equal intervals” method (EqIntThFe) and categorical by the “quantile” method (QuThFe). Then, all other steps were performed for each of these cases.

### 2.2.5 Feature Selection

Tests were performed using the filtering type feature selection, in comparison to the exhaustive search including all features extracted from SAR data. The objective was to verify the impacts of the feature selection process on the quality of the final AGB models developed.

The feature selection technique performed was the Correlation-based Feature Subset (CFS) Selection, as described [48]. In this case, the search method used was the greedy Best First, which performs the “hill climb” heuristic in the “forward” direction.

According to [49], the CFS feature selection method is adequate to identify features that are related to the AGB by using the Pearson correlation coefficient method.

### 2.2.6 Modeling

In the specific cases in which the constructions of the models were based on numerical quantitative data, that is, when the theme-feature has not been categorized, the methods of simple statistical regression – SR and multiple statistical regression – MR were used. On the other hand, for the specific cases of the qualitative categorized data, the methods of logistic statistical regression – LR and ordinary decision tree – ODT were applied.

In addition to these methods, the Multilayer Perceptron – MLP, Support Vector Machine – SVM and Random Forest – RF methods were used for all cases.

The feature selection and the model development steps were carried out entirely in the WEKA (Waikato Environment for Knowledge Analyzes) system, version 3.8.4, and followed algorithms described by [50].

### 2.2.7 Development and Evaluation of a Biomass Estimation Model

After the development of the models, the evaluation stage is carried out. In the case of the models based on numerical data, such as those of statistical regression, there are several parameters that can be observed and that reflects the assessment. The parameter used in this case was the correlation coefficient ( $r$ ), described by [51].

In the case of the models based on categorized qualitative data, the assessment was made by building a confusion matrix and calculating the respective Kappa coefficient of agreement [52]. Due to the reduced number of instances, the process of cross-validation divided into 10 folds was used, as suggested by [53].

### 2.2.8 Comparative Analysis between Biomass Estimation Models

Initially, the selected models were those that obtained the best correlation coefficient, in the case of the numerical quantitative data, and best Kappa coefficient, for the models based on categorized qualitative data.

In order to compare those different type of models, the numerical values resulting from the AGB will follow the process described in the flowchart presented in Figure 5. In this process, numerical quantitative values will be categorized using the equal intervals method, followed by the assessment obtained through the construction of the confusion matrices and calculations of the respective Kappa coefficients.

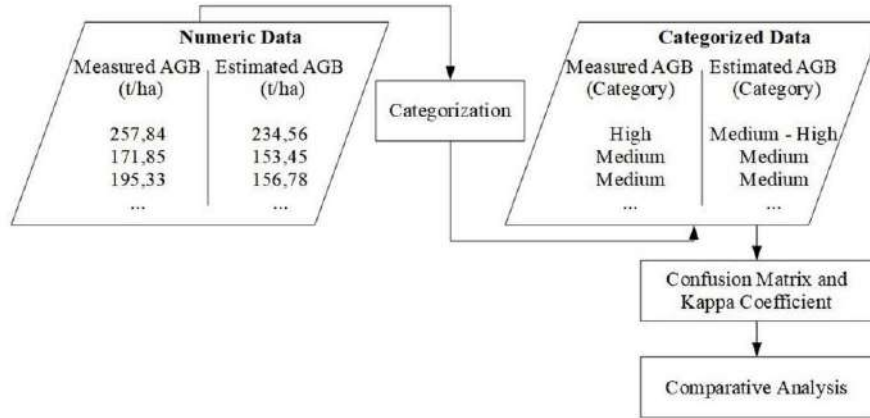


Fig. 5: Categorization process for comparative analysis.

**III. RESULTS AND DISCUSSION**

**3.1 Forest Biomass Data Processing**

From the AGB data granted by INPA, 3 sample sets were defined according to the region inventoried: São Gabriel da Cachoeira, Unini River ExRes and the joint regions. The statistics for each set, referring to the number of pixels and AGB in each plot, are shown in Table 2.

Table.2: Statistics for the number of pixels and AGB in the inventoried plots

Set	Joint Regions	
Statistics	Number of Pixels (un)	AGB (t/ha)
Mean	50,59	227,93
Minimum	35	92,21
Maximum	72	351,73
Standard Deviation	7,28	45,21
<b>Number of Plots</b>	128 plots	
<b>Set</b>	<b>São Gabriel da Cachoeira</b>	
Statistics	Number of Pixels (un)	AGB (t/ha)
Mean	50,17	224,95
Minimum	35	92,21
Maximum	69	351,73

Standard Deviation	8,19	52,24
<b>Number of Plots</b>	58 plots	
<b>Set</b>	<b>Unini River ExRes</b>	
Statistics	Number of Pixels (un)	AGB (t/ha)
Mean	50,93	230,40
Minimum	39	153,32
Maximum	72	311,57
Standard Deviation	6,48	38,65
<b>Number of Plots</b>	70 plots	

**3.2 SAR Data Processing**

Together with the features detailed in Table 1, the textural features were extracted for all available polarimetric bands, that is, Xhh, Phh, Phv, Pvv, Lhh, Lhv and Lv, for 3x3, 5x5 and 7x7 window sizes.

At the end of the SAR data processing, 231 features, or independent variables, were extracted, in addition to the theme-feature.

**3.3 Categorization**

The categorization by the equal intervals technique obtained a  $\delta$  of 52 (t / ha). Therefore, the AGB categories were defined as: Low (below 100 t/ha); Medium-Low

(between 100 and 200 t/ha); Medium (between 200 and 250 t/ha); Medium-High (between 250 and 300 t/ha); and High (above 300 t/ha). The number of categorized instances was 2 (two) for the Low class, 38 (thirty-eight) for Medium-Low, 42 (forty-two) for Medium, 40 (forty) for Medium-High and 6 (six) for High.

The categorization by the quantile method obtained 25 (twenty-five) or 26 (twenty-six) instances for each category.

**3.4 Feature Selection**

The process was carried out separately for numerical quantitative and categorized qualitative data. The results of the 5 (five) selected features, in decreasing order of relevance, are shown in Table 3. In the same table Pearson's correlation values between the selected feature and the respective theme-feature, quantitative or qualitative, was calculated.

In general, the selected features showed low correlation with the biomass theme-feature. The highlight was the  $H_{int}$  feature, which achieved a good correlation with the quantitative data, in addition to being selected for both cases.

Table.3: Result of the feature selection process

Quantitative Data		Qualitative Data	
Feature	Correlation	Feature	Correlation
$H_{int}$	0.449975	PC3	0.1765
Lhh	-0.188703	$H_{int}$	0.1592
CSI_L	-0.046255	TAlphaS3L	0.1059
FreeOddL	0.125393	7x7_Xhh_S e	0.2772
TPhiS1L	0.10413	7x7_Phh_M e	0.2851

**3.5 Development of Biomass Estimation Models**

The ML techniques applied in the biomass estimation modeling had the following specific configurations:

(1) SVM – the model applied to numerical quantitative data was the SMOreg, specific for statistical regression, as described by [54]. The complexity parameter c was 1.0 and the Radial Basis Function (RBF) kernel used 0.01 gamma;

(2) MLP – the models not submitted to the feature selection process were built with one (composed of 50 nodes) or two (composed of 50 and 10 nodes) hidden layers. The models submitted to the feature selection process were built with one (composed of 5 nodes) or two (composed of 5 and 5 nodes) hidden layers;

(3) RF – the parameter of 100 trees was used in the construction of the model;

(4) ODT – the minimum quantity of 2 instances per node was applied.

The correlation and kappa coefficients resulting from the tests are shown in Tables 4, 5, 6 and 7 and have the following characteristics:

(1) Tables 4 and 5 refers to models based on numerical quantitative and Tables 6 and 7 to models based on categorized qualitative theme-features;

(2) Tables 4 and 6 refer to the original values and Tables 5 and 7 refer to log values of the features ;

(3) the values before the bars (/) are those obtained by models that have not been submitted to the feature selection process, while the values after the bars are those referring to models with selected features;

(4) the results in MLP models with an asterisk (\*) are those obtained with 2 (two) hidden layers and that obtained results superior to those of a single hidden layer;

(5) the results in bold are the best obtained, having been highlighted 2 (two) results for each type of region and for each type of data (quantitative or qualitative).

Table.4: Correlation coefficients of AGB estimation models for numerical quantitative theme-feature and original feature values.

ML Technique	Joint Regions	São Gabriel da Cachoeira	Unini River ExRes
SR	0.42 /0.42	0.39 /0.39	0.35 / <b>0.43</b>
MR	0.21 /0.40	0.02 /0.41	0.04 /0.38
SVM	0.12 /0.21	0.13 /0.13	0.35 /0.12
MLP	0.07 /0.32*	0.12 / <b>0.70</b>	0.13 /0.23
RF	0.16 /0.39	0.21 /0.33	0.14 /0.29

Table.5: Correlation coefficients of AGB estimation models for numerical quantitative theme-feature and logarithmic feature values.

ML Technique	Joint Regions	São Gabriel da Cachoeira	Unini River ExRes
SR	0.49 / <b>0.54</b>	0.49 / <b>0.58</b>	0.30 /0.30
MR	0.09 /0.41	0.04 /0.25	0.01 /0.31
SVM	0.20 /0.22	0.16 /0.10	0.29 /0.06
MLP	0.33 */ <b>0.49</b>	0.26 */0.52*	0.06 / <b>0.36*</b>
RF	0.14 /0.39	0.14 /0.47	0.19 /0.25

Table.6: Kappa index of AGB estimation models for categorized qualitative theme-features and original feature values.

ML Technique	Joint Regions		São Gabriel da Cachoeira		Unini River ExRes	
	Equal Intervals	Quantile	Equal Intervals	Quantile	Equal Intervals	Quantile
LR	0.10 /0.22	0.22 /0.15	0.25 /0.10	0.20 /0.10	0.18 /0.35	0.30 /0.33
MLP	0.22 / <b>0.38</b>	0.32 /0.15	0.18 /0.02	0.13 /0.07	0.31 /0.29	0.14 /0.19
SVM	0.09 /0.01	0.04 /0.01	0.01 /0.01	0.01 /0.01	0.25 /0.01	0.10 /0.01
ODT	0.09 /0.19	0.11 /0.11	0.09 /0.01	0.04 /0.01	0.22 / <b>0.48</b>	0.27 /0.21
RF	0.13 /0.28	0.19 /0.25	<b>0.30</b> /0.16	0.24 /0.01	0.19 /0.38	0.26 /0.28

Table.7: Kappa index of AGB estimation models for categorized qualitative theme-features and logarithmic feature values.

ML Technique	Joint Regions		São Gabriel da Cachoeira		Unini River EsRes	
	Equal Intervals	Quantile	Equal Intervals	Quantile	Equal Intervals	Quantile
LR	0.23 /0.23	0.21 /0.18	0.21 /0.24	0.26 /0.12	0.20 /0.35	0.28 /0.31
MLP	<b>0.36</b> /0.24	0.18 /0.17	<b>0.30</b> /0.12	0.22 /0.16	0.36 / <b>0.47</b>	0.28 /0.32
SVM	0.05 /0.01	0.05 /0.01	0.01 /0.01	0.02 /0.01	0.01 /0.01	0.06 /0.01
ODT	0.11 /0.22	0.18 /0.12	0.07 /0.08	0.08 /0.03	0.21 /0.39	0.18 /0.32
RF	0.24 /0.22	0.22 /0.20	0.26 /0.11	0.26 /0.06	0.24 /0.39	0.31 /0.30

### 3.6 Comparative Analysis between Biomass Estimation Models

As observed in Tables 4, 5, 6 and 7, in general, there was an emphasis on MLP and SR techniques, corresponding to

58% and 25% of the highlighted results, respectively. MR, RF and ODT techniques achieved results close to the best, however, with a single highlight. The SVM technique

showed results significantly lower than the other techniques.

In the case of the numerical quantitative theme-feature, presented in Tables 4 and 5, only the MLP and SR techniques showed outstanding results. The MR technique was not able to increase the *r* from the input of new features.

The models developed for the categorized qualitative theme-feature, Tables 6 and 7, showed an increase in results for non-parametric techniques, including MLP, RF and ODT.

The models submitted to the feature selection process showed improvement in 73% of the numerical quantitative theme-feature cases. In these cases, only 10% worsened the results, all of which refers to the SVM technique.

On the other hand, for the case of categorized qualitative theme-feature submitted to the feature selection process, the percentages of improvement, worsening and maintenance of the results were, respectively, 35%, 10% and 55%. In this case, there was no correlation to the ML technique.

Regarding the categorization method, all the best results were obtained using the method of equal intervals. Despite this, considering all cases, there was not a conclusive difference in the results between the categorization methods.

The different areas analyzed also presented different results. For the case of the numerical quantitative theme-feature, the São Gabriel da Cachoeira region obtained the best results, unlike the region of the Unini River ExRes with the worst results. The opposite result was obtained for the case of the categorized qualitative theme-feature. In both cases, the results for the joint regions, as they aggregate data from both study areas, were average.

In order to carry out the comparative analysis, the process shown in Figure 5 was applied. The comparative analysis was performed on data from the same regions (Joint Regions, SGC or Unini River ExRes), separately for quantitative or qualitative data. The results obtained are shown in Tables 8, 9, 10, 11, 12 and 13. In all cases, 3 (three) types of Z hypothesis tests were performed, with a significance level ( $\alpha$ ) of 0.05:

In order to carry out the comparative analysis, the process shown in Figure 5 was applied. The comparative analysis was performed on data from the same regions (Joint Regions, SGC or Unini River ExRes), separately for quantitative or qualitative data. The results obtained are shown in Tables 8, 9, 10, 11, 12 and 13. In all cases, 3 (three) types of Z hypothesis tests were performed, with a significance level ( $\alpha$ ) of 0.05:

- test to analyze the hypothesis of Kappa \* (value referring to the first selected model) being equal to zero;
- test to analyze the hypothesis of Kappa \*\* (value for the second selected model) to be equal to zero;
- and test to analyze the hypothesis whether the difference between Kappa \* and Kappa \*\* is significantly greater (or lower) than zero, that is, if both are significantly different.

Table.8: Comparative analysis between confusion matrices: numerical quantitative theme-feature of the joint region.

Categorized	SR over logarithmic values (r=0.54)*					MLP over logarithmic values (r=0.49)**				
	Reference					Reference				
	Category	Low	Medium-Low	Medium	Medium-High	High	Low	Medium-Low	Medium	Medium-High
Low	0	0	0	0	0	0	1	0	0	0
Medium-Low	2	6	2	4	0	2	6	1	0	0
Medium	0	9	21	9	3	0	8	18	13	3
Medium-High	0	1	1	1	1	0	1	5	1	0

<b>High</b>	0	0	0	0	0	0	0	0	0	0	1
Kappa*: 0.17; Kappa Variance*: 0.0057 Global Accuracy*: 47%						Kappa**: 0.13; Kappa Variance**: 0.0073 Global Accuracy**: 43%					
<b>Analysis:</b> Hypothesis Z-Test: Kappa* = 0 Kappa is significantly higher than zero (z=2.25; p-value=0.0123; α=0.05)  Hypothesis Z-Test: Kappa** =0 Kappa** is significantly higher than zero (z=2.25; p-value=0.0123; α=0.05)  Hypothesis Z-Test: Kappa* - Kappa**=0 Kappa* - Kappa** is significantly higher than zero (z=2.25; p-value=0.0123; α=0.05)											

Table.9: Comparative analysis between confusion matrices: numerical quantitative theme-feature, from SGC.

<b>Categorized</b>	<b>MLP over original values (r=0.70)*</b>					<b>RS over logarithmic values (r=0.58)**</b>					
	<b>Reference</b>					<b>Reference</b>					
	<b>Category</b>	<b>Low</b>	<b>Medium-Low</b>	<b>Medium</b>	<b>Medium-High</b>	<b>High</b>	<b>Low</b>	<b>Medium-Low</b>	<b>Medium</b>	<b>Medium-High</b>	<b>High</b>
	<b>Low</b>	0	1	0	0	0	0	0	0	0	0
	<b>Medium-Low</b>	2	5	1	0	0	2	5	2	4	0
	<b>Medium</b>	0	10	18	5	0	0	10	17	8	3
	<b>Medium-High</b>	0	0	3	9	1	0	1	3	2	1
	<b>High</b>	0	0	0	0	3	0	0	0	0	0
Kappa*: 0.42; Kappa Variance*: 0.0082 Global Accuracy*: 60%						Kappa**: 0.11; Kappa Variance**: 0.0064 Global Accuracy**: 41%					
<b>Analysis:</b> Hypothesis Z-Test: Kappa* = 0 Kappa is significantly higher than zero (z=4.68; p-value=0.0000; α=0.05)  Hypothesis Z-Test: Kappa** =0 Kappa** is not significantly higher than zero (z=1.41; p-value=0.0798; α=0.05)  Hypothesis Z-Test: Kappa* - Kappa**=0 Kappa* - Kappa** is significantly higher than zero (z=2.57; p-value=0.0050; α=0.05)											

Table.10: Comparative analysis between confusion matrices: numerical quantitative theme-feature, from Unini River ExRes.

Categorized	RS over original values (r=0,43)*					MLP over logarithmic values (r=0,36)**					
	Reference					Reference					
	Category	Low	Medium-Low	Medium	Medium-High	High	Low	Medium-Low	Medium	Medium-High	High
	Low	0	0	0	0	0	0	0	0	0	0
	Medium-Low	0	0	1	0	0	0	0	0	0	0
	Medium	0	16	17	18	0	0	15	18	7	0
	Medium-High	0	0	0	6	2	0	1	0	13	1
High	0	0	0	0	0	0	0	0	4	1	
Kappa*: 0.10; Kappa Variance*: 0.0029 Global Accuracy*: 38%					Kappa**: 0.33; Kappa Variance**: 0.0046 Global Accuracy**: 53%						

**Analysis:**  
Hypothesis Z-Test: Kappa\* = 0  
Kappa is significantly higher than zero (z=1.89; p-value=0.0295; α=0.05)  
Hypothesis Z-Test: Kappa\*\* = 0  
Kappa\*\* is significantly higher than zero (z=4.85; p-value=0.0000; α=0.05)  
Hypothesis Z-Test: Kappa\* - Kappa\*\* = 0  
Kappa\* - Kappa\*\* is significantly lower than zero (z=-2.62; p-value=0.0045; α=0.05)

Table.11: Comparative analysis between confusion matrices: categorized qualitative theme-feature, from the joint region

Categorized	MLP over original values*					MLP over logarithmic values**					
	Reference					Reference					
	Category	Low	Medium-Low	Medium	Medium-High	High	Low	Medium-Low	Medium	Medium-High	High
	Low	0	0	0	0	0	2	0	0	0	0
	Medium-Low	2	25	12	4	1	0	18	10	10	0
	Medium	0	7	23	13	2	0	13	24	6	1
	Medium-High	0	6	7	23	1	0	7	8	24	2

<b>High</b>	0	0	0	0	2	0	0	0	0	3
Kappa*: 0.38; Kappa Variance*: 0.0039 Global Accuracy*: 57%						Kappa**: 0.36; Kappa Variance**: 0.0042 Global Accuracy**: 55%				
<b>Analysis:</b> Hypothesis Z-Test: Kappa* = 0 Kappa is significantly higher than zero (z=6.00; p-value=0.0000; α=0.05)  Hypothesis Z-Test: Kappa** =0 Kappa** is significantly higher than zero (z=5.60; p-value=0.0000; α=0.05)  Hypothesis Z-Test: Kappa* - Kappa**=0 Kappa* - Kappa** is not significantly different than zero (z=0.19; p-value=0.4255; α=0.05)										

Table.12: Comparative analysis between confusion matrices: categorized qualitative theme-feature, from SGC.

<b>Categorized</b>	<b>RF over original values*</b>					<b>MLP over logarithmic values**</b>					
	<b>Reference</b>					<b>Reference</b>					
	<b>Category</b>	<b>Low</b>	<b>Medium-Low</b>	<b>Medium</b>	<b>Medium-High</b>	<b>High</b>	<b>Low</b>	<b>Medium-Low</b>	<b>Medium</b>	<b>Medium-High</b>	<b>High</b>
	<b>Low</b>	2	0	0	0	0	1	0	1	0	0
	<b>Medium-Low</b>	0	10	7	4	0	0	8	8	2	0
	<b>Medium</b>	0	5	14	6	3	1	5	10	4	0
	<b>Medium-High</b>	0	1	1	4	1	0	3	3	7	1
	<b>High</b>	0	0	0	0	0	0	0	0	1	3
Kappa*: 0.30; Kappa Variance*: 0.0088 Global Accuracy*: 52%						Kappa**: 0.30; Kappa Variance**: 0.0091 Global Accuracy**: 50%					
<b>Analysis:</b> Hypothesis Z-Test: Kappa* = 0 Kappa is significantly higher than zero (z=3.16; p-value=0.0008; α=0.05)  Hypothesis Z-Test: Kappa** =0 Kappa** is significantly higher than zero (z=3.20; p-value=0.0007; α=0.05)  Hypothesis Z-Test: Kappa* - Kappa**=0 Kappa* - Kappa** is not significantly different than zero (z=-0.06; p-value=0.4762; α=0.05)											



Table.13: Comparative analysis between confusion matrices: categorized qualitative theme-feature, from Unini River ExRes.

Categorized	ODT over original values*					MLP over logarithmic values**					
	Reference					Reference					
	Category	Low	Medium-Low	Medium	Medium-High	High	Low	Medium-Low	Medium	Medium-High	High
	Low	0	0	0	0	0	0	0	0	0	0
	Medium-Low	0	12	5	4	0	0	14	8	4	0
	Medium	0	3	14	3	0	0	4	9	2	0
	Medium-High	0	7	1	17	0	0	4	3	20	0
High	0	0	0	2	2	0	0	0	0	2	
Kappa*: 0.48; Kappa Variance*: 0.0069 Global Accuracy*: 64%					Kappa**: 0.47; Kappa Variance**: 0.0071 Global Accuracy**: 64%						
<p><b>Analysis:</b></p> <p>Hypothesis Z-Test: <math>Kappa^* = 0</math>                      Kappa is significantly higher than zero (<math>z=5.76</math>; <math>p\text{-value}=0.0000</math>; <math>\alpha=0.05</math>)</p> <p>Hypothesis Z-Test: <math>Kappa^{**} = 0</math>                      Kappa** is significantly higher than zero (<math>z=5.61</math>; <math>p\text{-value}=0.0000</math>; <math>\alpha=0.05</math>)</p> <p>Hypothesis Z-Test: <math>Kappa^* - Kappa^{**} = 0</math>                      Kappa* - Kappa** is not significantly different than zero (<math>z=0.08</math>; <math>p\text{-value}=0.4697</math>; <math>\alpha=0.05</math>)</p>											

From the analysis of the results presented in the tables, it is observed that the kappa values obtained by the post-modeling categorization process (Tables 8, 9 and 10), in general, were lower than those obtained in the pre-modeling categorization process (Tables 11, 12 and 13). In both cases, the ML techniques built specific models for quantitative or qualitative data, suffering loss of accuracy in the transformation process between these types of data.

Due to the loss of accuracy in the post-modeling categorization process, the best results obtained are shown in Table 13, with insignificant difference in the kappa values for the ODT (Kappa = 0.48) and MLP (Kappa = 0.47).

The values obtained by the Kappa coefficient, in addition to serving as parameters for comparison between the categorizations, can also be evaluated, being classified

in different linguistic intervals, according to their level of agreement, as shown in Figure 6. In this case, according to [55], the best results obtained in this research are classified as *moderate*.

The *moderate* results obtained may have occurred for several reasons, including: the quantity of biomass samples; the sampling distribution of biomass values; and the low correlation between the biomass theme-feature and extracted the extracted features. Regarding the latter, Table 3 shows the low correlation, including on the selected features.

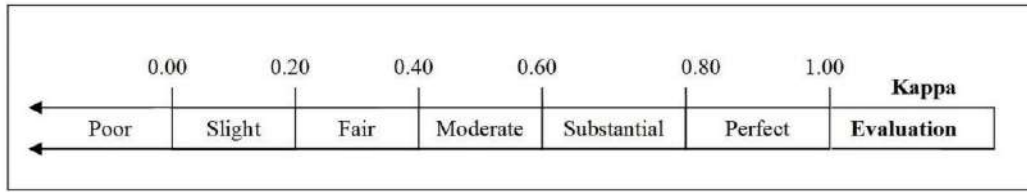


Fig.6: Linguistic evaluation of Kappa coefficient values. Adapted from [55].

**IV. CONCLUSION**

The present work aimed to develop and compare forest biomass estimation models, from different regions of the Amazon forest, built over numerical quantitative or categorical qualitative theme-feature. For this, ML techniques were applied on polarimetric and interferometric X, L and P bands SAR data extracted features, generating models that were analysed and compared.

In an innovative way, the work presents a methodology that involves:

- the process of feature selection and AGB estimation models development over quantitative and qualitative theme-features. It is noteworthy that, for each case, the feature selection and ML techniques were specific and configured in order to obtain the best results;
- comparative analyses between quantitative and qualitative results. In this case, the post-modeling categorization process and the respective confusion matrices construction was performed, followed by the comparison using hypothesis tests.

The results showed that the different study areas had very different characteristics, significantly impacting the feature selection and ML algorithms. The SGC area, due to the greater variation in AGB inventoried values (between 92.21 and 351.73 t/ha), obtained better results with the numeric quantitative theme-features. On the other hand, Unini’s River ExRes area, that had AGB values with less variation (between 153.32 and 311.57 t/ha), was better suited to categorized qualitative data modelling.

The different biomes of the Amazon Forest and their respective characteristics demanded specific models and techniques, not fitting into a single pattern. This conclusion is in agreement with the research of [2] who affirms that the heterogeneity of tropical forests is one of the main factors for the increasing uncertainty regarding the biomass stocks measurement in the region.

The process of feature selection was unanimous in selecting the interferometric height ( $H_{ini}$ ) as the most

relevant feature for all areas of study, both in the case of qualitative and quantitative theme-features, in agreement with the results obtained by [23-24,56-57]. Likewise, there was an emphasis on features obtained by target decomposition techniques on the L band, from the ALOS PALSAR 2 sensor. The textural features, on the other hand, did not show significant correlation with the AGB values, different from the results obtained by [58].

As a conclusion of the presented methodology, there was no significant improvement in the AGB estimation process, since the results obtained from Kappa varied between *fair* and *moderate*. Likewise, the post-modeling categorization process did not achieve the expected results, keeping the Kappa value stable and not being able to generalize the AGB values into categories. The result obtained may have occurred due to the low correlation between the biomass theme-feature and the extracted SAR features.

In order to develop more suitable AGB models for different regions of the Amazon Forest, further studies will be carried out aiming to adjust the training parameters of ML techniques. In this case, the possibility of applying search methods and deep learning, commonly used in the Artificial Intelligence area to define such parameters, will be verified.

Analysing the possible reasons that led to the limited results, two factors were identified that may contribute to new research in the area in focus.

The first factor refers to the inventoried forest management plots used as samples. In agreement with the quoted by [59-65], a large number of plots, including areas with greater variations of AGB values, allows a more reliable sample representation and more in-depth statistical analysis.

The second factor is related to the processing of SAR data and the possibility of extracting new polarimetric and interferometric features. Accessing data in SLC format of polarimetric X and P bands would enable the extraction and analysis of the respective target decomposition features. Likewise, through the construction of a digital elevation model in the L band, it would be possible to obtain new interferometric heights involving the

differences between the X-L and L-P bands and the corresponding analyzes.

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# Building scientific knowledge based on the solution of clinical cases: A contemporary learning process

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**Keywords**— *Dentistry, active methodology, PBL.*

**Abstract**— *The construction of scientific knowledge based on the solution of clinical cases, also called problem-situation or case study, is a contemporary methodology, centered on the student, problematizing, teaching-learning, which allows to know the previous knowledge of the group in the face of the presented situation, as well as identifying learning needs, building new meanings and knowledge, in addition to developing specific skills for self-learning. Strategically, it is the insertion, during a course, of a social material (texts, audios, printed matter, videos), whose analysis and discussion allow to contextualize the theoretical content. This work aims to present an experience in the construction, application and evaluation of clinical cases aimed at students in the fifth period of the dentistry course at Itpac - Porto Nacional in 2020. Clinical cases were previously screened by the teacher of endodontics at the multidisciplinary clinic at Itpac - Porto Nacional and presented to students in the classroom. The students were instructed to organize themselves in groups, a time of 1 hour was established for discussion of clinical cases and websites, scientific articles and books were made available to assist in solving the proposed activity. After the end of the established time, each group presented the diagnosis of each clinical situation presented. Based on this experience, it is possible to conclude that the use of clinical cases as a pedagogical practice brings students closer to the social reality and leads them to build networks of knowledge, making them active subjects in the learning process, without renouncing the depth and specificity knowledge that a dental student needs to develop.*

## I. INTRODUCTION

According to Latif, 2014, Clinical Cases are real or fictitious situations, with summarized data and cognitive intentionality, whose objective is to introduce or illustrate certain knowledge. However, due to their theoretical nature, they do not allow real experience, being only an artificial, partial, systematic and theoretical proposal of professional practice, sometimes presented with a caricatural tone. The insertion of a clinical case in the disciplines of the basic cycle without proper contextualization and without the proper baggage of practical experience can discourage or be little enlightening, even distorting the professional reality.

On the other hand, the presentation and discussion of clinical cases in the classroom as a way of stimulating reflection are essential when the student is already inserted in professional practice, in the case of Dentistry courses, or in the experience of multidisciplinary clinics, as the knowledge of the practical reality, even initial, allows a critical posture of the student in the face of the presented situation, being truly problematizing (Weeks et al., 2012).

The Motivating Case methodology, by promoting the mobilization of common sense, allows to know and challenge the previous knowledge of the group of students in the face of the presented situation, as well as to identify

learning needs, to build new meanings and knowledge, in addition to developing specific skills for the student. independent study (Crowe, et al., 2011). It differs from the discussion of the Clinical Case in that the situation presented challenges the student's knowledge based on what he already brings with him knowledge of life. Even without knowing the theoretical content, the student understands the situation presented and assumes the possibility of resolution. After the presentation of the proposal, the group discussion follows, which presents the various perspectives and opinions involved, many of them contradictory or partial, making the student aware that his current knowledge is insufficient for a resolute or uniform understanding. There follows an active search for knowledge and theoretical content, always under the guidance of the teacher, through the planning and execution of a strategy by the group, which generates new discussions and expansion of the perspective of the problem, seeking conciliatory syntheses (Souza et al., 2014).

This work aims to present an experience in the construction, application and evaluation of clinical cases aimed at students of the fifth period of the dentistry course at Itpac - Porto Nacional in 2020.

## II. METHODOLOGY

Clinical cases were previously screened by the professor of endodontics at the multidisciplinary clinic at Itpac - Porto Nacional and presented to students in the classroom. The students were instructed to organize themselves in groups, a time of 1 hour was established for the discussion of clinical cases and websites, scientific articles and books were made available to assist in solving the proposed activity. After the end of the established time, each group presented the diagnosis of each clinical situation presented (Pictures 01 and 02).



Picture 01: Clinical case 01



Picture 02: Clinical case 02

## III. DISCUSSION

The Motivator Case was a didactic tool used in the discipline of Endodontics for the fifth period of the dentistry course at ITPAC – Porto Nacional. Before, the course was theoretical, with a predominance of expository classes,

without the active participation of students, with classes without articulation as to content and with isolated assessments by the various participating disciplines. From the longitudinal application of Clinical Cases, students had

the opportunity to debate and synthesize in groups the various subjects taught under a guiding axis.

The option for the topic Diagnosis in endodontics aimed to create the possibility of exploring and discussing an aspect that, in general, dental courses with a biological focus do not prioritize. Thus, the approach to this theme in the dentistry course in the methodology of Clinical Motivating Cases, with the presentation of real cases and situations, extracted from everyday life and the average, results in students' reflection and active posture on the subject discussed.

From the New National Plan for University Extension (2000/2001) it became of fundamental importance to deepen in the new concepts of the classroom, which should not be limited to the physical space of the traditionally established dimension, but should include all the spaces inside and outside the University, mainly in the community directly involved with it, starting to express a multi, inter and transdisciplinary content.

The traditional "tri-leg" that sedimented the University was based on teaching, research and extension activities – where knowledge was originated in the academy and applied in society, with research activities as the main support. Today, with the inversion of this tripod, it has become essential that extension activities - expansion of the physical limit of the classroom - start to occupy the main level, where teaching and research activities should be directed according to the needs of the population.

In addition, the student must actively participate in the teaching-learning process, being subjected to theoretical reflection of the added knowledge, so that he can build knowledge and correlate it with other areas, comprising a human being as a whole and within a socio-economic-cultural context. The professor, in turn, must offer conditions for training based on scientific foundations, critical knowledge and concrete experience of social reality, consolidated by the approximation of the University and the Unified Health System.

Teaching activities should focus less on transmitting and more on seeking knowledge. Therefore, the basic and professional sciences must be associated during the course of the course and encourage permanent research with the objective of obtaining scientific and technological growth in the respective areas of knowledge.

#### IV. CONCLUSION

Based on this experience, it is possible to conclude that the use of clinical cases as a pedagogical practice brings students closer to the social reality and leads them to build networks of knowledge, making them active subjects in the

learning process, without renouncing the depth and specificity knowledge that a dental student needs to develop.

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# Survey on Publications that Discuss added Value in Family Farming

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**Keywords – Horticulture. Short supply chains.  
Agriculture industrialization. Organic  
production and certification.**

**Abstract—** It is known that family farming, besides being responsible for a large part of the food products put on the Brazilian table, is the source of survival for many families. Thus, to value the family farmer is to enable this value chain to be continued and to grow. This paper aimed to survey the publications that discuss added value in family farming. To this end, exploratory research of a qualitative nature was used. The research sought articles in the Web of Science indexing bases, SCOPUS, SCIELO, SPELL, in addition to the CAPES Publications Portal. The journals *Horticultura Brasileira* and *Revista Brasileira de Fruticultura* were also searched. The results pointed out that the articles discussed 10 variables of value addition, and short circuits, organic production, and agriculture industrialization were the most used. However, it was realized that there are several other ways that rural family farmers can use to add value to their products and thus be better remunerated. Therefore, a research gap was found, since, besides the existence of other adding variables, rural producers must consider the extremely fluid context in which they are inserted.

## I. INTRODUCTION

It is known that nowadays, products are increasingly similar, and it is often not possible to identify the producer/brand. With agricultural products, this is even more accentuated since they are commodities. Thus, differentiating the product in the market is essential to remain in the market, which is increasingly competitive.

The differentiation of products can happen in many ways, as long as you pay attention to what is important to your consumers. Knowing this, value is added to the product in order to draw the consumer's attention so that he or she prefers a certain product or brand and is willing to pay a higher amount to get it.

When it comes to manufactured products, attracting the consumer's attention is a little less complex, despite the number of competitors. It is common for companies to use differentiation of product, adding value through unique

features, functionality, or aspects, by distribution channel, which involves easier access to the consumer, by image, which encompasses the creation of a brand, logo, and other elements of visual identification, by employees, which covers a better qualification of employees to deal with consumers, and by services, which has elements such as delivery, assembly, billing, among others, according to Kotler and Armstrong (2015).

As for commodities, although they can also use these differentiations, this is not often seen in producer fairs and supermarkets. Because they mostly use short distribution chains, or at most, have an intermediary, it is necessary that rural family producers can add value to their products, since, in this way, they will be better paid, allowing them a better quality of life and permanence in their property.

Thus, given this context, the research issue is: What are the main variables used to add value to rural family

production? Therefore, the objective of this study is to raise, in the publications, the variables addressed for adding value in family farming.

## II. METHOD

To reach the proposed objective, the type of research used was exploratory, which, according to Lakatos and Marconi (2010), is the one that allows the researcher to get closer to the phenomenon studied. As for the nature of data analysis, this was qualitative. According to Richardson et al. (2008), the qualitative nature does not use statistical tools in its analysis, instead, it considers the main nuances in the data collected.

Publications on adding value in family farming available on the Web of Science, SCOPUS, SCIELO, SPELL, and the CAPES Publications Portal, were analyzed. The journals *Horticultura Brasileira* and *Revista Brasileira de Fruticultura* were also searched. The intention in using these journals was to obtain information in specialized sources about horticultural products. The research clipping was cross-sectional, and the collection took place in 2018 and 2019.

The inclusion/exclusion parameters for the selection of articles were as follows: on June 5, 2018, the descriptor ‘family farming’ was used in the SPELL database, the period limitation was between 2008 and 2018. As for the type of document, this was limited to full articles and abstracts of theses/dissertations, the type of access was limited to free, and the areas of knowledge were administration and engineering. The result was 92 articles and thesis/dissertation abstracts, and from these 7 were selected. Using the same parameters, the descriptor was changed to vegetables. The result was 11 articles and abstracts of theses/dissertations, three were selected.

On July 13, 2019, the descriptors add\* value and value add\* AND family farm\* OR orcharding were used in the SPELL database. The period was limited from 2008 to 2019, the type of document: article, the area of knowledge: administration and economics, and the type of access: free. However, in SPELL database, there was no occurrence.

In the SCOPUS database, the knowledge area was changed to Agricultural and Biological Sciences, Social Sciences, Multidisciplinary, Economics, Econometrics and Finance and Business, Management and Accounting, the other parameters remained the same. The result was 78 articles, and 7 articles were selected.

On July 20, 2019, in the Web of Science database, the descriptors add\* value AND value add\* AND family farm\* OR orcharding were used. The period was limited between 2008 and 2019, the type of document: article, the type of access: free, and the selected knowledge areas were horticulture, Management, Multidisciplinary sciences, Economics and Business. 164 articles were obtained, from these, 7 were selected.

The *Revista Brasileira de Fruticultura* (Brazilian Journal of Fruit Culture) was also searched using the descriptor Agricultura Familiar (Family Farming), and the result was 2 articles, which were selected, and the *Horticultura Brasileira* journal resulted in 2 articles, one of which was selected. In the Periodicals Portal, in the search by subject item, the following parameters were used: period: the last two years, document type: articles, and access type: free. The descriptors used were Added Value AND Family farming. The search resulted in 15 articles, 3 of them were selected. Figure 1 shows the selection process adopted.



Fig.1: Inclusion and exclusion criteria for the selection of materials  
Source: Prepared by the authors, 2019.

As it can be seen, a total of 30 full articles was selected, with free access in Portuguese, English, and Spanish, which discussed added value in family farming.

After a full reading, for the data analysis, there was a new process of exclusion of the articles that ran away from the objective of this study, which is to raise in the publications the variables addressed for added value in

family farming, thus remaining 10 articles. The NVIVO® and UCINET® software was used for content analysis.

### III. RESULTS AND DISCUSSION

As mentioned, after the second exclusion, 10 articles were selected and analyzed in order to answer the research question: What are the main variables used to add value to rural family production? These are shown in chart 1.

Chart 1 Data from the selected articles

N	AUTHOR	TITLE	JOURNAL	COUNTRY
<b>WEB OF SCIENCE</b>				
1	(PARODI, 2018)	Agroecological transition and reconfiguration of horticultural work among family farmers in Buenos Aires, Argentina	Cahiers Agricultures	Argentina
<b>SPELL</b>				
2	(ROCHA; COSTA; CASTOLDI, 2012)	Comercialização de produtos da agricultura familiar: um estudo de caso em Passo Fundo – RS	REIMED - Revista de Administração IMED	Brazil
3	(FREITAS; RIBEIRO, 2013)	Experiences of agro-extractivist commercialization of family farmers of Rio dos Cochos, Januária/Cônego Marinho - MG	Organizações rurais & Agroindustriais	Brazil
4	(GODOY; WIZNIEWSKY, 2013)	The role of pluriactivity in strengthening family farming in the municipality of Santa Rosa/RS	Desafio online	Brazil
5	(FOGUESATTO; MACHADO, 2017)	The decision-making process in the creation of units that add value to agricultural production: the family agribusinesses	Desenvolvimento em questão	Brazil
6	(CAUMO; STADUTO, 2014)	Organic production: an alternative in family farming	Revista Capital Científico	Brazil
<b>SCOPUS</b>				
7	(CAMPOS; VALENTE, 2010)	The construction of the coffee market in Alto Paraíso de Goiás	Revista de Economia e Sociologia Rural	Brazil
8	(AGUIAR; DELGROSS; THOMÉ, 2018)	Short food supply chain: characteristics of family farming	Ciência Rural	Brazil
<b>PORTAL PERIÓDICOS</b>				
9	(FERREIRA, 2017)	Added value in family farming products from Foz do Iguaçu -PR: the case of the agribusiness Delícias do Campo	Revista Latino-americana de Estudos em Cultura e Sociedade	Brazil
<b>HORTICULTURA BRASILEIRA</b>				
10	(HENZ, 2010)	Challenges faced by family farmers in strawberry production in Distrito Federal	Horticultura Brasileira	Brazil

Source: Prepared by the authors, 2019.

The largest contribution of empirical studies on adding value in family farming comes from Brazil. The studies varied by crop, involving coffee, fruits, vegetables, and legumes, and by region, ranging from the South to the Center-West of Brazil.

Despite the particularity of each study, the main added value variables discussed in the articles were, Agroecological, Agriculture industrialization, Organic certification, Origin certification, short supply chains,

Branding, Diversification, Organic, Quality, and Seal of origin.

Short supply chains, organic production, agriculture industrialization, quality and origin certification were the ways most used by family farmers to add value to their products. Figure 2, using the UCINET® software, shows the relationship between the titles and the variables of value addition.

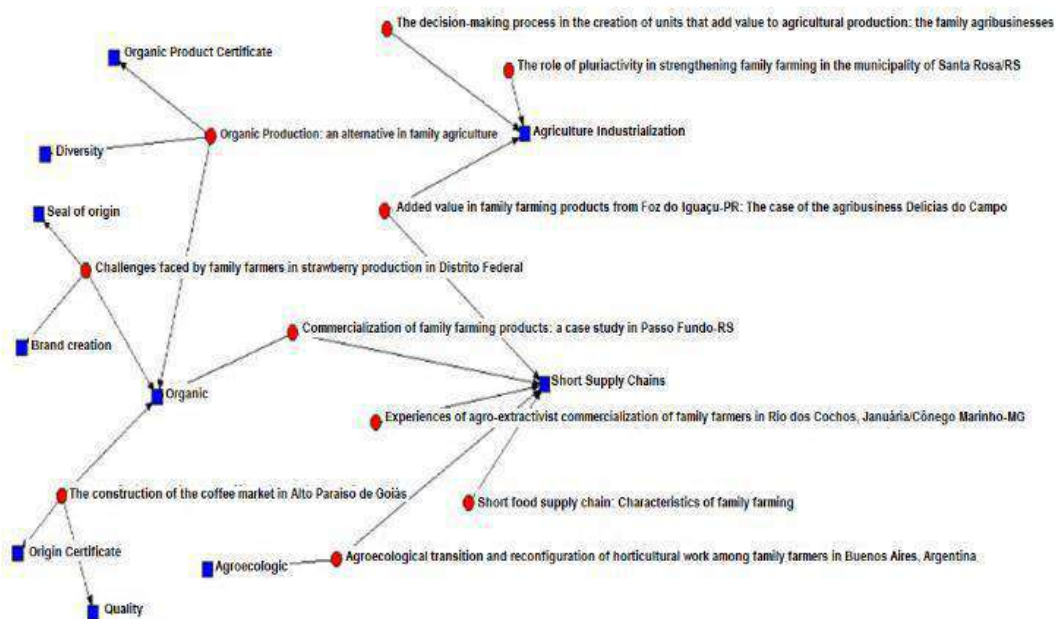


Fig.2: Relationship between titles and variables

Source: Prepared by the authors, 2019.

When verifying the relationship, 5 articles discussed the short supply chains as a way to add value to their products, 4 studies discussed adding value by means of organic production, and 3 of them addressed agriculture industrialization as a way to add value. Agroecological

production, crop diversification, organic certification, seal of origin, branding, origin certification and quality were also discussed as a way of adding value. Table 2 shows each variable of added value that was discussed in the selected articles.

Chart 2 – Added value variables discussed in the selected articles

VARIABLES	ARTICLES
<b>Agroecological</b>	1. Agroecological transition and reconfiguration of horticultural work among family farmers in Buenos Aires
<b>Agriculture industrialization</b>	1. Added value in family farming products from Foz do Iguaçu - PR: the case of the agroindustry Delícias do Campo 2. The role of pluriactivity in strengthening family farming in the municipality of Santa Rosa/RS 3. The decision-making process in the creation of units that add value to agricultural production: the family agribusinesses
<b>Organic Product Certification</b>	1. Organic production: an alternative in family agriculture
<b>Origin Certification</b>	1. The construction of the coffee market in Alto Paraíso de Goiás

<b>Short supply chains</b>	<ol style="list-style-type: none"> <li>1. Added value in family farming products from Foz do Iguaçu -PR: The case of the agroindustry Delícias do Campo</li> <li>2. Agroecological transition and reconfiguration of horticultural work among family farmers in Buenos Aires</li> <li>3. Commercialization of family farming products: a case study in Passo Fundo - RS</li> <li>4. Agroextractivist commercialization experiences of family farmers in Rio dos Cochos, Januária/Cônego Marinho - MG</li> <li>5. Short food supply chain: characteristics of a family farm</li> </ol>
<b>Brand Creation</b>	<ol style="list-style-type: none"> <li>1. Challenges faced by family farmers in strawberry production in Distrito Federal</li> </ol>
<b>Diversification</b>	<ol style="list-style-type: none"> <li>1. Organic production: an alternative in family farming</li> </ol>
<b>Organic</b>	<ol style="list-style-type: none"> <li>1. The construction of the coffee market in Alto Paraíso de Goiás</li> <li>2. Commercialization of family farming products: a case study in Passo Fundo - RS</li> <li>3. Challenges faced by family farmers in the production of strawberries in Distrito Federal</li> <li>4. Organic production: an alternative in family farming</li> </ol>
<b>Quality</b>	<ol style="list-style-type: none"> <li>1. The construction of the coffee market in Alto Paraíso de Goiás</li> </ol>
<b>Seal of Origin</b>	<ol style="list-style-type: none"> <li>1. Challenges faced by family farmers in strawberry production in Distrito Federal</li> </ol>

Source: Prepared by the authors, 2019.

Besides identifying the main elements of added value used in the selected articles, it is also possible to verify that some studies have shown that more than one way of adding value is employed in the same property.

Short supply chains are a more direct way of commercialization between rural producers and consumers, and there may even be an intermediary between them (SILVA et al., 2017). This way of commercialization is the most common when it comes to rural family producers. In addition, it is the least complex way to add value, since it allows relationships with the consumer, which enables the producers to better understand the needs of each customer they serve, allowing them to develop specific offers for specific customers.

With the survey, it was possible to verify that some ways of adding value are more difficult to be implemented by family farmers, since some actions do not depend only on the farmer. As it is the case of organic cultivation, where there are variables that are not controllable by the farmers, such as, how their neighbors cultivate.

According to the Brazilian legislation, a product, either *in natura* or processed, is considered organic when it is acquired in an organic production system or originated from a sustainable extractive process and not harmful to the local ecosystem. Organic products to be commercialized need to be certified by bodies accredited in the Ministry of Agriculture, however, products produced by family farmers who participate in social control organizations registered in the Ministry of Agriculture, Livestock and Supply (MAPA)

and sell exclusively and directly to consumers, are exempted from certification (MAPA, 2019).

Another way of adding value is agriculture industrialization, which is an activity that transforms raw material originated from small farms into food. The product of this activity, at first, was intended for family consumption, and, over time, and changes in consumption habits, the products of family agriculture industrialization began to be sold in the market assisting in the income of producers (STRATE; CONTERATO, 2018). This, as observed in the selected articles, is one of the ways of adding value most used by rural producers, and it is common to produce pasta, cookies, juices, pulps, among others.

The agroecological system can be carried out in several ways, and it is known that one of them is the Agroforestry practice, which is a simple process of food production. It is known that the forest has been a space where new production practices are introduced, but the use of forest spaces does not allow for their transformation into a monoculture space, thus, the result is a mosaic of managed forests and Agroforestry systems. Hence, it can be noticed that the agroecological system is a positive and relatively easy way to be adopted by rural family farmers, and thus, add value to their products (STEENBOCK et al., 2013).

The ways of adding value least used by family farming are the Seal of origin, Branding and Organic Certification, being mentioned only in one paper each. The organic certification process was little discussed in only one article,

and despite being an interesting way of adding value, it is one of the most complex practices to be applied, since it is necessary to have an accurate follow-up on all points of the value chain. It is necessary to ensure the quality and health of products, which also involves the process of transportation, storage and delivery to the final consumer, as it is necessary to ensure that there is no contamination (SILVA; OLIVEIRA, 2013).

The seal of origin and origin certification are the types of Geographical Indication (GI). The GI emerged gradually when producers and consumers began noticing distinctive qualities in some products that were from certain places and understood that this had the ability to be a competitive advantage. Thus, they began to designate these products with the geographical name of their place of origin. However, obtaining the Geographical Indication is not so easy, there must be mechanisms that can protect this intangible value that adds value to the product (VIEIRA et al., 2014). It can be noticed that to obtain the Geographical Indication, it is necessary that the rural family producer is engaged in the search for a differential in their product, follow the legislation and apply for registration and issuance of certificate with the INPI - National Institute of Intellectual Property.

As indicated, another way to add value is branding. It is known that the brand plays a crucial role in the perception of products by consumers (GARCIA et al., 2011). According to Kotler and Armstrong (2015), a brand is a name, sign, term, symbol or design that serves to identify the product. However, brands are more than unassuming symbols, they are strong links in the relationship between company and consumers. For this link to happen, it is necessary to manage the brand very well, using a set of practices and techniques aimed at building it stronger, known as branding. In order this to happen in family farming, it is necessary that the producer has knowledge or help with management, a factor that is an obstacle to the use of this element of value addition.

Another point identified is that the biggest driver for adding value to products from family farming is the financial factor. It is understood that family farmers seek ways to improve their income and consequently their quality of life.

However, more than that, the improvement in family farmers' income is a way to stimulate their perpetuation in the property, as pointed out by Ferreira (2017, p. 01), when stating that "[...] agriculture industrialization acts as a strategic role in strengthening family farming, especially in local development".

In order to better understand the selected articles, the most frequently cited words were checked. These are shown in the word cloud shown in figure 3.



Fig.3: Word cloud

Source: Prepared by the authors, 2019.

NVIVO® was used to find the 50 most frequent words, with at least 5 letters, in the selected articles. As a grouping, exact correspondences and derived words were chosen. Prepositions, pronouns, and adverbs were excluded from the graph.

As it can be observed, the most cited words are family and its derivatives 574 times, followed by agricultural, farmers and agriculture (524). It was already expected that there would be many citations of terms related to the researched theme. However, the words that most called attention were those related to added value: chain (172), consumer (163), agroindustry (152), local (150), organic (139), region (135), short (104), agroecology and agroextractivist (101), quality (89). It is worth noting that the number of citations encompasses the term and its derivatives as plural, foreign language terms. It is noticeable that the elements that add value, although they appear with less emphasis, if compared to the terms directly linked to the theme, appear many times.

#### IV. CONCLUSION

Based on the above, it is possible to realize that several variables of added value were discussed in the selected articles. However, there is still a range of variables that can be used so that rural family farmers can add value to their products and thus get a better return on the investment made in their land and their work.

Although the articles address 10 different ways of adding value, which are often combined together, there is the possibility to go beyond, through variables such as, a) Product handling, such as washing, peeling and chopping

the products, b) Standard packaging, which protects the product both for transport and sale, c) Defined market positioning, working a differentiation according to what is valued by the consumer, d) Service, such as specialized deliveries, and also e) Image, using a tag/label with the producer's brand/logo.

In addition, family farmers must consider the context in which they are inserted, as Bauman states, in a liquid society. A society that encompasses rapid changes, market uncertainties, lack of references, temporariness, insecurity, and even demands that are greater than the capacity or conditions they had to solve them.

Thus, family farmers need to be aware of what happens to their consumers, since what they produce and how they produce can influence the acceptance or not of their products in the market, which is made up of increasingly demanding people who live in this liquid context.

So, there is a gap between what has been researched so far and other ways of adding value in a liquid society, that is, a society that is in constant mutation.

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# A Simplified Mesh Generation Scheme for 3D Geometries Composed by Planar Faces to be used with BEM

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**Keywords—** boundary element method (BEM), computational geometry, Delaunay triangulation, geometrical transformations, unstructured mesh generation.

**Abstract—** This paper presents the development of a simplified mesh generation scheme for three-dimensional boundary element method (BEM). The developed program presented in this work takes into account three-dimensional geometries composed by planar faces. This is a simplification regarding the form of the acceptable geometries, but a great variety of geometries and problems can be modelled with sufficient accuracy to perform numerical analysis. The main program's idea consists of moving each face belonging to the three-dimensional geometry to bi-dimensional space using geometrical transformation matrices. In bi-dimensional space, then, it is applied a bi-dimensional mesh generation algorithm for element generation. After element generation is done, new geometrical transformations are applied in order to send the meshed face back to its original position in three-dimensional space. The continuity of the final mesh is assured by promoting the discretization of the edges of the geometry only once. The proposed scheme has several positive aspects regarding simplicity, efficiency and robustness. A practical and immediate use of the proposed algorithm can be found for those who already have a bi-dimensional mesh generator code implemented and intent to expand its functionalities to treat simple three-dimensional geometries composed by planar faces. Several examples of meshes in arbitrary three-dimensional geometries composed by planar faces are presented in order to illustrate the capabilities of the developed computational program and some computational simulations have been performed to show the quality of the meshes in problems with specific boundary conditions.

## I. INTRODUCTION

The mesh generation process is crucial for computational simulations since it strongly affects the results obtained by the numerical solution of partial differential equations that govern the analyzed problem [1-3]. The generated mesh should be able to provide sufficiently accurate results according to the complexity of the geometry and physical phenomena involved. Several complex applications can be analyzed with sufficient accuracy level [4,5]. In computational numerical simulations, the pre-processing phase is one of the “bottle-

neck” with respect to the computer processing time. This is due to the fact that in the pre-processing phase the mesh is generated and the problem is modelled with specific boundary conditions. It is very difficult to generate suitable meshes for problems involving complex three-dimensional geometries and/or boundary conditions. The algorithms for three-dimensional mesh generation are usually very difficult to be implemented for arbitrary cases and the computational costs are generally expensive [6]. That is why, still nowadays, great efforts and investments are done to develop new techniques and algorithms for



improving the mesh generation process on three-dimensional geometries. In this paper it is presented a simplified scheme to implement a three-dimensional mesh generator to be used in numerical analyses by the boundary element method. The boundary element method has some particular features that make it more favorable in certain types of applications, when compared to other numerical methods. Among those features, there is the fact that, in boundary element method, only a discretization of the geometry boundaries is necessary [7,8]. In other words, in three-dimensional cases only surface elements must be generated. This is a huge benefit from the mesh generation point of view. The algorithm proposed in this work only takes into account three-dimensional geometries composed by planar faces. This is a simplification regarding the form of the acceptable geometries, but a great variety of geometries and problems can be modelled with sufficient accuracy to perform numerical analysis. The main algorithm's idea consists of moving each face belonging to the three-dimensional geometry to bi-dimensional space using geometrical transformation matrices. In bi-dimensional space, then, it is applied the Delaunay triangulation method over a grid of points to cover the face domain with triangular-linear elements, but other algorithms and elements could also be used taking into account the general idea. The Delaunay triangulation method is one of the best methods to generate meshes with triangular elements devoted to numerical analysis. It has the property of maximizing the triangles' minimum internal angles which is favorable and suitable for numerical methods in general [9,10]. After element generation is done, new geometrical transformations are applied in order to send the meshed face back to its original position in three-dimensional space. The continuity of the final mesh is assured by promoting the discretization of the edges of the geometry only once. This is essential because each edge belongs to two planar faces of the three-dimensional geometry. Therefore, no duplicate nodes should be generated over an edge and the final mesh is supposed to contain only conformal elements. The proposed scheme has several positive aspects regarding simplicity, efficiency and robustness. Firstly, the code is extremely simplified since the problem is transformed from three-dimensional space to bi-dimensional space by using geometrical transformations matrices. The algorithms for element generation are bi-dimensional, that is to say, they are much simpler, reliable and easier to be implemented [11-13]. Regarding efficiency and robustness, as each face of the three-dimensional geometry is moved to bi-dimensional space and the mesh is generated over one face per time, the occurrence of a bad element generation is minimized. As the whole mesh is

performed face by face, the problem is subdivided in several small problems and the main algorithm assumes the divide-to-conquer paradigm, which assures high efficiency and computer processing velocity [14,15]. A practical and immediate use of the proposed algorithm can be found for those who already have a bi-dimensional mesh generator code implemented and intent to expand its functionalities to treat simple three-dimensional geometries composed by planar faces. The generated surface meshes over these geometries can be used in three-dimensional boundary element analysis or, even though, in numerical analysis using the shell finite element formulation. All the code has been written using the object-oriented paradigm in C++ combined with UML notation. Using this approach the program can be easier modified, the maintenance costs are reduced and new implementations can be carried out as user's and/or programmer's needs [16].

## II. THREE-DIMENSIONAL BOUNDARY ELEMENT METHOD

The boundary element method is based upon boundary singular integral equations. The analytical formulation involves the transformation of the governing differential equation applicable to the whole domain into an integral over the boundary [7]. To illustrate the technique it is presented the elasticity problem in the form of the partial differential equation known as the Navier equation of elasticity:

$$\mu u_{i,jj} + \frac{\mu}{1-2\nu} u_{j,ji} + b_i = 0, \quad (1)$$

where  $b_i$  are body force components,  $\mu = E/2(1 + \nu)$  is the shear modulus,  $E$  is the Young's modulus,  $\nu$  is the Poisson's ratio and  $u_i$  are displacements components. Equation 1 can be transformed into an integral equation over the boundary. The displacement boundary integral formulation of elasticity can be derived using the Somigliana's Identity and Betti's reciprocity theorem [8]. The fundamental solutions for displacements and tractions are given respectively by:

$$U_{ij}(X', X) = \frac{1}{16\pi(1-\nu)\mu R} \{(3 - 4\nu)\delta_{ij} + R_{,i}R_{,j}\} \quad (2)$$

$$T_{ij}(X', X) = \frac{-1}{8\pi(1-\nu)R^2} \left\{ \frac{\partial R}{\partial n} [(1 - 2\nu)\delta_{ij} + 3R_{,i}R_{,j}] - (1 - 2\nu)(n_j R_{,i} - n_i R_{,j}) \right\} \quad (3)$$

where  $R = \sqrt{R_i R_i}$ ,  $R_i = X_i - X'_i$ ,  $R_{,i} = \frac{\partial R_i}{\partial X_i} = \frac{R_i}{R}$  and  $\frac{\partial R}{\partial n} = R_{,i} n_i$ . The load point or source point is represented by  $X'$  and the field point by  $X$ . Therefore, the displacement boundary integral equations for elasticity can be written, neglecting the body forces  $b_i$ , by considering the limiting process of an internal point that goes to the boundary [7,8], i.e.,  $X' \rightarrow x'$ , as:

$$c_{ij}(x')u_j(x') + \int_{\Gamma} T_{ij}(x',x)t_j(x)d\Gamma(x) = \int_{\Gamma} U_{ij}(x',x)t_j(x)d\Gamma(x) \quad (4)$$

where  $c_{ij}(x')$  is a function of the contour shape at the boundary point  $x'$ . From Equation 4 one can note that there are only boundary dependent terms. Thus, it is not necessary to generate domain elements in the discretization procedure. That is why the three-dimensional mesh generator implemented in this work only generates surface elements. For simplicity, the mesh generator was implemented by using a bi-dimensional Delaunay mesh generation algorithm, which gives origin to triangular-linear elements, as shown by Figure 1. Therefore, a boundary element solver with three-dimensional elasticity isotropic-linear homogeneous formulation, for example, can be used to perform numerical analyses considering solid mechanics engineering problems. Using the shape functions  $N^1, N^2, N^3$ , Equation 4 can be written in a discretized form as [7]:

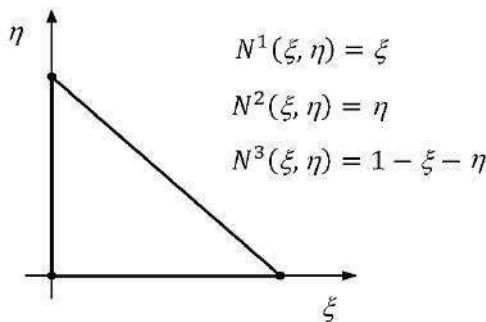


Fig.1: Triangular-linear continuous element and its shape functions.

$$c_{ij}(x^k)u_j(x^k) + \sum_{n=1}^N \sum_{m=1}^M u_j^{nm} \int_{-1}^1 \int_{-1}^1 T_{ij}[x^k, x(\xi, \eta)] N^m(\xi, \eta) J^n(\xi, \eta) d\xi d\eta = \sum_{n=1}^N \sum_{m=1}^M t_j^{nm} \int_{-1}^1 \int_{-1}^1 U[x^k, x(\xi, \eta)] N^m(\xi, \eta) J^n(\xi, \eta) d\xi d\eta \quad (5)$$

where  $M$  is the number of nodes per element,  $N$  is the total number of elements on the mesh,  $\kappa$  represents the number of the node on the mesh that is being evaluated as source point and  $J^n$  is the Jacobian of the transformation. The Jacobian can be calculated by  $J_n = |x_{\xi} \times x_{\eta}|$ , where the subscripts  $\xi$  and  $\eta$  denote the derivatives with respect to  $\xi$  and  $\eta$ , respectively. Equation 5 can be presented in the matrix form as:

$$Hu = Gt, \quad (6)$$

which can be rearranged in  $Ax = f$  and readily solved.

### III. MESH GENERATION

This work uses bi-dimensional Delaunay triangulation over a grid of points to generate elements in an arbitrary planar faces of the three-dimensional geometry. There are several ways to perform bi-dimensional mesh generation over an arbitrary planar straight line graph (PSLG). As bi-dimensional algorithms for mesh generation are extensively know in literature, the main focus of this paper is devoted to present the structure of the program that allows three-dimensional surface mesh generation. To perform this task, geometrical transformation matrices are used to move each planar face from the three-dimensional geometry to bi-dimensional space and vice-versa.

#### Data Structure

The process to obtain the input file for the mesh generator presented in this work is illustrated by Figure 2. First, the three-dimensional geometry is drawn using CAD software. The three-dimensional geometry must only be constituted by planar faces. Then, the geometry is saved on IGES format and an IGES translator developed during this research project is used to generate the input file accepted by the mesh generator program. This input file contains the geometry information in the format presented by Figure 3(a). A similar data structure for the input file can be found in [11]. The MeshPar parameter is a numerical value provided by the user. It is given in length unit. This parameter affects the level of the mesh refinement. The key-words Vertex, Edge and Facet contain information about the vertexes, edges and planar faces of the 3D geometry, respectively. The format of the output file containing the mesh data is presented by Figure 3(b).

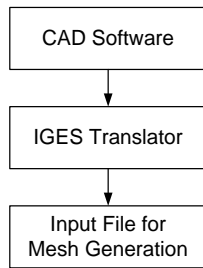


Fig.2: Process to obtain the input file for the mesh generator.

```

    MeshPar = [ (meshpar_value) ]

    Vertex=[
      (number) (coordinate_X coordinate_Y coordinate_Z)
      ...
    ]

    Edge=[
      (number) (vertex_A vertex_B)
      ...
    ]

    Facet=[
      (quantity_of_edges) (number) (edge_A) (edge_B)
      (edge_C) (edge_D) ...
      ...
    ]
  
```

(a)

```

    NodeNumber = number_of_nodes
    ElementNumber = number_of_elements

    Nodes=[
      (number) (coordinate_X coordinate_Y coordinate_Z)
      ...
    ]

    Elements=[
      (number) (node_A node_B node_C)
      ...
    ]
  
```

(b)

Fig.3: Data structures: (a) input file and (b) output file.

**Computational Aspects**

In this subsection the main classes of the developed program are presented. The classes were modeled by using the UML notation. A special focus is given to the Node, Segment, Facet, Element, Triag, Mesh and GeoTrafo

classes, which are the main classes of the program. In Figure 4 are presented the Node, Element, Triag and Centroid classes. It is also possible to see the Dictionary class, with its hidden attributes and methods. The Dictionary class is very important for the developed program because it makes possible to read the input data file easily and efficiently. It can be seen from the diagram presented in Figure 4 that both the Element and Node classes depend on the Dictionary class. In fact, the Segment and Facet classes also depend on it, but they were not shown in this diagram for simplification purpose.

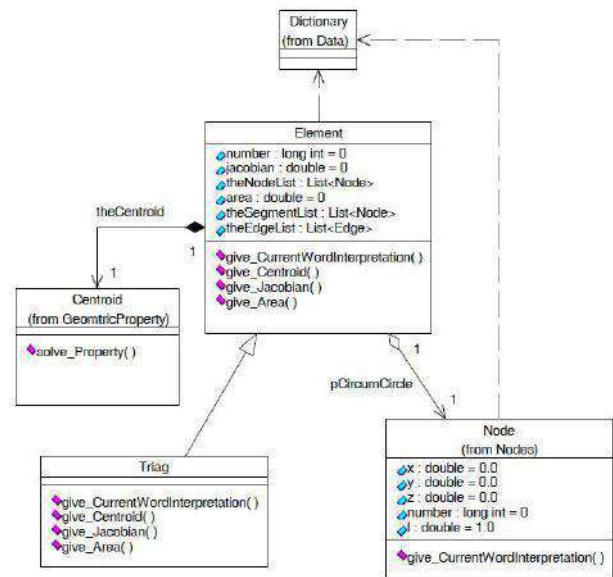


Fig.4: Class diagram exhibiting the relationship between Node and Element Classes.

The Element class has a number of attributes and methods, as can be seen. The signature of the methods, i.e., the type of method and the arguments that are passed to it were not shown at the diagram for visual simplicity. The give\_CurrentWordInterpretation() method is a static method and, therefore, it can be called without the need to instantiate an object. It is only necessary to use the class name and the "::" operator followed by the name of the method. The Triag class is the only class derived from the Element class, because generated meshes consist only of triangular elements. The give\_CurrentWordInterpretation() method is a specialist that has the ability to interpret input file information related to a word previously added to the dictionary. The Node, Segment, and Facet classes also have the give\_CurrentWordInterpretation() method to read the data structure shown by Figure 3. The other methods of the Element class, give\_Centroid(), give\_Jacobian(), and give\_Area() are virtual methods, which allow the assignment of Element-type pointers to Triag-type objects.

Thus, the code for calculating the centroid, the Jacobian and the area of a triangular element are implemented in the methods of the Triag class. It is possible to note two associations existing in Figure 4: an association between the Element class and the Node class; and, an association between the Element class and the Centroid class. In the first, a Node-type object is aggregated by reference to the Element class, which implies that every Element-type object will have a Node-type attribute, called pCircumCircle, aggregated by reference. This pCircumCircle attribute will have the coordinates of the center of the circle that circumscribes a Triag element. In the second, an object of the Centroid-type, theCentroid, is added by value to the Element class. Figure 5 shows the Segment, Facet, and Edge classes. Also, the List and Container classes are presented. They are Template classes, that is, they are parameterized. Note that the List class depends on the Node, Segment, Facet, Edge and Element classes, because it is necessary to create lists of Node-type objects, Segment-type objects and so on.

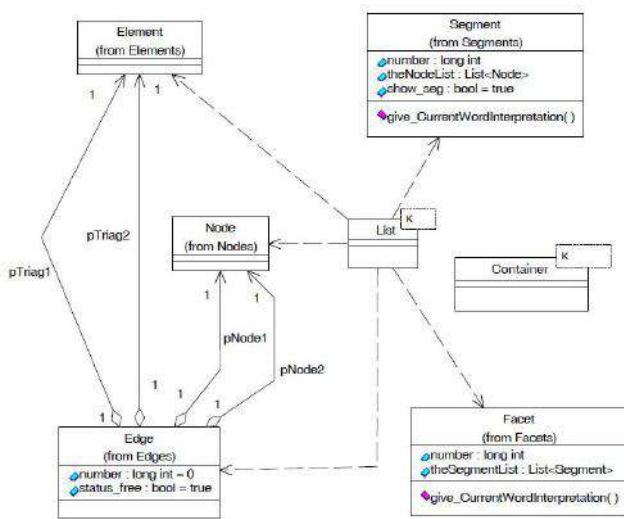


Fig.5: Class diagram showing the modeling of Segment, Facet and Edge classes.

The Edge class was abstracted aiming at the improvement of the element generation algorithm. With the Edge class it is possible to know the geometric entities in a certain region of interest more quickly and efficiently. For example, as the Edge class relates to the Element class and the Node class, it is possible to see that each Edge-type object has two Element-type objects (pTriag1 and pTriag2) and two Node-type objects (pNode1 and pNode2). Thus, for a particular Edge-type object, it is immediately known which are the two triangles of the mesh that are part of it, and which are the two nodes that

define it. This is extremely beneficial from the processing time saving point of view, because, it is not necessary to search for a whole set of geometric entities, but only in a particular region of interest. Figure 6 shows the GeoTrafo and Mesh classes that are the most important classes of the developed program. Again, to facilitate viewing of the classes, the signatures of the methods were not displayed.

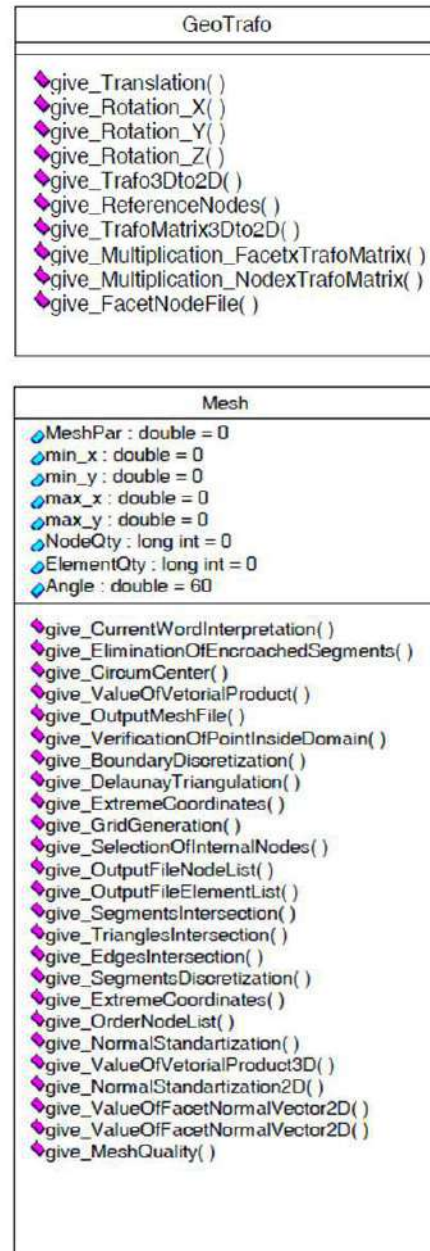


Fig.6: GeoTrafo and Mesh classes modeled using UML notation.

**Mesh Generator Flowchart**

The execution flowchart of the implemented mesh generation program is presented in Figure 7. The mesh

generation process begins with the input file reading. As soon as this file is read, the computer has already stored in memory all lists needed to generate the mesh on the geometry. Three lists are created: a VertexList which contains Vertex-type objects with information about the geometry vertexes; an EdgeList which contains Edge-type objects with information about the geometry edges; and a FacetList which contains Face-type objects with information about the planar faces of the geometry. The MeshPar value is stored in a double type variable. The mesh generation process starts from a loop in the FacetList. For each face belonging to the FacetList, it is applied a geometrical transformation matrix which will move it to bi-dimensional space. After the face is in bi-dimensional space, a loop in the EdgeList is performed, which defines the current face. Each face owns as attribute an EdgeList which contains all the segments of the face. Each segment of the face owns as attribute a VertexList which contains the Vertex-type objects that define the segment. Initially, it is checked if the VertexList of the current segment has only two Vertex. This means that the segment has not been discretized. If the VertexList of the segment contains more than two Vertex, it means that the segment has already been discretized and should not be discretized again. This verification is crucial because each segment belongs to two faces. So, in order to respect the continuity of the final mesh, the nodes on the edges of the geometry are defined a priori and only once. Afterwards the loop in the EdgeList of the Face object is finished, it is called the method that generates the mesh over the face using a grid of points. Good references to implement a bi-dimensional mesh generator using the Delaunay triangulation method, can be found in [12,17-19]. However, there are several approaches to generate meshes with different types of elements [13]. An advancing front approach, instead of generating a grid of points over a region, is also very efficient for generating triangular meshes [14]. This technique is particularly suitable for the boundary element method because it starts the element generation from the boundary data. An execution flowchart using the advance front technique for mesh generation, whose structure is similar in some aspects to the proposed flowchart, can be found in [15]. As soon as the mesh on the face is generated in a conformal procedure, the inverse of the transformation matrix, used to move the face to bidimensional space, is applied to send the meshed face back to its original position in 3D space. Then, another face of the geometry is selected and the process goes on until all the faces have been analyzed. At the end of the process, the program will have stored a NodeList containing the nodes of the final mesh and an ElementList containing the nodal connectivity. An output

file containing this information is written and used as input file by the boundary element solver.

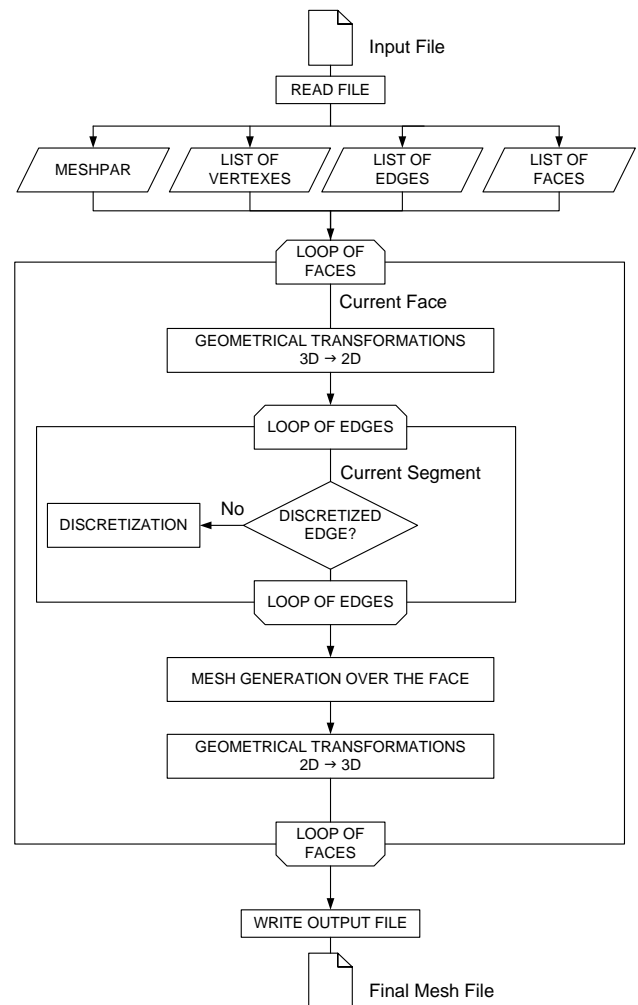


Fig.7: Execution flowchart of the developed mesh generation program.

### Geometrical Transformations

The process of moving each planar face of the geometry from three-dimensional space to bi-dimensional  $xy$  plane is obtained by using geometrical transformation matrices [20]. In Figure 8 this process is illustrated step by step. In Figure 8(a) it is presented an arbitrary planar face in three-dimensional space constituted by linear segments. This face can be a non-convex polygon and have holes in its interior. First, it is detected the point of the face which has the minimum  $y$ -coordinate, in this case  $P_{ij}$ . Then it is applied a translation matrix in order to move all the face entities to the origin of the coordinate system, as presented in Figure 8(b). The translation matrix  $\mathbf{A}$  is given by:

$$A_{ij} = \delta_{ij} + \delta_{i4}(-P_{ki}) - \delta_{i4}(-P_{ki})\delta_{j4} \quad (7)$$

where  $P_{ki}$  is the point used for the face translation. The subscript  $k$  is the number of the point,  $i$  represents the cartesian components of the point, and,  $\delta_{ij}$  is the Kronecker delta function. The vector  $V_n$  is the face normal vector calculated by the cross product between  $V_1$  and  $V_2$ . As soon as the face is moved to the origin of the coordinate reference system, it is necessary to apply a geometrical transformation matrix  $B$  in order to align  $V_n$  with  $z$ -axis and  $V_2$  with  $y$ -axis. This is shown by Figure 8(c). The matrix  $B$  is given by:

$$B_{ij} = R_{ij} - (\delta_{4j}R_{1j} + \delta_{i4}R_{1j}) + \delta_{i4}\delta_{j4}R_{1j} + \delta_{i4}\delta_{j4} \text{ for } i, j = 1, 4 \quad (8)$$

where  $R_{ij}$  are the cartesian components of the  $R_i$  vectors. The  $R_i$  vectors can be calculated by  $R_3 = \frac{V_n}{|V_n|}$ ,  $R_1 = \frac{V_2 \times R_3}{|V_2 \times R_3|}$  and  $R_2 = R_3 \times R_1$ . So, the transformation matrix  $T$  to be implemented is given by the product of matrices  $B$  with  $A$ , as:

$$T_{ij} = B_{ik}A_{kj}. \quad (9)$$

Applying on a set of points  $P$ , the face  $F_i$  is moved to  $xy$  plane as shown in Fig. 8(d) by the transformation:

$$P_{ij}^T = T_{ik}P_{kj} \quad (10)$$

The inverse of the transformation matrix  $T^{-1}$  is used to send the planar face back to its original position in three-dimensional space.

#### IV. RESULTS AND DISCUSSIONS

##### Generated Meshes

In order to show the capabilities of the developed mesh generator, it is presented four meshes in arbitrary three-dimensional geometries composed by planar faces, see Figures 9 to 12. Since the developed mesh generator uses

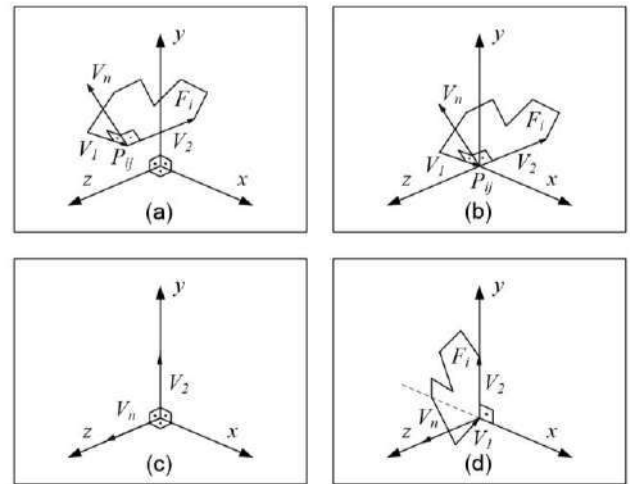


Figure 8: Process of moving an arbitrary planar face  $F_i$  from 3D space to 2D  $xy$  plane.

the Delaunay triangulation method, the triangles' minimum internal angles found in every mesh are significantly high, being limited only by the minimum angle of the drawing geometry. Therefore, it can be noticed that all presented meshes shown good quality and are suitable for numerical analysis using the three-dimensional boundary element method or shell finite element formulation. The meshes presented in this paper are for illustration purposes and, thus, they have a very small number of nodes and elements. However, the MeshPar parameter can be easily adjusted as user's needs in order to generate more refined meshes, with much more nodes and elements, according to computational hardware availability.

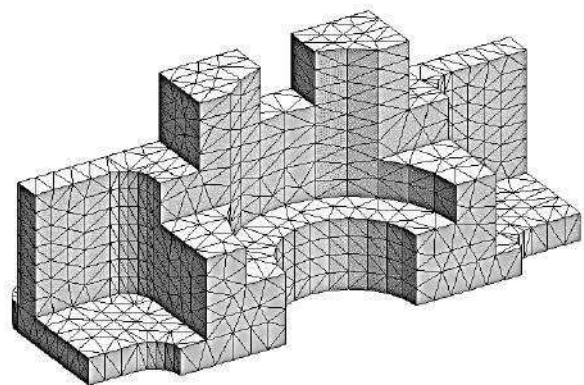


Fig.9: Three-dimensional surface mesh with 1148 nodes and 2292 elements.

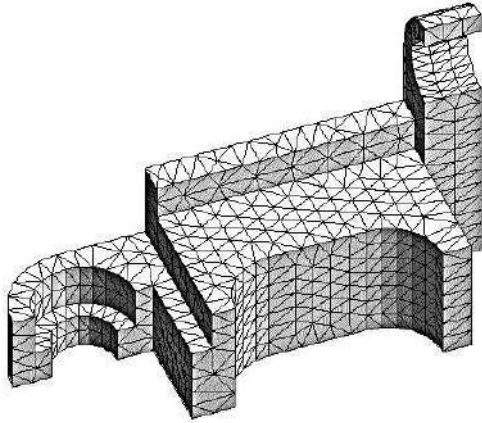


Fig.10: Three-dimensional surface mesh with 957 nodes and 1910 elements.

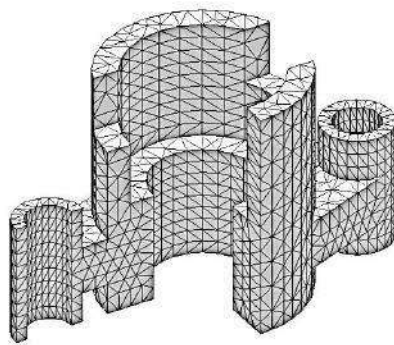


Fig.11: Three-dimensional surface mesh with 1737 nodes and 3474 elements.

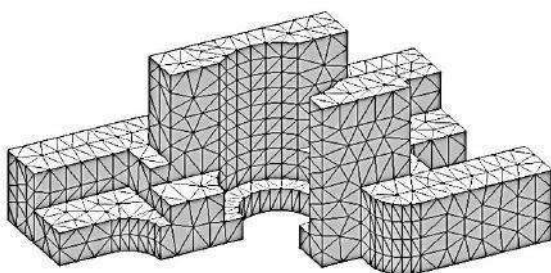


Fig.12: Three-dimensional surface mesh with 1058 nodes and 2116 elements.

**Computational Simulations**

Some computational simulations were performed in order to demonstrate practical applications of the generated meshes. The first problem analyzed is a tub with

internal pressure. The Poisson ratio used is equal to 0.3 and the Young’s Modulus is 2600 units. The boundary conditions applied are:

- $x$ -direction displacement restriction on the nodes of the face parallel to  $yz$  plane;
- $y$ -direction displacement restriction on the nodes of the face parallel to  $xz$  plane;
- $z$ -direction displacement restriction on the nodes of the faces parallel to  $xy$  plane;
- 50 units of internal pressure applied on the elements of the internal wall tub.

Figure 13 shows the displacement map for the studied problem considering that the modeled mesh is generated by the mesh generator presented by this work having 200 nodes and 396 triangular-linear elements; and, the solution is calculated by a boundary element solver, ECon-3D, which was developed prior to this research project. In a similar way, the same problem was analyzed again considering a modeled mesh generated by the Ansys software having 212 nodes and 420 Shell63 triangular-linear elements; the solution shown by Figure 14 was also calculated by ECon-3D solver. It can be seen that the mesh modeling strongly influences the results. The analytical solution for this problem can be found in [7] by means of comparison. A good agreement can be observed among all the achieved results.

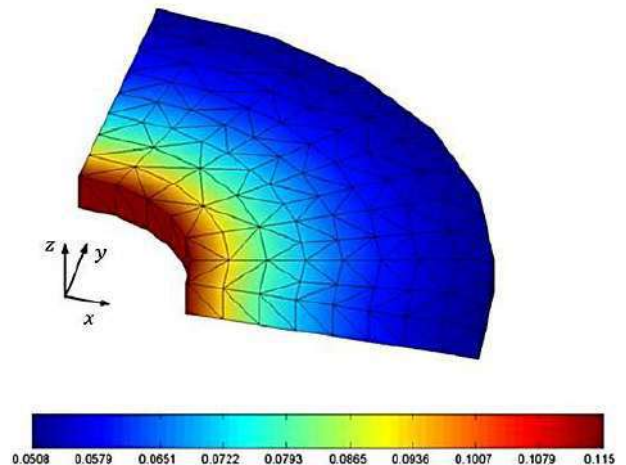


Fig.13: Displacement map for a mesh generated by the mesh generator developed by this work; the solution was carried out by Econ-3D boundary element solver.

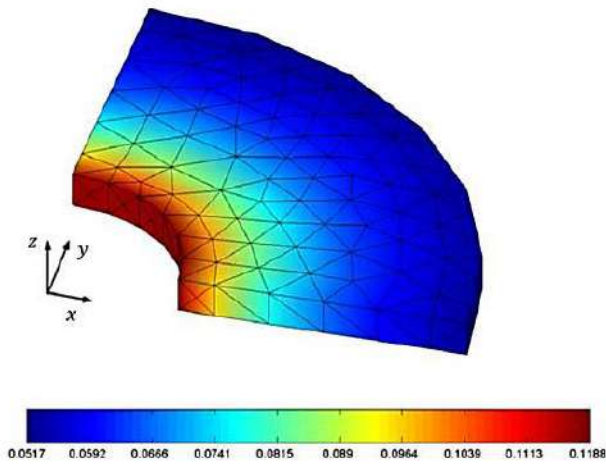


Fig.14: Displacement map for a mesh generated by the Ansys software; the solution was carried out by Econ-3D boundary element solver.

A second case study was performed considering the structural support whose geometry is presented by Figure 15. To analyze this problem, a Poisson ratio of 0.21 and a Young’s Modulus of 2900 units were adopted. The applied boundary conditions applied are:

- x- and z- direction displacement restriction on the nodes of the two holes;
- y- direction displacement restriction on the nodes of the two outer side faces containing the holes;
- 500 units of pressure applied to the elements at the rod end.

Figure 15 shows the displacement map of the solution considering the problem modeled with a mesh generated by the Ansys software having 934 nodes and 1832 Shell63 elements. The respective solution of this problem was calculated out by ECon-3D solver. Figure 16 shows another displacement map of the solution considering the problem modeled with a mesh generated by the mesh generator developed by this work having 936 nodes and 1876 elements. The respective solution of this problem was also performed by ECon-3D solver. A final analysis was performed using the finite element method in the Ansys software by using Solid45 elements. Figure 17 shows the mesh generated by the Ansys software with 1618 nodes and 6013 elements. The Solid45 element was chosen because it has linear interpolation functions, thus allowing a fairer comparison among the results. All three analyzes showed very close results. This demonstrates that the meshes generated by the mesh generator developed by this work are of good quality and suitable for using in numerical analysis.

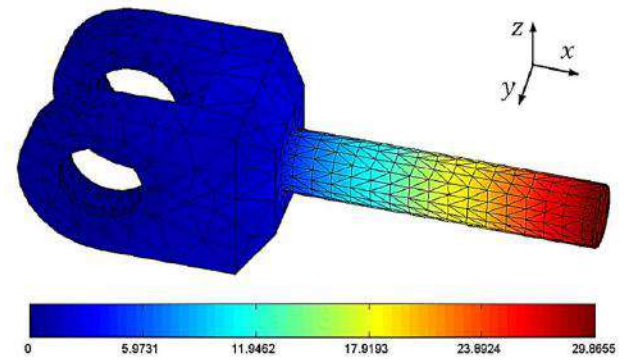


Fig.15: Displacement map for a mesh generated by the Ansys software; the solution was carried out by Econ-3D boundary element solver.

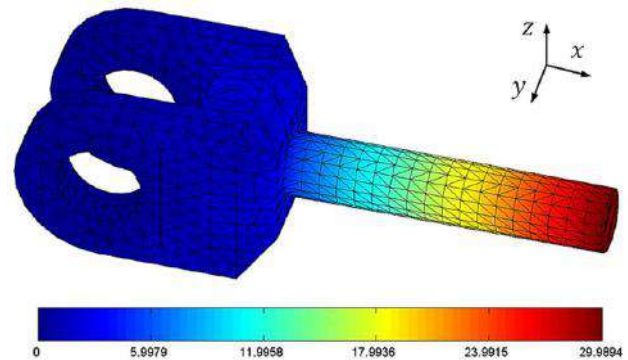


Fig.16: Displacement map for a mesh generated by the mesh generator developed by this work; the solution was carried out by Econ-3D boundary element solver.

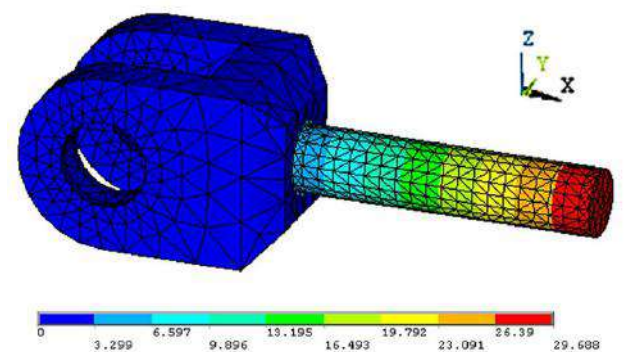


Fig.17: Displacement map for a mesh generated by the Ansys software with Solid45 elements; the solution was carried out by the Ansys solver.



## V. CONCLUSIONS

It was developed a triangular-linear surface mesh generator for arbitrary three-dimensional geometries composed by planar faces. As programming was done using the object-oriented paradigm, it was possible to construct a very clear and efficient program structure. In addition, this structure is extremely flexible and allows for faster and easier code expansion and enhancement. Although the mesh generator developed by this work only accepts geometries composed by planar faces, it can be seen from the analysis of the presented results that a wide variety of three-dimensional problems can be modeled with considerable complexity. All the geometries analyzed by the program lead to the generation of satisfactory meshes which can be progressively refined according to the MeshPar parameter and the processing capacity of the computer hardware. The proposed algorithm makes use of geometrical transformation matrices which allow the development of a fast, robust and efficient program. The program flowchart can be particularly useful for those who already have a bi-dimensional mesh generator code implemented and intend to extend its functionalities to treat simple three-dimensional geometries composed by planar faces. Some computational simulations have been performed to show the quality of the meshes in problems with specific boundary conditions. It could be observed that the developed mesh generator provides triangular-linear elements with good technical features for numerical analysis considering the boundary element method or the shell finite element formulation. Besides, the developed program is an open source engineering program that can be used for research purposes. Future improvements can be done according to user's needs.

## ACKNOWLEDGEMENTS

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# Identification of Driver Specific Parameters Using Real-Time Testing

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**Keywords**— ODE- Ordinary differential equation, S- Laplace domain, MISO- Multi-input single-output model, POF- Percentage of fit.

**Abstract**— This paper emphasis on how to estimate the specific driver parameters corresponding to the human driver using the driver model approach. Subsequently, the specific driver parameters are defined based on the human driver under longitudinal driving conditions. To accomplish this, the mathematical description (Ordinary differential equation (ODE)) of the driver model is considered, representing the specific driver parameters.

As stated before, the specific driver parameters are investigated for longitudinal driving conditions so, car following based model is selected this model determines how far the vehicle is in front of the other vehicle. Thereafter, the mathematical description of the driver model (ordinary differential equation) is transformed into the Laplace domain (S-domain) for estimating the specific driver parameters by using the input-output behaviour of the driver model.

In this research system identification method is used to obtain the higher order transfer function for the given input and output variable. In addition to it, the acquired higher order transfer function needs to be approximated to the theoretical transfer function of the driver model.

In a nutshell, it can be said that based on the defined goal the specific driver parameters were investigated using the driver model approach. In addition to it, one driver is analysed based on the identified specific driver parameters and correspondingly conclusions are drawn. Consequently, the same approach can be carried out for comparing different human drivers.

## I. INTRODUCTION

In the automotive field, over the past decades, Advanced Driver Assistance Systems (ADAS) have been developed and implemented by the manufacturers. Such systems improve the shortcoming of human drivers, such as unavoidable reaction times, workload, low vigilance, etc. in recent years. Nowadays improving safety, comfort, and assistance to the driver is a major concern in the automotive industries and to do so new ADAS systems are developed. To develop the ADAS systems that are safe and comfortable for a human driver to use, it is necessary to understand real

human driving behavior. Thus, the human driver behavior can be analysed and modelled using the existing driver models.

The modelling human driver behavior is challenging due to its imaginary nature and a high degree of human driver variability. As stated before, human behavior is analysed using the existing driver models as the driver model accounts for the human driver traits. To study the driver behavior first the driver parameters needs to be specified according to the selected driver model and the driving condition (longitudinal and lateral). Based on the recent

advancements in the technology of automotive, electronics and communication, it is easy to collect real-time data during test using various sensors, control unit, etc. Later, on this real-time data is used for estimating the specific driver parameters corresponding to the human driver.

As the technology in the field of automation is improving day-by-day, a stepwise development of vehicle automation is shown in Fig. 1. Society of Automotive Engineers (SAE) has proposed 6 levels of automation ranging from 0 (Driver Only) to 5 (Full Automation).

Currently, more research is being done on level 3 and level 4 of automation but companies are working on to achieve level 5 also. Recently, Volvo has officially kicked “Off Drive Me”, the ambitious and advanced public autonomous driving experiment on their autonomous car (XC90 SUV).

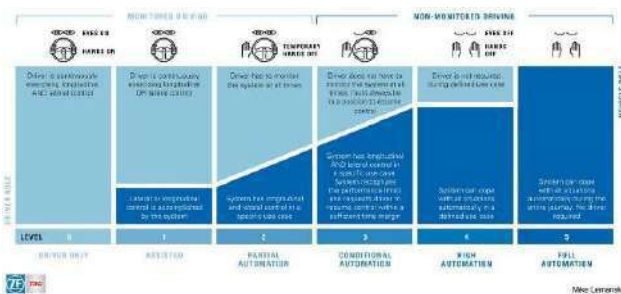


Fig 1: Levels of vehicle automation [4].

The modelling presents an economic and safe methodology for investigating various approaches. Every research is done first on the simulation level, later it moves into the production stage. In this project, the concept of the car-following model is used for estimating the specific driver parameters corresponding to the human driver. This model states that; how far the vehicle is in front of the other vehicle. Furthermore, estimating a suitable driver model is significant in the development of autonomous vehicles, as well as in simulation, evaluation, and optimization of a driver-vehicle closed-loop system. Thus, the schematic car following model is shown in Fig. 2. A large amount of real-time traffic data provide the potential to better calibrate and validate car-following models for more realistic traffic simulations [6].

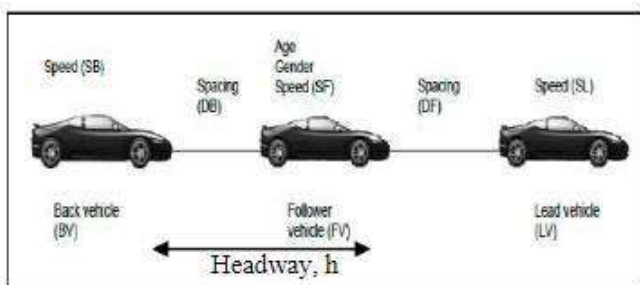


Fig 2: Car following model [6].

This project estimates the specific driver parameters corresponding to the human driver using the driver model approach. Here the problem is to identify the effects of the specific driver parameters on the driving conditions and how to solve the problems related to human factors. There are several human factors related to the human driver which are unique for everyone such as slow reaction time, fatigue, low vigilance, etc. This study is about, how the specific driver parameters (time delay, driver gain) affects the driving condition of the human driver which can be investigated as per the following approach shown in Fig. 3.

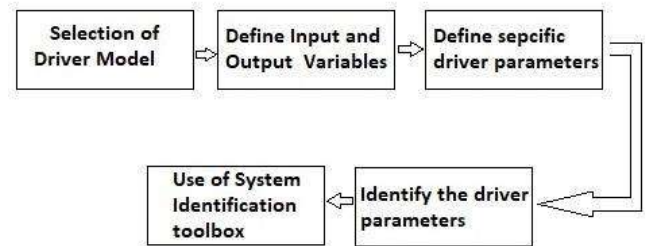


Fig 3: The project approach.

The rest of the paper is organized as follows. We first present the methodology in Section II. We then introduce the test description which explains the procedure of testing in Section III. Further, section IV deals with the approach towards the objective. The approach is subdivided into parts to elaborate the process of finding specific driver parameters. Section V deals with the results and discussion of the research. Conclusions are given in Section VI.

## II. METHODOLOGY

This section is concerned about the different aspects of the research and the approach used to reach a satisfactory result. An explanation on the driver model, use of system identification toolbox and methods of estimating specific driver parameters have been discussed.

First, to start with the research, real-time test data is required which is gathered by conducting the test on HAN Automotive Test Vehicle BMW 320i, however, the driver details are anonymous. Thus, the test route was found by using the global coordinates of X and Y (GPS Longitude & Latitude), provided in the data set.

For understanding how the specific driver parameters are changed according to the driving conditions, a study was conducted and based on the analysis, results are presented. To accomplish this, the specific driver parameter are investigated using the driver model approach (see Fig. 3). Furthermore, in the sub-sections explanation is given for;

how and which specific driver parameters are identified corresponding to the human driver.

2.1 Driver Model

Generally, a driver model is defined by an ordinary differential equation (ODE) describing the complete description of the driver parameters, input and output variables which imitate the human driver. As stated before, in this research longitudinal driver behaviour is examined so it is decided to use car following model.

In this section, the car following based model is described. The car following model is selected in this research, due to its simplicity and ease of understanding the longitudinal driver behaviour. Fundamentally, this model considers a scenario where one car is following another car in front. In this condition, the human driver of the following car is observing errors in the desired headway distance, and the relative velocity, which is different for every human driver and changes accordingly [7].

The basic representation of the car following model is shown in Fig. 4. In this research, specific driver parameters; driver gain ( $K_D$ ) and time delay ( $t_d$ ) are estimated using the driver model approach.

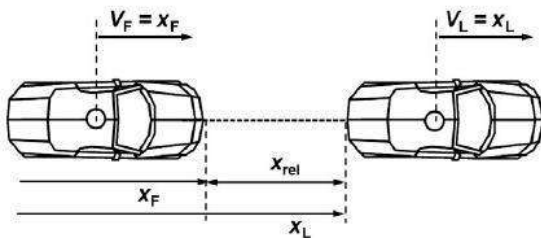


Fig 4: Schematic layout of the car following model [7].

Here the car following model is expressed in the terms of mathematical description assuming the desired time headway  $THW_{des}$  and considering a time delay  $t_{d1,2}$  & driver gain  $K_{1,2}$  [7].

$$P_a = K_1 * \dot{x}_F * (t - \tau_{d1}) * (THW((t - \tau_{d1}) - THW_{des})) + K_2 * V_{rel} * (t - \tau_{d2}) \quad (2.1)$$

Where;

$P_a$  : Percentage of accelerator pedal depression,

$K_1$  &  $K_2$  : Driver gains,

$T$  : Reaction time delay,

$t_d$  : Delay time,

$THW$  : Time to headway,

$THW_{des}$  : Desired time to headway,

$V_{rel}$  : Relative velocity between the vehicles.

The mathematical description of the driver model (see Eq 2.1) is transformed into the Laplace domain (S-domain). Therefore, the above-mentioned driver model corresponds to the following transfer functions depending upon the input and output variables. In addition to it, the delay terms in transfer functions can be expressed as a power series eliminating higher order terms [3]. Fig. 5 represents the block diagram of the mathematical description of the driver model in the Laplace domain. Thus, the complete driver model results into a multi-input single-output model (MISO) and it is further elaborated in sub-sections.

$$G(s)_1 = \frac{P_a}{THW - THW_{des}} = K_1 e^{-\tau_{d1}s} \quad (2.2)$$

$$G(s)_2 = \frac{P_a}{V_{rel}} = K_2 e^{-\tau_{d2}s} \quad (2.3)$$

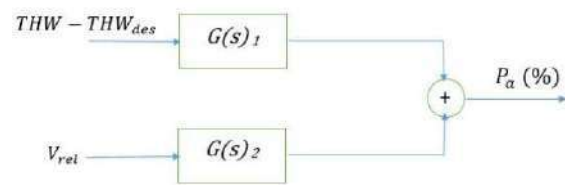


Fig 5: Representation of driver model in Laplace domain.

The above given transfer functions (see Eq 2.2 & 2.3) use different inputs for identifying the specific driver parameters corresponding to the human driver accounted in the driver model. The transfer function  $G(s)_1$ , formulates the input and output behaviour by using the output as throttle % ( $P_a$ ) and input as the difference between the time to headway and the desired time to headway (error). The desired time to headway is assumed based on the literature [7]. The two-second rule (also known as the three-second rule) is a rule of thumb, in which a driver maintains a safe trailing distance at any speed [11, 9]. The rule states that a driver should ideally stay at least 2-2.5 seconds behind any vehicle which is in front of it.

Whereas, the transfer function  $G(s)_2$ , formulates the input and output behaviour by using the output as throttle % ( $P_a$ ) and input as the relative velocity between the vehicles. From the given transfer function models  $G(s)_1$  &  $G(s)_2$ , four specific driver parameters can be identified which corresponds to the human driver i.e., reaction time delay of the driver (time needed by the driver to analyse/percept the information from the vehicle and the road environment) and the driver gain (this quantity defines how attentive the driver is while

driving) [8]. Therefore, the complete description of the driver model results in a multi-input single-output system (see Fig. 5). Finally, the schematic diagram is shown below in Fig. 6, explains about the vehicle and driver subsystems. From this closed-loop system of vehicle and driver, it can be stated that the driver provides input as throttle and brake to the vehicle according to the deviations from the reference set point to maintain the desired headway time (error).

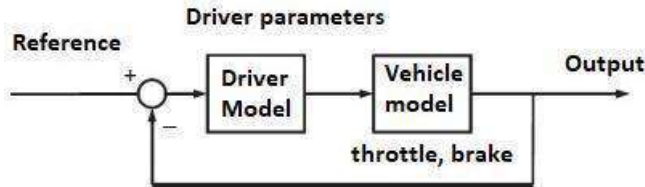


Fig 6: Vehicle driver system [[12, 5]

## 2.2 Driver Parameters

As stated before, the driver gain ( $K_1$ ,  $K_2$ ) and reaction time delay ( $t_{d1}$ ,  $t_{d2}$ ) are the specific driver parameters which are being investigated in this research using the driver model approach (see 2.1). These human specific driver parameters physically vary from person to person, according to human traits such as age, gender, the experience of driving. Fundamentally, the reaction time delay ( $t_d$ ) specifies the time needed to elaborate the information from the vehicle and the environment. Whereas, the driver gain ( $K_D$ ) specifies, how attentive the driver is while driving the vehicle. Furthermore, in the subsequent section it is explained how to identify these specific driver parameters ( $K_1$ ,  $K_2$ ,  $t_{d1}$  &  $t_{d2}$ ) using the driver model approach.

## III. TEST DESCRIPTION

As mentioned in section II, the testing has been performed earlier with the HAN Automotive Test Vehicle BMW 320i as shown in Fig. 7, and the data set was used for analysis. The testing is used for gathering the input variables as per the requirement of the project mentioned above. Since the project is only specific to longitudinal driver behavior based on that the input variables are selected.

The vehicle was mounted with a VBOX 3i measurement system, through which the required data was recorded. Moreover, the vehicle was also equipped with the CAN Bus cable through which all the data coming from the vehicle CAN have been recorded within the flashcard. The variables which were obtained from the VBOX measurement system are:

- Longitudinal acceleration,
- Vehicle velocity,
- Collision front time,

- Brake,
- Throttle.

Along with these data variables, there are few more variables which were present in the data set. VBOX manager uses CAN-Bus cable (RLVBCABO5C) for communicating the data. On the other hand, RS232 was another connector used for VBOX configuration and also the output for real-time GPS data. Furthermore, IMU (Inertial Measurement Unit) was also equipped in the vehicle which acts as external equipment on the vehicle on which external sensors can be mounted if required. The serial port (SER) is connected to IMU which allows the system to retrieve the data through VBOX setup. The vehicle was also well-found with other sensors such as Steering Interface Unit, Radar, GPS Antennas and Mobil-Eye to collect most of the data. As the project is concerned with the longitudinal driver behaviour, therefore the respective data has been recorded.



Fig 7: Test vehicle.

Fig. 8 represents the test route which was obtained using the GPS data (Longitude, Latitude), readings provided in the data set. Therefore, the test was conducted on this specified route to collect the required variables for further analysis.

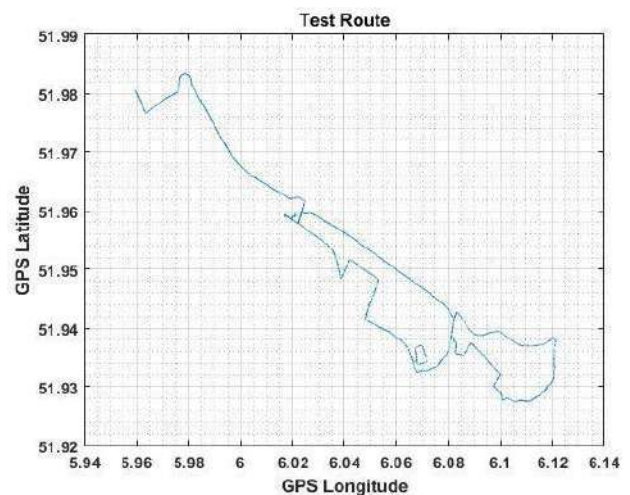


Fig 8: Test route.

**IV. APPROACH**

In this section, the approach towards the estimation of specific driver parameters is discussed. A general description of the approach was discussed earlier in section 2.1. As stated before, based on the driver model we need to define the input-output variables and identify the specific driver parameters respectively. Therefore, to build the mathematical model (transfer function) of a driver model, using the input-output variables (test data), system identification method is used.

Below in Fig. 9, represents the flow chart of the approach followed for estimating the specific driver parameters using the car following model. Thus, the flow chart is being elaborated in subsequent sections.

**4.1 Analysis of the Test Data**

This section describes the analysis/extraction of the test data. Since the gathered data has many readings therefore out of which arbitrarily data is selected and divided into a different number of sets based on the condition where one car is following the other car (car-following model). Therefore, the required data is categorized based on the driver model and used respectively for further steps.

Furthermore, the graphs (Fig. 11, 12) are plotted in which output variable (y) is shown as a function of input variable (x) for instance,  $y = f(x)$ . From these plots, one can understand how the output variable varies with respect to the input variable. Therefore, these two figures are plotted as an example, which changes according to the data set.

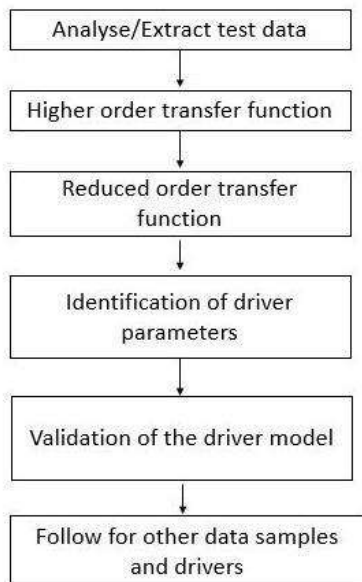


Fig 9: Flow chart.

From the graph shown below in Fig. 10, it is observed that the throttle output varies with the error in time to headway.

Initially, when the error in time to headway is 0.5 secs the throttle output increases from 52 to nearly 60 %. Afterwards, the error in time to headway decreases from 0.5 secs to 0 secs, thus the value of throttle output increases in slight slope and later on, the throttle output is constant as given in test data.

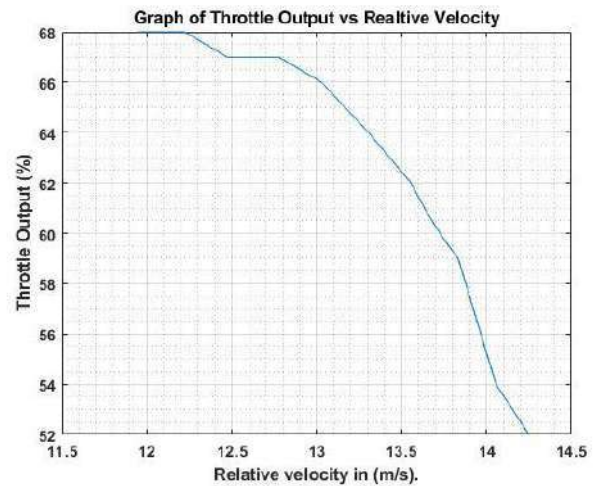


Fig 10: Graph representing Throttle vs Error in Time to Headway.

From the graph shown below in Fig. 11, illustrates throttle as a function of relative velocity. As the driver model is car following that means the cars are travelling in the same direction therefore, the relative velocity of the scenario is  $(V_F - V_L)$ . Moreover, this quantity can be positive or negative (i.e., direction) depending upon the respective car velocities.

Where;

Velocity of following car:  $V_F$  (m/s)

Velocity of leading car:  $V_L$  (m/s)

From the graph shown below in Fig. 11, it can be observed that the value of throttle decreases with an increase in the relative velocity. The graph is plotted for a particular data set and from this it can be stated that when the relative velocity is less, throttle output is more to maintain the desired headway distance.

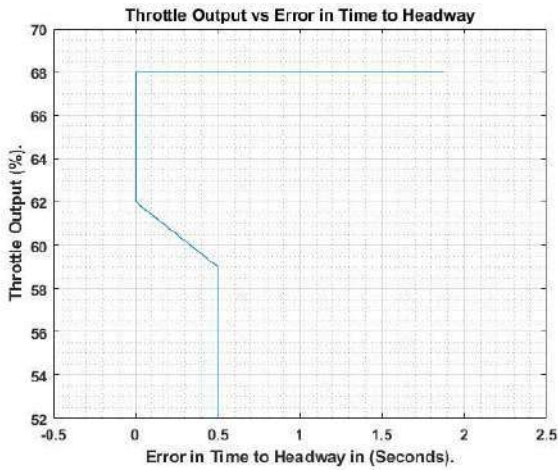


Fig 11: Graph representing Throttle vs Relative Velocity.

#### 4.2 Estimation of Higher Order Transfer Function

According to the flowchart (see Fig. 9), the second step is to estimate the higher order function based on the input-output variables of the driver model by using system identification toolbox. To do so, the data set is already analysed before according to the objective i.e., where the following car follows the leading vehicle. Before estimating the higher order transfer function, the input-output data is pre-processed to remove the trends and disturbance.

Furthermore, the higher order transfer function is obtained for the complete driver model (two different transfer functions) given above (see 2.1), considering it as a MISO system. Hence, the obtained higher order transfer function is selected based on the maximum percentage of fit (less than 90% fit is rejected). As given before, there are two different transfer functions for the driver model (depending upon the input variable). An example for both the higher order transfer functions is given below:

The higher order transfer function  $G_{(s)1}$ , which is obtained using the system identification toolbox, for a particular set of data is given below.

$$G(s)_1 = \frac{-3.559s^3 + 458.5s^2 + 8749s + 2.494e04}{s^4 + 4.926s^3 + 432.5s^2 + 617.5s + 1.076e04} \quad (2.4)$$

The mathematical description of the estimated transfer function model  $G_{(s)1}$  is given in equation 2.4. From the graph shown below in Fig. 12, it is observed that the test data sufficiently approximates the estimated transfer function model  $G_{(s)1}$  with POF 95.39.

In following steps, this estimated transfer function model  $G_{(s)1}$  is further reduced to the theoretical form (driver model)

to identify the specific driver parameters ( $K_1$  &  $t_{d1}$ ) corresponding to the human driver.

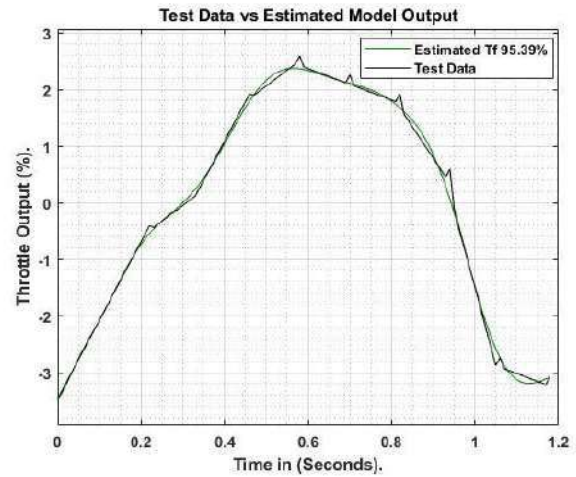


Fig 12: Response of test data vs estimated fit.

Similarly, the higher order transfer function  $G_{(s)2}$ , is obtained for a same set of data and is given below.

$$G(s)_2 = \frac{-4.292e08s^6 + 5.753e08s^5 - 5.67e11s^4 + 6.339e11s^3 - 2.182e14s^2 - 2.119e14s - 1.618e16}{s^{11} + 47.59s^{10} + 5411s^9 + 1.414e05s^8 + 8.355e06s^7 + 1.267e08s^6 + 4.518e09s^5 + 3.758e09s^4 + 8.245e11s^3 + 3.037e12s^2 + 3.331e12s + 1.565e13} \quad (2.5)$$

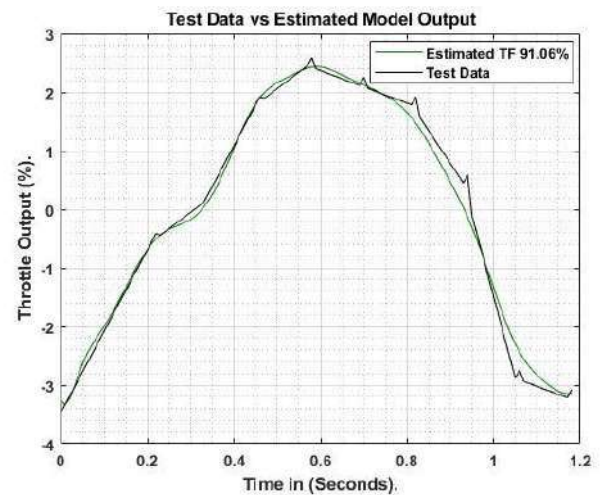


Fig 13: Response of test data vs estimated fit.

The mathematical description of the estimated transfer function model  $G_{(s)2}$  is given in equation 2.5. From the graph shown below in Fig. 13, it is observed that the test data sufficiently approximates the estimated transfer function model  $G_{(s)2}$  with POF 91.06. Furthermore, this estimated transfer function model  $G_{(s)2}$  is reduced to the theoretical



form (driver model) to identify the specific driver parameters ( $K_2$  &  $t_{d2}$ ) corresponding to the human driver.

4.3 Reduced Order Transfer Function

In this step, the obtained higher order transfer function for the specific set of data is approximated/converted to the lower order (FOPDT) using the process estimation method. The process/steps to estimate the specific driver parameters are presented in the flow chart as shown in Fig. 9. To start with this process, the initial step is to obtain the higher order transfer function according to the respective input-output variable of the driver model. As the complete driver model (see Fig. 5) is a multi-input single-output system (MISO) so, the higher order transfer function is found accordingly.

In addition to it, data object (in the time domain) is created by using the respective input variable with a specified sample time. Later on, this data object is used to reduce the higher order transfer function to the required form. As the test data was recorded at 100 Hz so, the sample time is used as 0.01 secs globally. Further, it is necessary to define the type of model based on the requirement such as PID

=> one pole with delay, PIUZ => one undamped pole with the extra numerator, etc. Therefore, with the help of this process estimation method, specific driver parameters were identified in this research using the driver model approach.

Now the higher order transfer function for  $G_{(s)1}$  &  $G_{(s)2}$  (see Eq 2.4 & 2.5) is reduced to the theoretical transfer function which represents the driver model, using the above method (process estimation). The general form of the theoretical transfer function is given below which represents the  $G_{(s)1}$  TF of the driver model.

$$G(s)_1 = \frac{K_1}{1 + \tau_{d1}s} \tag{2.6}$$

The above transfer function  $G_{(s)1}$  (Eq 2.6), represents the driver model for output as throttle (%) and input as the difference between the time to headway & desired time to headway, which exemplify the driver gain ( $K_1$ ) & reaction time delay ( $t_{d1}$ ). Similarly, the general form of the theoretical transfer function  $G_{(s)2}$  is given below.

$$G(s)_2 = \frac{K_2}{1 + \tau_{d2}s} \tag{2.7}$$

The transfer function  $G_{(s)2}$  (Eq 2.7), represents the driver model for output as throttle (%) and input as relative velocity, which exemplify the driver gain ( $K_2$ ) & reaction time delay ( $t_{d2}$ ).

4.4 Identification of Driver Parameters

In this section, specific driver parameters are identified based on the reduced order transfer function model and are elaborated further. The approach towards the estimation of the specific driver parameters is already described earlier

(see Fig. 9). Thus, here four different specific driver parameters ( $K_1, K_2, t_{d1}$  &  $t_{d2}$ ), will be identified using the driver model approach.

In the previous step, the reduction/approximation of higher order transfer function is discussed. So, by following the same method higher order transfer function (see Eq 2.4 & 2.5) is reduced to the following.

$$G(s)_1 = \frac{7.8095}{1 + 0.141s} \tag{2.8}$$

$$G(s)_2 = \frac{6.654}{1 + 0.144s} \tag{2.9}$$

From the transfer functions are given above the specific driver parameters are tabulated and discussed respectively. The table presents the driver gain ( $K_D$ ), reaction time delay ( $t_d$ ) for a particular driver. However, the variation in the specific driver parameters is due to the different input variables, since the location (position) of the vehicle is the same.

Table 1: Illustration of driver parameters for a driver.

Driver	Specific Driver Parameters
$K_1$	7.8095
$\tau_{d1}$	0.141
$K_2$	6.654
$\tau_{d2}$	0.144

As mentioned before, the driver gain interprets the attention of the driver while driving. Whereas, the reaction time delay interprets that the driver responds  $t_d$  seconds later than the error input. Therefore, based on the parameters obtained it can be stated that the driver has a positive gain in both the cases (means the driver is responding to the error input sufficiently). Whereas, reaction time delay  $t_{d1}$  is less than  $t_{d2}$  which means the driver is more attentive in the second case and is correcting the error input quickly.

4.5 Validation of the Driver Model

In this section, the validation of the driver model approach is discussed. To validate the approach, a comparison of higher order transfer function model is presented with the lower order transfer function model (driver model) as shown in Fig. 16. From the graph shown in Fig. 14, it is observed that the combined estimated transfer function model (MISO system) sufficiently approximates the test data with POF 96.36. Whereas, Fig. 15 illustrates the reduced transfer function model of the complete driver model with POF 89.76.

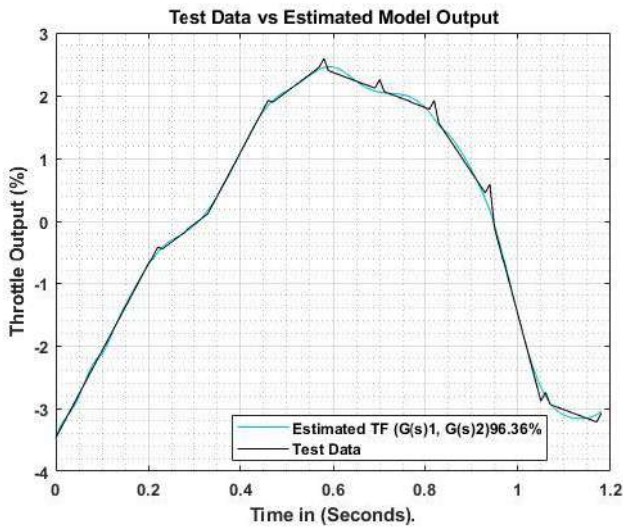


Fig 14: Response of estimated TF model.

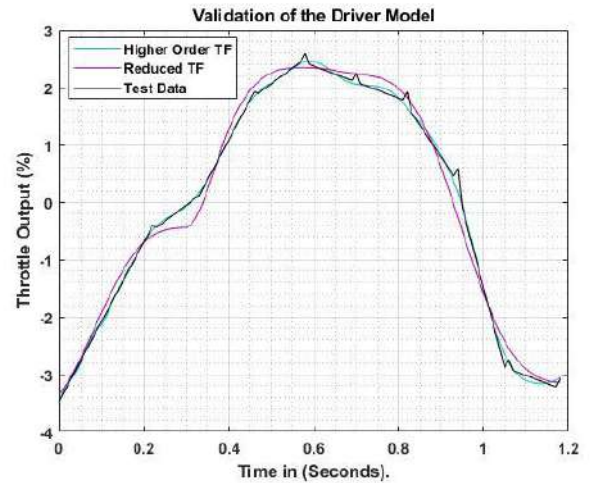


Fig 16: Validation of complete driver model as MISO system.

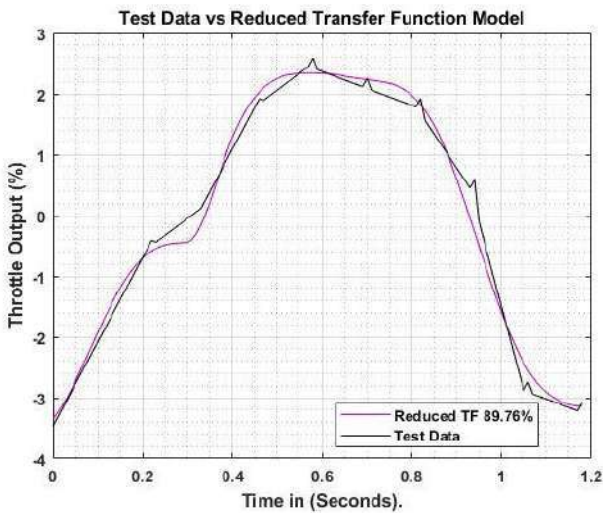


Fig 15: Response of reduced order TF model.

Fig. 16 shows the comparison of the driver model as a MISO system. The graph represents the test data, estimated driver model & reduced transfer function model. Overall, it can be stated that the various models (Higher order TF, Reduced Order TF), sufficiently approximates the input test data which is satisfactory. The reasons why the reduced transfer function model has less POF because every data sample of the higher order transfer function cannot be approximated to the required lower order transfer function model. However, the reduced transfer function model depicts a good relationship with the test data (POF as 89.76).

Therefore, the above comparisons were made for the same set of data to get an insight about the specific driver parameters corresponding to the human driver. Additionally, the driver model is compared with the test data and subsequently results are discussed in the next section.

## V. RESULTS

In this section, results are being discussed based on the defined approach towards the estimation of specific driver parameters.

To start with this section of results, three different sets of data were used for a human driver and were analysed respectively. As the driver model is a MISO system therefore, two different transfer functions ( $G_{(s)1}$ ,  $G_{(s)2}$ ) results into four different specific driver parameters ( $K_1$ ,  $K_2$ ,  $t_{d1}$  &  $t_{d2}$ ) which describes the human behavior. Although, the procedure for estimating the specific driver parameter is explained before (see IV).

Initially, one driver is taken into account and four different specific driver parameters are estimated by using the process estimation technique. Later on, these specific driver parameters are analysed and the conclusion is drawn based on the variations. However, the analysis of the four different specific driver parameters is done for the same location of the vehicle.

Thus, the variation in the specific driver parameters is due to the respective inputs being used for estimating the desired specific driver parameters as well as how the human driver is reacting to the deviations while driving. Moreover, these specific driver parameters describe the driver behavior which is unique and varies according to human traits such as age, gender, etc. Therefore, three different sets of

readings were considered for a human driver and conclusion are drawn respectively.

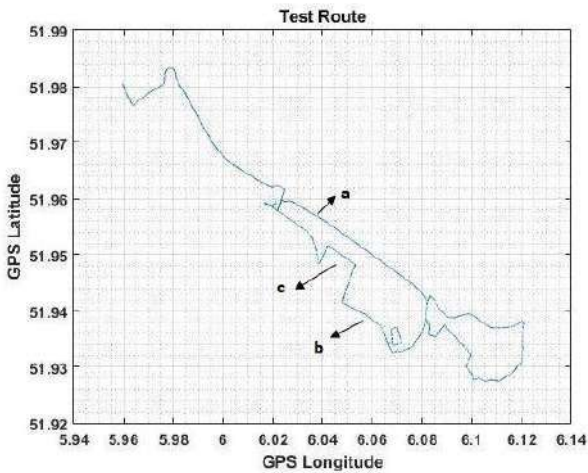


Fig 17: Representation of vehicle on the test route.

The graph is shown above in Fig. 17, represents the location of the vehicle for three different sets of readings taken into account. It can be observed from the graph that the vehicle is located at different locations that means the driver parameters are also being affected due to the road geometry.

Table 2: Representation of driver parameters for one driver.

S.No	Human Driver
1	$K_1 = 4.3671, \tau_{d1} = 0.685, K_2 = 5.6303, \tau_{d2} = 0.401$
2	$K_1 = 11.408, \tau_{d1} = 0.1857, K_2 = 4.867, \tau_{d2} = 0.0262$
3	$K_1 = 4.1461, \tau_{d1} = 0.734, K_2 = 4.3372, \tau_{d2} = 0.0362$

For this case, the four different specific driver parameter are estimated and listed below in Table 2. The analysis of the specific driver parameters is done based on the understanding and shown as follows.

Firstly, looking at the location of the vehicle on the test route (see Fig. 17), it is observed that the driver is on a completely straight road. Further, for case 1 the specific driver parameters ( $K_1, K_2, t_{d1}$  &  $t_{d2}$ ) are listed in Table 2. While observing the value of the driver gains ( $K_1, K_2$ ) it can be seen that the driver gain  $K_2$  is slightly more and correspondingly the reaction time delay ( $t_{d2}$ ) is less that is due the different input variable (relative velocity in the second case) as the location of the vehicle is same.

In other words, it can be stated that the driver is more attentive during the second case correcting the error input

quickly compared to the first case  $K_1$  (the driver showed reduced attention to the leading vehicle’s behavior). Thus, the response of the driver model as a MISO system is shown below in Fig. 18, it represents a comparison of test data, higher order TF model & reduced order TF model.

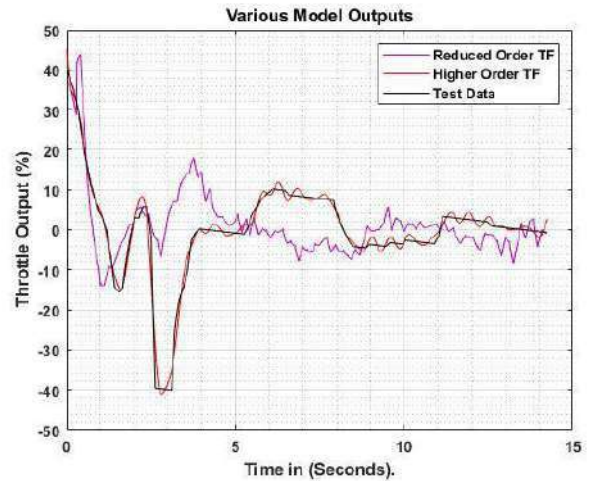


Fig 18: Response of the driver model (case 1).

Similarly for the second case 2, initially examining the location of the vehicle on the test route (see Fig. 17), it is observed that the driver is on a slightly curved path. In other words, the human driver is expected to be more attentive in this case compared to the first. The specific driver parameters ( $K_1, K_2, t_{d1}$  &  $t_{d2}$ ) are listed in Table 2. While observing the value of the driver gains ( $K_1, K_2$ ) it can be seen that the driver gain  $K_1$  and  $K_2$  are significantly more which is satisfactory and correspondingly the reaction time delays are less. Therefore, the human driver is more attentive during the curvy road and correcting the error input quickly so, the driver gains are comparatively higher. Below in Fig. 19, the response of the driver model as a MISO system is shown as well as it represents a comparison of test data, higher order TF model & reduced order TF model.

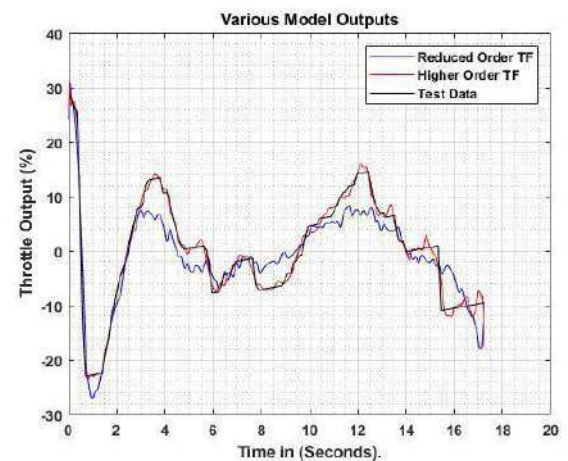


Fig 19: Response of the driver model (case 2).

Finally the last case 3, looking at the location of the vehicle on the test route (see Fig. 17), it is observed that the driver is on a completely straight road. The specific driver parameters ( $K_1$ ,  $K_2$ ,  $t_{d1}$  &  $t_{d2}$ ) are listed in Table 2. While observing the value of the driver gains ( $K_1$ ,  $K_2$ ) it can be seen that the driver gains  $K_1$  and  $K_2$  are almost similar because the driving conditions are the same. Moreover, a minor change in the driver gains can be observed which is due to the response time of the driver (more response time, less driver gain). Thus, in this case, the driver is correcting the error input sufficiently and the parameters are estimated respectively. The response of the driver model as a MISO system is shown below in Fig. 20, it represents a comparison of test data, higher order TF model & reduced order TF model.

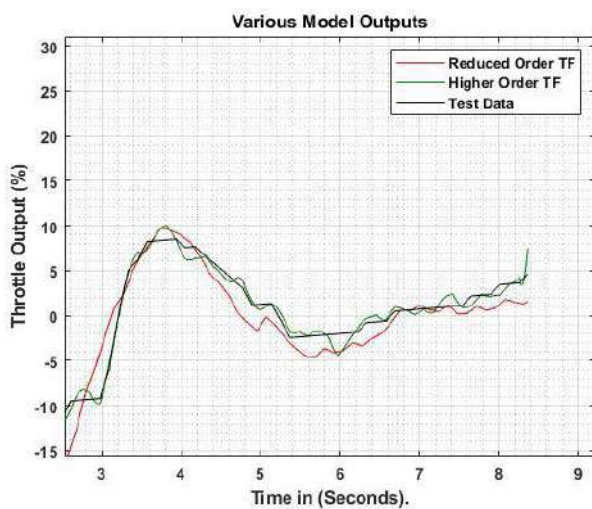


Fig 20: Response of the driver model (case 3).

Based on the analysis of the human driver it can be concluded that the driver is sufficiently correcting the error input i.e., attentive towards the driving. Therefore, the same approach can be followed for different human drivers. Additionally, a number of different human drivers can be compared to understand their behavior while driving in a specified test route.

## VI. CONCLUSIONS

In this section, the conclusion were made based on the work. Following are some conclusions:

- Based on the defined goal specific driver parameters were estimated using the driver model approach.
- The driver model was considered as the first order system with a dead time (FOPDT) based on the research.

- The process estimation method was found to be a useful method/tool for obtaining satisfactory results.
- An approach has been created to estimate the specific driver parameters using the real-time test data, in where the steps are documented in the paper.

Future research can be followed for the improvement of the results and research methodology. The driver model can be extended which also considers external factors and driver traits. Some of the works are given below:

- Compare number of different drivers to have a comprehensive understanding of this key topic.
- Investigate different driver models for longitudinal driving behavior.
- Investigate lateral driving behaviour such as steering wheel angle, yaw, etc.
- Incorporate number of specific driver parameters corresponding to the human driver to understand the human driver preferably.
- Investigate different approach towards the estimation of the specific driver parameters (extended the given above).

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# Effect of noise generated by pressure control valves in natural gas distribution networks

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**Keywords**— Aerodynamic noise, IEC Code  
60534-8-4, Matlab, distribution networks.

**Abstract** — Piped natural gas is commonly distributed by regional gas distribution companies, which have pipelines that are responsible for distributing this fluid to final consumers. These meshes operate with maximum pressures in the order of 40 bar (4.0 MPa), however, there are other pressure levels involved, either for operational or safety reasons. The reduction of these working pressures is carried out in devices commonly called pressure reducing stations (EPRs), which have interconnected valves and accessories that enable the referred pressure reductions as necessary. These stations, therefore, include pressure control valves or simply pressure regulators, which produce aerodynamic noise when in operation due to their physical configuration, local flow conditions and their own functionality. This paper presents a proposal for the determination of aerodynamic noise present in pressure regulating valves of piped natural gas distribution networks, based on the resulting mathematical formulation, predicted and recommended in IEC 60534-8-4 “Prediction of noise generated by hydrodynamic flow” code. From these assumptions a computational code was developed in Matlab environment that allows the operations engineer to simulate and evaluate the noise level present in a certain operating condition, favoring his decision making.

## I. INTRODUCTION

Piped natural gas is commonly distributed through regional gas distribution companies, which own pipelines that are responsible for localized transportation and distribution of this fluid to end consumers, whether industrial, commercial, or residential, among others. This distribution meshes operate at lower pressures than transmission pipelines, reaching maximum pressures in the order of 40 bar (4.0 MPa), although there are usually still other pressure levels involved along the meshes, either for reasons of concern operational or safety.

The reduction of these working pressures is performed in devices commonly referred to as pressure reducing stations (EPRs), which feature a set of interconnected valves and accessories that enable said pressure reductions

as required. These stations thus include pressure control valves of various types (axial and globe, for example), depending on the flow rates involved and the design configuration considered by each distribution company. Pressure control valves or simply pressure regulators produce aerodynamic noise when in operation due to their physical configuration, local flow conditions and their own functionality.

This noise has been, in many situations, a focal point of attention by regulatory and supervisory bodies, triggered in part by local legislation and current occupational health standards. Between 70 dBA and 85 dBA, the noise source becomes quite pronounced. However, long-term exposure to noise at this level is unlikely to damage human hearing. At 90 dBA and above, the noise source reaches a level

where sustained exposure can begin to damage human hearing. For these reasons, guidelines from the Occupational and Safety Hazard Administration (OSHA) mandate an 90 dBA limit for exposure of up to eight hours, as reproduced in “Table 01”.

*Table.1: OSHA Exposure time limits for various noise levels (Lipták, 2006)*

Duration of exposure (h)	Sound level (dBA)
8	90
4	95
2	100
1	105
0.5	110
0.25 or less	115 (max)

The present work presents, therefore, a revision corresponding to the mathematical formulation of the noise generated during the operation of pressure control valves (according to IEC 60534-8-4 “Prediction of noise generated by hydrodynamic flow”), as well as the development of a mathematical algorithm, developed in Matlab environment, which allows a quick assessment of this problem by the operations engineer responsible for a certain piped natural gas distribution network.

## II. MAJOR SOURCES OF NOISE

### 2.1 – Mechanical vibration

Mechanical vibration is caused by the response of internal components within a valve to turbulent flow through the valve. The noise generated by this type of vibration presents a worrying feature, as resonance problems may arise in the valve, a fact that would certainly cause fatigue failures in the internal parts of the valve. In practice, however, noise from mechanical vibration is infrequent in control valves. It is noteworthy that there is currently no reliable method for predicting noise generated by mechanical vibration in control valves.

Mechanical vibration is generally below 100 dBA.

### 2.2 – Hydrodynamic noise

The Liquid flow noise, cavitation noise, and flashing noise can be generated by the flow of a liquid through a valve and piping system. Of the three noise sources, cavitation is the most serious because noise produced in this manner can be a sign that damage is occurring at some point in the valve or piping.

Hydrodynamic noise caused by liquid turbulence, cavitation, or flashing is generally below 110 dBA.

### 2.3 – Aerodynamic noise

Aerodynamic noise is a direct result of the conversion of the mechanical energy of the flow into acoustic energy as the fluid passes through the valve restriction. The proportionality of conversion is called acoustical efficiency and is related to valve pressure ratio and design. The aerodynamic noise is the most important component of the acoustic problem of a control valve, since it is generated by the pressure waves produced by the fluid turbulence or by other fluid dynamic phenomena connected with supersonic waves. Aerodynamic noise can reach 150 dBA.

Aerodynamic noise prediction is based on the equations and nomenclature of the international standard for control valve noise prediction, IEC 60534-8-4.

## III. AERODYNAMIC NOISE PREDICTION

The conversion of static pressure to kinetic energy at the vena contracta in the control valve creates high-velocity jets which can be subsonic, sonic or even supersonic. Turbulence and sonic shock waves create a noise spectrum with a characteristic peak frequency.

The standard IEC 60534-8-3 - consists of a mix of thermodynamic and aerodynamic theory and empirical information. The design of the method allows a noise prediction for a valve based on the measurable geometry of the valve and the service conditions applied to the valve (Emerson, 2017).

The method describes two different noise sources that can contribute to the overall noise generated by the valve: trim noise and valve outlet noise. The trim noise is dependent on the type of trim and its geometric features. The valve outlet noise is dependent on the valve outlet area, valve outlet Mach number and any expander downstream of the valve.

The flow regime for a particular valve is determined from inlet pressure, downstream pressure, fluid physical data, and valve pressure recovery factor. Five flow regimes are defined as (ANSI/ISA, 1991):

Regime I - Subsonic

Regime II - Sonic with turbulent flow mixing (recompression)

Regime III - No recompression but with flow shear mechanism

Regime IV - Shock cell turbulent flow interaction

Regime V - Constant acoustical efficiency (maximum noise)

The control valve aerodynamic noise prediction flowchart illustrated in “Fig. 1” illustrates the steps to be considered by the designer.

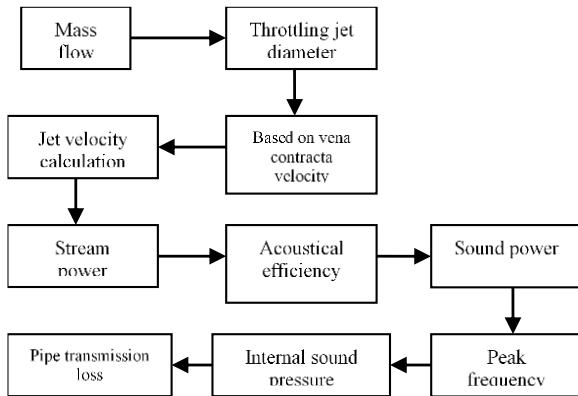


Fig. 1: Aerodynamic noise prediction flowchart on a control valve (Dresser, 2002 – adapted)

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### 3.1 – Throttling jet diameter

$$D_j = 4.6(10^{-3})F_d \sqrt{C_v F_L} \tag{1}$$

where  $C_v$  is the valve capacity and  $D_j$  is the equivalent jet diameter at the trim output, which is a typical constructive data for each trim type. It is directly proportional to the trim form factor  $F_d$ , whose typical values are easily found in the reference bibliographies (for a fully open circular flow orifice:  $F_d = 1$ ). The most important of these parameters is the recovery coefficient  $F_L$ , which, at subsonic flow conditions, represents the energy fraction wasted inside the valve.

### 3.2 Flow regime

Regime I – Subsonic – this deals with all flow conditions in which the pressure drop is less than or just equal to the pressure drop that would produce sonic flow at the vena contracta. The flow is therefore subsonic and there is isentropic recompression.

$$p_1 > p_2 \geq p_{2c} \tag{2}$$

where  $p_{2c}$  is the downstream pressure, corresponding to the threshold of criticality.

$$p_{2c} = p_1 - F_L^2(p_1 - p_{vcc}) \tag{3}$$

and

$$p_{vcc} = p_1 \left( \frac{2}{\gamma+1} \right)^{\frac{\gamma}{\gamma-1}} \tag{4}$$

where,  $p_{vcc}$  is absolute vena contracta pressure at critical flow conditions and  $\gamma$  is the ratio of specific heats.

Under this condition part of the mechanical energy existing in vena contracta is recovered as pressure energy

downstream the vena contracta. The remaining energy is wasted by turbulence, thus changing into heat and noise.

Regime II – Sonic with turbulent flow mixing (recompression) - flow is sonic at the vena contracta.

$$p_{2c} > p_2 \geq p_{vcc} \tag{5}$$

Under such a condition the fluid speed in vena contracta reaches the sound speed and supersonic impact waves arise downstream. A loud noise is given out, due to the fact that the sound velocity is reached and other complex aerodynamic disturbances are generated.

Regime III – No recompression but with flow shear mechanism - flow is sonic at the vena contracta but supersonic after, resulting in shock waves. There is no isentropic recompression.

$$p_{vcc} > p_2 \geq p_{2B} \tag{6}$$

where  $p_{2B}$  is the valve outlet absolute pressure at break point.

$$p_{2B} = \frac{p_1}{\alpha} \left( \frac{1}{\gamma} \right)^{\frac{\gamma}{\gamma-1}} \tag{7}$$

and  $\alpha$  is the recovery correction factor, given by:

$$\alpha = \frac{p_{vcc}}{p_{2c}} \tag{8}$$

Regime IV – Shock cell turbulent flow interaction - flow is sonic at the vena contracta but supersonic after. Shock interaction dominates noise. There is no isentropic recompression.

$$p_{2B} > p_2 \geq p_{2CE} \tag{9}$$

where  $p_{2CE}$  is the valve outlet absolute pressure where region of constant acoustical efficiency begins.

Regime V – Shock cell turbulent flow interaction - begins when downstream pressure drops to  $p_{2CE}$  and is where acoustical efficiency becomes constant.

$$p_{2CE} > p_2 \tag{10}$$

The velocity at the vena contracta is sonic. Further reductions in outlet pressure will not increase the noise level.



3.3 Jet velocity

$$U_{VC} = \sqrt{2 \left( \frac{\gamma}{\gamma-1} \right) \left[ 1 - \left( \frac{p_{VC}}{p_1} \right)^{\frac{\gamma-1}{\gamma}} \right] \frac{p_1}{\rho_1}} \tag{11}$$

where  $\rho_1$  is the upstream specific mass of gas.

3.4 Stream power

The noise of interest is generated by the valve in and downstream of the vena contracta. If the total power dissipated by throttling at the vena contracta can be calculated, then the fraction that is noise power can be determined. The noise from a freely expanding jet of air would be equal to some acoustical efficiency factor multiplied by the power of the jet  $W_m$ . Equation (12) is valid for Regime I while equation (13) is valid for Regime II, III, IV and V.

$$W_m = \frac{m_m (U_{VC})^2}{2} \text{ (watts)}, \tag{12}$$

$$W_m = \frac{m_m (c_{VCC})^2}{2} \text{ (watts)}, \tag{13}$$

where  $m_m$  is the mass flow and  $c_{VCC}$  is speed of sound in the vena contracta at critical flow conditions, given by:

$$c_{VCC} = \sqrt{\frac{\gamma R T_{VCC}}{M}}, \tag{14}$$

where R is the universal gas constant (8314 J/kmol.K), M is the molecular mass of gas and  $T_{VCC}$  is the vena contracta absolute temperature at critical flow conditions.

$$T_{VCC} = \frac{2T_1}{\gamma+1}, \tag{15}$$

3.5 Acoustical efficiency

The acoustic efficiency factor is not constant; it is approximately equal to  $1.10^{-4}$  at *Mach* 1 (Singleton, 1999). It considers the flow conditions applied through the valve to determine the noise generation mechanism in the valve. For the five defined regimes, there is dependence on the relationship of vena pressure contracts and downstream pressure. For each of these regimes, an acoustic efficiency is defined and calculated. This acoustic efficiency establishes the fraction of the total energy flow. When

designing a regulating valve, lower acoustic efficiency is desirable. For the 5 different regimes, consider:

$$\eta_1 = (10^{-4}) M_{VC}^{3.6} \tag{16}$$

$$\eta_2 = \eta_3 = (10^{-4}) M_j^{6.6 F_L^2} \tag{17}$$

$$\eta_4 = \eta_5 = (10^{-4}) \left( \frac{M_j^2}{2} \right) (\sqrt{2})^{6.6 F_L^2} \tag{18}$$

where  $M_{VC}$  is the *Mach* number at the vena contracta, and  $M_j$  is the freely expanded jet *Mach* number.

$$M_{VC} = \frac{U_{VC}}{c_{VC}} \tag{19}$$

$$M_j = \sqrt{\left( \frac{2}{\gamma-1} \right) \left[ \left( \frac{p_1}{\alpha p_2} \right)^{\frac{\gamma-1}{\gamma}} - 1 \right]} \tag{20}$$

3.6 Sound power

The sound power of a source is the total acoustic energy radiated by the source per unit of time. Given in watts.

$$W_{a1} = \eta_1 \eta_W W_m F_L^2 \tag{21}$$

$$W_{a2} = \eta_2 \eta_W W_{ms} \left( \frac{p_1 - p_2}{p_1 - p_{VCC}} \right) \tag{22}$$

$$W_{a3} = \eta_3 \eta_W W_{ms} \tag{23}$$

$$W_{a4} = \eta_4 \eta_W W_{ms} \tag{24}$$

$$W_{a5} = \eta_5 \eta_W W_{ms} \tag{25}$$

3.7 Peak frequency

Because the transmission loss through the pipe walls is affected by the frequency of the sound waves it is experiencing it necessary to calculate the peak frequency of the noise generated by the valve. The peak frequency is given in Hertz.

$$f_{p1} = \frac{0.2 U_{VC}}{D_j} \tag{26}$$

$$f_{p2} = f_{p3} = \frac{0.2M_j c_{VCC}}{D_j} \tag{27}$$

$$f_{p4} = f_{p5} = \frac{0.35c_{VCC}}{1.25D_j \sqrt{M_j^2 - 1}} \tag{28}$$

### 3.8 Internal sound pressure

Sound power and sound pressure are customarily expressed using the logarithmic scale known as the decibel scale. This scale relates the quantity logarithmically to some standard reference. Thus, the internal sound pressure level,  $L_{pi}$ , referenced to  $2 \times 10^{-5}$  Pa for sound pressure is calculated in dB from the following:

$$L_{pi} = 10 \log_{10} \left[ \frac{3.2(10^9)W_{\alpha} \rho_2 c_2}{D_i^2} \right] \tag{29}$$

where  $\rho_2$  is the gas density and  $c_2$  is the speed of sound, both at downstream conditions.  $D_i$  is the internal downstream pipe diameter.

$$\rho_2 = \rho_1 \left[ \frac{p_2}{p_1} \right] \tag{30}$$

$$c_2 = \sqrt{\frac{\gamma R T_2}{M}} \tag{31}$$

### 3.9 Pipe transmission loss

The pipe vibration mode, for the objective of this prediction method is determined from a simplified model, considering the noise source peak frequency and the natural frequencies from the tube. Natural tube frequencies are functions of tube diameter, wall thickness and density. Transmission loss according to the model used by the IEC standard is based on the work of Fagerlund and Chow (Singleton, 1999).

Ring frequency ( $f_r$ ) - as its name implies, this is the frequency at which a ring section of the pipe vibrates naturally circumferentially. Frequency that has a wavelength exactly equal to the circumference of the tube, favoring the production of a resonant stress around this circumference. Mathematically:

$$f_r = \frac{5000}{\pi D_i} \tag{32}$$

External coincidence frequency ( $f_g$ ) - the frequency at which the external acoustic wave speed is equal to the velocity of a flexural wave in the pipe wall. To the speeds of sound of 5000 m/s and 343 m/s, in the steel and in the air, respectively ( $t$  = pipe wall thickness):

$$f_g = \frac{12.973}{t} \tag{33}$$

First internal coincidence frequency ( $f_o$ ) - for frequencies higher than the cutoff frequency (wavelengths shorter) the acoustic pressure waves are able to travel in transverse direction rebounding off the pipe walls as they travel down the pipe. This frequency has the lowest natural frequency of the pipe wall. It produces a longitudinal flexural wave that spirals along the length of the pipe.

$$f_o = \left( \frac{f_r}{4} \right) \frac{c_2}{343} \tag{34}$$

Cutoff frequency ( $f_c$ ) - frequency that is significant because at the cutoff frequency and below, the wavelengths are too long to reflect off the internal pipe wall, making them incapable of vibrating the pipe.

$$f_c = \frac{0.586c_2}{D_i} \tag{35}$$

### 3.10 Transmission loss across the pipe wall

The only way in which noise within the downstream pipe can be experienced outside the pipe is through vibration of the pipe walls. If there is no vibration, no sound will be transmitted. Transmission loss through the pipe wall can be calculated by the equation:

$$TL = 10 \log_{10} \left( 7.6(10^{-7}) \left( \frac{c_2}{t f_p} \right)^2 \frac{G_x}{(415 G_y + 1)} \left( \frac{p_a}{p_s} \right) \right) \tag{36}$$

where  $G_x$  and  $G_y$  are the frequency factors (according to "Table 2"),  $p_a$  is the atmospheric pressure outside pipe and  $p_s$  is the standard atmospheric pressure.

Table.2: Frequency factors (Lipták, 2006 - adapted)

$f_p < f_o$	$f_p \geq f_o$
$G_x = \left(\frac{f_o}{f_r}\right)^{2/3} \left(\frac{f_p}{f_o}\right)^4$	$G_x = \left(\frac{f_p}{f_r}\right)^{2/3} \Rightarrow f_p < f_r$
$G_y = \frac{f_o}{f_g} \Rightarrow f_o < f_g$	$G_x = 1 \Rightarrow f_p \geq f_r$
$G_y = 1 \Rightarrow f_o \geq f_g$	$G_y = \frac{f_p}{f_g} \Rightarrow f_p < f_g$
	$G_y = 1 \Rightarrow f_p \geq f_g$

used in the reference calculations of the present work is reproduced in “Table 3”. These values are compatible with the average chemical composition of natural gas from Bolivia.

The computational routine developed has the main objective of facilitating the effective evaluations and the necessary calculations, by the operations engineer involved. From simplified input data it is possible to obtain answers about the predominant flow rate type as well as the calculation of the noise generated by the pressure regulating valve.

Table.3: Average chemical composition of the natural gas considered

Component	Mole fraction %	Molar mass kg/kmol
CH <sub>4</sub>	0.8901	16.043
C <sub>2</sub> H <sub>6</sub>	0.0593	30.069
C <sub>3</sub> H <sub>8</sub>	0.0185	44.096
n-C <sub>4</sub> H <sub>10</sub>	0.0042	58.123
i-C <sub>4</sub> H <sub>10</sub>	0.0031	58.123
n-C <sub>5</sub> H <sub>12</sub>	0.0011	72.151
i-C <sub>5</sub> H <sub>12</sub>	0.0008	72.151
n-C <sub>6</sub> H <sub>14</sub>	0.0008	86.178
N <sub>2</sub>	0.0067	28.013
CO <sub>2</sub>	0.0154	44.010
Natural gas	1.0000	18.374

3.11 Downstream pipe velocity correction factor

Downstream pipe velocity correction factor can be calculated by the equation:

$$L_g = 16 \log_{10} \left( \frac{1}{1-M_2} \right) \tag{37}$$

where  $M_2$  is the Mach number in downstream pipe.

$$M_2 = \frac{4m_{im}}{\pi D_i^2 \rho_2 c_2} \tag{38}$$

3.12 Weighted sound pressure level 1 m from pipe wall

The recognized observation point for noise predictions is 1 m downstream from the valve and 1m from the pipe wall (the pipeline is considered as a line source). The sound pressure level is adjusted, with a 5 dB correction to account for all frequency peaks, for this location by:

$$L_{pAe,1m} = 5 + L_{pi} + TL + L_g - 10 \log_{10} \left( \frac{D_i + 2r + 2}{D_i + 2r} \right) \tag{39}$$

IV. COMPUTATIONAL ROUTINE

The distributed natural gas comes from different production points, configuring variations in the average chemical composition of the gas, a condition that affects, even in small proportions, the calculations performed in the context of the present work. Thus, when proposing the corresponding computational routine, it was decided to allow the end user to adjust the partial percentages of the various independent components that might be part of the final chemical composition of the gas considered. As an example, the average chemical composition of the gas

In sequence, as an example, the result of a computational routine performed.

\*\*\*Program for Regulators Valves Noise Calculation - according International Standard IEC 60534-8-3\*\*\*

\*\*\*Preliminary data entry\*\*\*\*\*

Chemical composition of natural gas analyzed:

- CH<sub>4</sub>: 89.01
- C<sub>2</sub>H<sub>6</sub>: 5.93
- C<sub>3</sub>H<sub>8</sub>: 1.85
- nC<sub>4</sub>H<sub>10</sub>: 0.42
- iC<sub>4</sub>H<sub>10</sub>: 0.31
- nC<sub>5</sub>H<sub>12</sub>: 0.11
- iC<sub>5</sub>H<sub>12</sub>: 0.08
- nC<sub>6</sub>H<sub>14</sub>: 0.08
- O<sub>2</sub>: 0

$N_2$ : 0.67  
 $CO_2$ : 1.54  
 total percentage: 1.00  
 critical pressure of natural gas -  $P_C$  (MPa): 4.6316  
 critical temperature of natural gas -  $T_C$  (K): 204.4777  
 specific heat the constant pressure of natural gas -  $C_p$ : 2177.8405  
 specific heat at constant volume of natural gas -  $C_v$ : 1690.4426  
 ratio between specific heats of the natural gas -  $(C_p/C_v)$ : 1.2883  
 molecular mass of the natural gas -  $M$  (kg/kmol): 18.3745  
 enter the value of  $F_d$ : 0.31  
 enter the flow coefficient of the valve -  $C_v$ : 152  
 specific mass of the fluid upstream -  $\rho_1$  (kg/m<sup>3</sup>): 10.3642  
 jet diameter -  $D_j$  (m): 0.016679

\*\*\*Calculation of pressure and pressure rates\*\*\*\*\*

pressure of "vena contract" -  $P_{vc}$  (MPa): 1.5123  
 pressure of "vena contract" at critical flow conditions -  $P_{vcc}$  (MPa): 1.3696  
 downstream pressure at the critical pressure drop (sonic flow) -  $P_{2c}$  (MPa): 1.5844  
 break point pressure (shocks turbulent) -  $P_{2B}$  (MPa): 0.93234  
 factor correction: 0.86444  
 downstream pressure (where acoustical efficiency becomes constant) -  $P_{2ce}$  (MPa): 0.13146  
 Subsonic flow; isentropic recompression; turbulent shear noise - Regime I  
 gas velocity for the "vena contracta" region -  $U_{vc}$  (m/s): 478.8963  
 stream power for the "vena contracta" region -  $W_m$  (Watts): 1043504.4265  
 absolute temperature for the "vena contracta" region -  $T_{cv}$  (K): 476.3826  
 speed of sound for the "vena contracta" region -  $c_{vc}$  (m/s): 526.9724  
 Mach number for the "vena contracta" region -  $M_{vc}$ : 0.90877  
 acoustical efficiency factor -  $\eta_1$ :  $7.0865 \cdot 10^{-05}$   
 sound power -  $W_a$  (watts): 14.9745  
 peak frequency -  $f_p$  (Hz): 5742.604

\*\*\*Noise calculations\*\*\*\*\*

downstream mass density -  $\rho_2$  (kg/m<sup>3</sup>): 7.0477  
 downstream sonic velocity -  $c_2$  (m/s): 550.6218  
 Mach number at valve outlet -  $Mo$ : 0.28924  
 internal sound pressure level -  $L_{pi}$  (dB): 162.522  
 ring frequency -  $f_r$  (Hz): 15603.4258  
 external coincidence frequency -  $f_g$  (Hz): 2154.9834  
 first internal coincidence frequency -  $f_o$  (Hz): 6262.0888  
 cutoff frequency -  $f_c$  (Hz): 3163.376  
 frequency factor -  $G_x$ : 0.38479  
 frequency factor -  $G_y$ : 1  
 transmission loss across the pipe wall -  $TL$ : -51.4464  
 downstream pipe velocity correction factor -  $L_g$ : 2.3504  
 weighted sound pressure level 1m from pipe wall -  $L_{pAc\_1m}$ : 105.7454

## V. CONCLUSION

This paper presents a simplified and fast proposal for the determination of aerodynamic noise in pressure regulating valves used in piped natural gas distribution networks. Such a proposition, focused on the noise prediction standard IEC 60534-8-4, accomplished the difficult task of producing reasonably accurate answers to a more complex problem entirely by theoretical means. The possibility of variation in the input parameters of the problem also allows the professional involved, a more accurate comparative analysis from variable operational data.

It should also be noted that the IEC 60534-8-4 - Prediction of noise generated by hydrodynamic flow - is the most reliable method available at the moment.

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# Review of Construction and Demolition Waste management in Municipalities in Brazil and Portugal

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**Keywords**— Construction industry, CD&waste, Management, Reinsertion System, Sustainability.

**Abstract**— The intense urbanization resulting from the world populations growth makes the construction industry responsible for causing extensive environmental damage, given the vast generation of CD&waste. Considering the management of CD&waste in Brazil and Portugal, both have a deficit in preventing dynamic interactions between the factors inherent to the management. The implementation of management strategies drives the economy and social sustainability. Therefore, their order to analyze the CD&waste management methods in Brazil and Portugal, this study was based on a thorough investigation of the theme in a municipality in each country, considered as tourist areas. With the objective of filling in the gaps related to the legal and regulatory instruments created to national and word governmental control about CD&waste management. The methodology used for the development was a bibliographic review with primary and secondary data from technical and scientific sources, in addition to interviews with those responsible for the inspection, execution of works and environmental management of the municipalities from Santa Fé do Sul, Brazil and Covilhã, Portugal, followed by field research. As a result, it can be mentioned that the municipality of Santa Fé do Sul has greater control over the management of CD&waste, the reality of the country that has a more developed CD&waste reinsertion system compared to Portugal, which in the municipality of Covilhã, has no practices of CD&waste reusing management. The reinforcement of government supervision and the implementation of economic incentives are strategies for improvement and insertion in the concept of sustainable cities and circular economy.

## I. INTRODUCTION

Sustainability consists in the way natural goods and resources are used. Therefore, due to the notable natural catastrophes caused by nature's inability to absorb waste generated by human activities, it has become an extremely relevant topic in government meetings [21;23].

In New York (USA), from 25 to 27 September 2015, the United Nations General Assembly consolidated a document entitled Transforming our World: 2030 Agenda for sustainable development (UN, 2015), There are 17 goals that allow us to establish concrete and measurable goals towards a sustainable world. Among the 17

objectives is that of Sustainable Cities and Communities, 11th, which includes as one of its goals “to reduce the negative environmental impact per capita of cities, including paying special attention to air quality, municipal waste management and others, until 2030” [1].

It is identified that the generation of waste CD&waste is influenced by several factors which are: population, urbanization and GDP, that is, the CD&waste per capita income increases when construction activities and population increase.

In recent years, the world population growth rate has undergone sudden changes reaching a total of 1.2% annual growth, Brazil assumes 0.80% of this value and Portugal 0.19% [7]. As a result, the development of urbanization has taken on extraordinary proportions worldwide, reaching 55%, in Brazil about 85% of its population live in urban areas and across Europe this figure reaches 75%. These fees are responsible for the excessive generation of CD&waste requiring government entities to take management measures aimed at solving environmental problems and improving the current economy [26;28].

The circular economy is a model of production and consumption that involves sharing, reusing, repairing and recycling existing materials and products, extending their life cycle. In practice, the circular economy implies reducing waste to a minimum. When a product reaches the end of its life cycle, its materials are kept within the economy whenever possible and can be reused, that is, the reintegration of this waste in new construction, reducing the use of virgin materials and negative environmental impacts. Despite being a promising strategy for the construction industry, they estimate that the global economy is only about 6% circular [13].

The construction industry is considered the most damaging to the environment, due to the high level of extraction of natural resources and for generating about 35% of landfill waste worldwide [14]. The European Union member states have an estimated 870 million tonnes of CD&waste as a global annual production, Portugal is responsible for 1.5 thousand tons [3]. In Brazil, the average generation of construction and demolition waste was approximately 84 million m<sup>3</sup> each year [9].

CD&waste have a very heterogeneous constitution, that is, they can contain a wide variety of materials accumulated to these solid residues generated by different origins, the main ones being: new constructions, demolitions, renovations and extensions of existing constructions [24]. This type of waste has in its composition inert materials, of low risk, which cause environmental impacts due to the large volume generated and its illegal disposal in inappropriate places, causing

damage, not only to the landscape, but also to public health, compromising other sanitation areas, such as drainage, water and sewage [16].

The classification from CD&waste can be done according to their origin, chemical properties, or even recycling possibilities, among others [2]:

- Class A: Are reusable or recyclable waste as aggregates (Bricks, Blocks, Tiles, Cladding Plates.)
- Class B: These are recyclable waste for other purposes. (Plastics, Paper, Cardboard, Metals, Glass, Wood.)
- Class C: Waste for which no economically viable technologies or applications have been developed to enable recycling or recovery. (Plaster and Polyurethane Foam.)
- Class D: These are hazardous wastes from the construction process, those that are contaminated or harmful to health. (Paints, Solvents, Oils and others.)

The generation of CD&waste is related to four factors that are part of the day-to-day work: lack of management CD&waste at construction sites; unprepared labor in relation to waste management; material losses and waste due to poorly optimized designs; ineffective methods and excessive consumption of natural resources due to the oversized construction services [10]. And Increasing research efforts have been devoted to strategies and CD&waste management measures& waste, ranging from waste reduction, treatment and recycling until final disposal [26].

With the least possible impact CD&waste in the environment, must followed a hierarchical principle, optimizing its potential value as shown in Figure 1.

Leaving of this hierarchical principle it is possible to implement the Sustainable Construction in the civil construction industry, for being able to meet to the principles of sustainability disseminated worldwide, thus constituting a form of rational use of resources.

Both Brazil and Portugal are countries that, despite having a governing government policy on construction and demolition waste, have low rates of implementation of sustainable buildings. Due to the lack of social sustainability and lack of economic incentive to develop strategies for managing CD&waste [19].

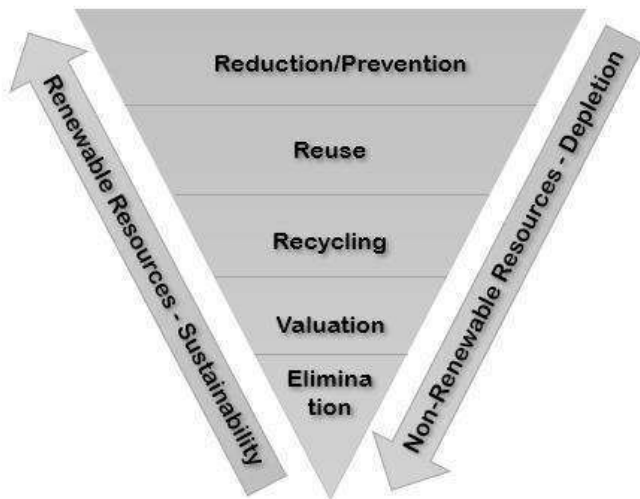


Fig.1: CDW management hierarchy [25].

The novelty of this study lies mainly in two aspects: The first is to reveal the current situation of CD&waste in Brazil and Portugal considering the strategies existing in two municipalities in the interior of both countries considered as tourist areas, a factor that causes the construction of buildings aimed at accommodating tourists in high seasons. And finally, to analyze the framing of case studies within the legislation of Agenda 30. When investigating this issue, this research can offer valuable information to allow countries like Brazil and Portugal having as reference one of their municipalities to obtain greater awareness and best practices of CD&waste.

The municipalities chosen for this study were Covilhã in Portugal and Santa Fé do Sul in Brazil were studied. Covilhã is a Portuguese city in the Castelo Branco district, with 51800 inhabitants subdivided into 21 parishes [20]. Santa Fé do Sul -SP, Brazil a Brazilian city in the interior of São Paulo with 32,563 inhabitants [13].

## II. MATERIALS AND METHODS

The research / research methodology followed was divided into two parts:

- National and international bibliographic research based on data such as the level of CD&waste production, conditions for the treatment and management of this waste, using the keywords Construction and Demolition Waste, Sustainability, Sustainable Cities, Recycling and Reuse.
- Field survey to know and analyze the management of construction and demolition waste in the two municipalities, through the

application of a questionnaire to professionals in the area of Civil Construction, Environment and licensed companies for the collect and treatment of CD&waste.

Three questionnaires were developed in order to develop the research and add specific knowledge about the two municipalities. The interview (semi-structured) was carried out face-to-face with three specialists from each municipality, totaling six interviewees, including 1 Civil Engineer responsible for municipal inspection, 1 Civil Engineer from a private company and 1 Manager of licensed operators for resection of workers. CD&waste. The interviews aimed to obtain information about the situation of the management of the CD&waste of each municipality, based on a questionnaire with open and closed questions, and primary and secondary data from technical and scientific sources such as books were used; theses and dissertations; standards and manuals; periodic magazines and internet sites.

Management of CD&waste and within the construction industry, when properly executed, it has the function of promoting sustainable buildings and the creation of a circular economy. The nature of the research questions that should be investigated was a vital factor in choosing the research method, reaching the main objective of the study to understand the current strategies for managing CD&waste practiced. Questionnaire surveys are considered the most appropriate way to study, with a known level of accuracy, the work and behavior of a large population [9].

### 2.1 INTERVIEW

The semi-structured interview, as a research method, is defined as a method of qualitative data collection, where the researcher asks the informants a series of planned but open questions [8]. The interviews were conducted through three questionnaires. Where the first was used for interviews with the specialists representing the municipal public bodies, which was elaborated through the justification of obtaining a perspective on the current situation of the management of CD&waste, with emphasis on the existence of government directives, reinsertion and reuse programs, difficulties and municipal potential in the implementation of management strategies. The second questionnaire was submitted to specialists from private construction companies in order to clarify the inspection activities carried out by the public agency regarding the management of CD&waste in private works and the management of works in progress. Finally, the last questionnaire was prepared for companies licensed for resection and treatment of CD&waste, which focused on the processing and classification of waste received,



quantity control, municipal and national legislative requirements on accountability in the management of waste. CD&waste.

The interviewed specialists are considered suitable for the research, as they have rich information in view of the vast experience in the labor market of the construction industry. Therefore, a response rate of 100% of the questions was obtained considering the data and information provided in these studies valid and adequate. Given that the response rate in interviews within the construction industry is low or almost nil [4].

The questions submitted to the specialists during the interviews are shown in Table 1. Therefore, the survey of responses made it possible to assess the current management of CD&waste before government legislation and policy imposed at municipal and national level. Finally, check the quantity control actions CD&waste generated, recycled and reinserted back to the local economy and the inspection activities related to the implementation of the measures imposed for the management of CD&waste. In view of these questions, it is possible to obtain results that meet the objectives desired in this study.

### III. RESULTS

The questionnaires were specific to investigate perceptions of construction and demolition waste management CD&waste in the construction industry. Justifying the importance of exemplifying two municipalities in order to demonstrate the way in which CD&waste before the national regulations of each country. With reference at information obtained through interviews through questionnaires, the results of the cases can be presented below.

#### 3.1 Santa Fé do Sul, Brazil

Municipality also known as "Tourist resort of Santa Fé do Sul" has a territorial area of 206.537 km<sup>2</sup> and an index of 22.7% of urban households on public roads with adequate urbanization [14]. The municipality is located in the state of São Paulo, which is considered the most industrialized state in Brazil with more than 44 million inhabitants producing about 20 million tons of CD&waste per year [18].

To achieve sustainability and preservation of the environment, measures to regulate the disposal of construction waste have become necessary. In this way, Brazil started to count on CONAMA Resolution No. 307 of 2002, which establishes guidelines, criteria and procedures for the management of CD&waste, and also with the Brazilian Federal Law 12,305 / 2010, which

instituted the National Solid Waste Policy (PNRS). Based on this national policy, the municipality created municipal legislation to implement strategies for managing CD&waste and appreciation of the current economy. As is the case with Complementary Law 92, of December 3, 2003, which specifies the master plan for sustainable development, to reduce the generation of waste and improve the quality of life. of the population [17].

For the control of the works of private companies, the Municipality of Santa Fé do Sul imposes the follow-up of Bill no.91/2014 that establishes segregation procedures in accordance with the regulation of the master plan for sustainable development, storage, transport and final disposal of solid waste from civil construction, as well as responsibilities and penalties, with the purpose of guiding and disciplining the disposal of waste of construction in the municipality, establishing responsibilities to the generators, and, in their omission, the application of penalties. In addition to the municipality having a Plan Basic Sanitation that defines an appropriate treatment for all types of waste generated in the municipality, according to Politic National Waste Solids (PNWS) 2010, there is revision in its application and gives an appropriate destination for CD&waste.

Brazil has a recycling rate for CD&waste generated annually by 20%, which is considered a high value and which presents rates of continuous increase [18]. Of the 5,564 Brazilian municipalities, 4,031 municipalities (72.44%) have management services for CD&waste, and only 392 municipalities (9.7%) have some form of processing CD&waste [14]. The municipality of Santa Fé do Sul fits the statistics, as it has its own landfill for recession, management and reinsertion of CD&waste. The city hall municipal is responsible for CD&waste public works, while private ones are left to the owner, who hires private companies to collect through containers. An average of 800 cont are collected sprains of 3m<sup>3</sup> / month, or be, 2,400m<sup>3</sup> / month which is equivalent to 28800 m<sup>3</sup> / year.

The materials collected in the buckets are very heterogeneous, requiring pre-sorting before processing to separate waste such as concrete, tiles and ceramic floors from other products not used in the process, such as wood, paper and plastic, which have other destinations. Due to this characteristic, it is not possible to use 100% of the collected rubble and, currently, up to 60% of this garbage can be used the equivalent of 17280 m<sup>3</sup> / year, depending on how the CD&waste is segregated at the source.

Instead of discarding the CD&waste in landfills, it has been considered a recycling material to replace natural aggregates, such as crushed rocks, reducing potential

environmental impacts and improving the potential economic value of recycling [6]. The CD&waste generated in the municipality are destined to the civil construction waste landfill located on the Santa Fé to Rubinéia highway, as shown in Figures 2 and 3, the waste being crushed and transformed into coarse, medium and small aggregates, which are reused on the sub-bases. urban roads and municipal highways, an activity that generates jobs and increases the circular economy of the municipality.



Fig.2: CD&waste crushed at the landfill in Santa Fé do Sul [ Own Authorship2020].



Fig.3: Crusher at CD&waste landfill in Santa Fé do Sul [ Own Authorship2020].

The CD&waste that arrive at the landfill and are packed, shown in the figure above, go through proper sorting first and are separated by their class; Class A: Are separated and follow the crushing phase. Are the focus of the current management strategy, which can be recycled almost in its entirety; Class B: As soon as it separates these residues are sent to another landfill specialized in treating this type of waste; Class C: The only purpose Currently, this type of waste can be given to a landfill, to be disposed of.; Class D: They suffer the same destination as class c waste.

The crushers work to reduce the granulometry of the residues present in the rubble of buildings and demolitions. In other words, they are capable of crushing concrete

blocks, ceramics, bricks, remains of piles, rocks, etc., transforming them into smaller and homogeneous particles and making them reusable [6].

### 3.2 Covilhã, Portugal

Named “Snow City”, the municipality of Covilhã belonging to Cova da Beira has a territorial area of 555.6 km<sup>2</sup>, including its 21 parishes. Located on the slope of Serra da Estrela, the municipality has an area for urban use of 2.19 ha / km<sup>2</sup>, its region is responsible for producing about 78000 tons of solid waste per year [15].

Regarding policy national governmental body in Portugal on the management of CD&waste, it is extremely important to clarify that in Portugal there are no municipal laws or decrees, only national ones that are valid equally throughout the country, and measures defined by the European Union are also adopted. In Portugal the first Decree regarding the management of construction waste is Decree-Law 488/85 of 25 November. In 2008 it is established in Portugal, by Decree-Law 46/2008, of 12 March. Based on these Decree-Laws in force throughout Portugal, the Municipal Regulation of Urbanization and Edification of Covilhã was created, in Article 77 Construction and Demolition Waste, which determines that the deposition of construction and demolition waste in containers intended for use is not permitted. deposition of solid urban waste, on roads or other public spaces [20;22].

In Covilhã, Public and Private Works Contracts have their execution projects monitored by the CD&waste Prevention and Management Plan, during the execution of the contract, the amount of waste produced is monitored by the Executing Entity (contracted),. The Public Contracts Code requires, for public works, the elaboration of a plan for the prevention and management of construction and demolition residues. The procedure for the preparation of the CD&waste Prevention and Management Plan and monitoring in the execution phase of the works until their conclusion, is implemented in all public works contracts in progress in the municipality of Covilhã.

CD&waste they are collected by licensed operators who provide containers for the deposit of the CD&waste and who subsequently collect and transport them, the collected waste is sent to licensed landfills according to the type of waste produced. Part of the CD&waste from contamination is reinstated in the works when that possibility exists. The reintegration of these residues back at works can contribute to the growth of the local economy through the practical implementation of the concepts and procedures of circular economy.

It is important stand out the municipality of Covilhã does not have its own landfill for receiving CD&waste,

however there are companies from other municipalities responsible for collecting and managing this waste, such as the private company Biscarroça located in the municipality of Fundão. Being operation for three years, responsible for collecting an average of 17 containers of 6m<sup>3</sup> of CD&waste month in the municipality of Covilhã, which is equivalent to 102 m<sup>3</sup> / month equivalent to 1224 m<sup>3</sup> / year, with only 5% of this value recycled. Value equivalent to 61 m<sup>3</sup> / year. The CD&waste collected were mostly reused in the company itself. Through use as a basis for the construction of a landfill in order to increase the resection capacity of CD&waste, as illustrated in the Figures 4 and 5. Waste that cannot be used with this function, such as cardboard, plasterboard, wood and others, receives another purpose.



Fig.4: Landfill of CD & waste company Biscarroça Fundão [Own Authorship 2020]

Above, the existing landfill for resection of CD&waste and class A waste is shown. The rest, such as classes B, C and D after sorting, are duly forwarded to other companies specialized in each class.



Fig.5: Landfill of CD&waste company Biscarroça Fundão [Own Authorship 2020]

Construction of the new landfill, being used only CD&waste class A for base composition. In cases of reinforced concrete, the materials are separated and the Class B service receives another purpose.

The company's future projects are based on finalizing the landfill using CD&waste and after that start recycling them, so that they enter as waste and leave as reusable materials. The recycled aggregate from construction and demolition waste has been used successfully as a granular pavement material, particularly in structural layers, such as pavement bases and sub-bases [6].

#### IV. DATA ANALYSIS AND DISCUSSION

The information revealed in this review would be valuable for understand current management practices for CD&waste both in Brazil and in Portugal, the above results are justified through the demonstration of two municipalities in potential urbanization as a portrait of the current situation of the management of CD&waste in each country.

The CD&waste requires effective government regulations, strategies, objectives, adequate recycling and disposal systems and compliance for its controls and minimization efforts [5]. Portugal has a regulatory policy for the control and management of CD&waste valid throughout the national territory that presents a better efficiency when compared with Brazil. That it also has national and regional legislation regarding CD&waste however, they do not exercise the function of controlling the CD&waste that are carried out in their municipalities. The lack of enforcement on compliance with legislation in both countries is extremely detrimental to a further improvement in construction and demolition waste management techniques.

As presented in the results of this case study in the case of Portugal, private companies must account for the amount of C&waste generated and their final disposition. However, inspection by the municipality to assess whether these companies are correctly carrying out what is required by law, without omissions or illegal activities. The same is true in the studied municipality of Brazil, where this lack of inspection becomes even more serious in view of the fact that there is no national control platform for the management of CD&waste as in Portugal. Because some contractors can illegally evict the CD&waste in unauthorized areas, in order to reduce your waste disposal costs, which seriously pollutes the environment [27].

It is identified that the generation of waste CD&waste is influenced by several factors, including population, urbanization and GDP. In the municipality of Santa Fé

there is a high rate of RCD production, but the existence of strategies for the management and reuse of this waste is satisfactorily effective, being able to recycle more than half of the waste. CD&waste arriving at the landfill. Boosting the creation of a circular economy within the municipality, serving as a mirror for Brazil's current situation, which is considerably good for recycling 20% of CD&waste generated per year across the national territory. The municipality of Covilhã also reflects the reality of the management of CD&waste in the country, considering the recycling rate extremely low at both municipal and national level. The simultaneous adoption of combined management strategies and measures can lead to better results in relation to the economic benefit and reduction of CD&waste [11].

A lesson learned from analyzing different economies is that the proper use of recycled materials can generate financial income and strong economic and environmental advantages with specialized recycling facilities. Otherwise, most waste CD&waste would go to disposal areas. In view of the concern with the environmental impact caused by the construction industry in today's society, there are some methods that can be implemented and applied so that CD&waste become a source of consolidation of sustainable cities, such as:

- Base and sub-base layers for paving;
- Manufacture of laying and coating mortars;
- Manufacturing of precast (blocks, curbs, among others);
- Drainage layers.
- Permeable floor.

Some studies were carried out with the objective of evaluating the technical, as well as economic, feasibility of using CD&waste in the production of construction materials such as concrete, mortars, concrete blocks, precast and paving elements [6].

The two Municipalities studied in this research have economic viability for the implementation of some of these projects mentioned as a way of reusing the CD&waste generated in the works. That if implemented in a national and rigorous way can contribute to the improvement of national data regarding construction and demolition waste.

## V. CONCLUSION

It can be confirmed that the irregular disposal of these CD&waste causes serious damage to the environment, and to public health. Both municipalities studied have waste management plans that include

construction and demolition waste. According to the data collected, it is possible to conclude that in the municipality of Covilhã there is a lack of adequate actions to control the collection and reverse flow of CD&waste, as they face great difficulties in giving an adequate destination to this waste. What contributes to this reality is the lack of infrastructure that creates minimum conditions for the correct management of the CD&waste.

The Municipality of Santa Fé do Sul has a control of the generated CD&waste and makes a good management of them having a plant treatment installed in the city that recycles this waste and consequently leverages their reinsertion in the necessary activities in the municipality.

Given the data presented in this study, it is possible to conclude initially that none of the Municipalities studied can be considered how "Sustainable Cities. It is necessary to seek better urban planning, implementation of inspection strategies and implementation of CD&waste. Just like its municipalities, each country has a management system for CD&waste extremely different, based on this study it is possible to define that even in the face of the difficulty in controlling the execution of management strategies throughout the national territory. Brazil is a country that produces a large amount of CD&waste which is supplied by the considerable percentage of reuse and reinsertion of this waste back into the labor market. Portugal is considerably smaller than Brazil, has methods of controlling the generation of CD&waste throughout the national territory, but has a low recycling rate for these residues. Improving legislation and public awareness on both sides can fill current gaps and make an additional contribution to improving management current of CD&waste.

However, in view of the case studies, it is concluded that it is of fundamental importance that governmental entities take more rigid measures in order to improve the management of CD&waste and encourage their recycling. The capacity of government entities to control the management of CD&waste in a municipality reflects the final result of the issue at the national level.

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## The relevance of text review for creative economy companies

## A relevância da revisão de texto para empresas de economia criativa

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**Keywords**— *Review, Text, Economy, Creative. Communication.*

**Abstract**— *This article seeks to present a theoretical discussion, with a bibliographic research, approach on the role of the functions performed by the proofreader within the communication sector of creative economy companies, among its various fields of activity. The proposal arose from the need to show your need due to the lack of knowledge of the activity and in relation to professionals who are daily replaced by other people with communication skills, but specialized in textual revision. More specifically, this study seeks to help reviewers about their skills and how to work within the creative segment, always looking for expansion and knowledge in social media.*

**Resumo**— *O presente artigo busca apresentar uma discussão teórica, com abordagem de pesquisas bibliográficas, sobre a importância das funções desempenhadas pelo revisor de texto dentro do setor de comunicação das empresas de economia criativa, entre seus diversos campos de atuação. A proposta surgiu da necessidade de mostrar sua relevância pela falta de conhecimento da atividade e em relação aos profissionais que são diariamente substituídos por outras pessoas com habilidade em comunicação, mas raramente especializadas em revisão textual. Mais especificamente, este estudo busca auxiliar os revisores sobre suas habilidades e como trabalhar dentro do segmento criativo, buscando sempre pela expansão e conhecimento nos meios sociais.*

**Palavras-chave**— *Revisão. Texto. Economia. Criativa. Comunicação.*

### I. INTRODUÇÃO

Os revisores de texto estão se aprimorando diariamente às novas tecnologias e ao novo comportamento humano para atender sua função típica, que é transmitir informações alinhadas entre autor e público, com a finalidade de se obter garantia nas produções textuais e um posicionamento aceitável diante de tantos concorrentes presentes na era da informação e da tecnologia.

Este trabalho busca destacar a relevância da revisão de texto para empresas de economia criativa, setor em constante expansão e composto por diferentes segmentos, que necessita da presença de revisores para aperfeiçoar textos antes de destiná-los ao público. Formado por quatro segmentos principais: consumos, mídia, cultura e tecnologia, exige desses profissionais a necessidade de participar ativamente do processo de criação dos textos e fortalecer sua relação com autor/criador da redação para compreender linguagens, o

serviço, a proposta real de comunicação para obter excelentes resultados.

Aqui também será tratado sobre os desafios da profissão e o quanto a revisão é fundamental para todas as empresas, independente do ramo e do mercado de atuação, mas destaca-se a economia criativa por ser um setor que abrange grande segmentação de produtos e serviços, com diferentes tipos de leitores, consumidores, com variações linguísticas e meios de comunicação específicos para se propagar uma mensagem.

Outro desafio é sobre a necessidade de valorizar os profissionais da área, bem como estabelecer estratégias para executar perfeitamente a profissão na prática. Da mesma forma, independentemente do tipo de redação a ser otimizada, seja publicitária, jornalística ou administrativa, revisar considera que o autor é dono da produção e que é imprescindível ao revisor o respeito às ideias do texto, alterando apenas o necessário para garantir a coesão e coerência, às normas gramaticais e sua fiel interpretação.

Apesar do restrito mercado nos cursos de especialização em revisão de texto, existem poucos profissionais realmente capacitados e por isso, são normalmente substituídos por graduados em letras ou por profissionais de comunicação que tenham afinidade com a escrita, mas não absoluta. Este trabalho se atenta também a outro obstáculo que é compreender que revisores necessitam de ferramentas para trabalhar, aprimorar suas habilidades e evitar autocorreções presentes nas modernas tecnologias, que costumam automatizar o trabalho e que nem sempre garante a real correção daquilo que se deseja passar ao leitor.

O trabalho a seguir busca comprovar o poder do profissional de revisão de texto no setor de economia criativa, destacando seu objetivo e demonstrando a importância desse processo para alavancar a credibilidade das marcas e desenvolver uma linguagem apropriada para se utilizar em diferentes meios de comunicação.

### **A economia criativa**

Diante do desenvolvimento econômico de países desenvolvidos e subdesenvolvidos, empresas de grande, médio e pequeno porte trabalham arduamente para se adaptarem às novas tecnologias, culturas e diferentes comportamentos que surgem na sociedade. A inovação tem sido a palavra-chave para que as empresas sobrevivam à alta concorrência, e é dentro desse contexto que surge a Economia Criativa, capaz de movimentar a globalização e gerar oportunidades em diferentes níveis.

A Economia Criativa é um setor econômico, que cresce constantemente, formado por um conjunto de negócios e indústrias do meio criativo. É um setor que exige capital intelectual e cultural para trabalhar a

criatividade e gerar valores, como: rendas, empregos, diversidade cultural, desenvolvimento humano e fortalecimento entre os mercados concorrentes.

Para um revisor de texto, que trabalha dentro desse modelo econômico, é importante conhecer o cliente: se é homem ou mulher, idade, o que buscam, onde estão e como se comunicar com esse público a fim de que essas empresas possam oferecer um produto ou serviço de valor ao mercado, mas, afinal, quais segmentos pertencem a esse modelo?

De acordo com o site Inteligência Corporativa Rockcontent, a Economia Criativa gira em torno de quatro campos que são: consumo, mídias, cultura e tecnologia. Cada campo possui sua atuação típica e que nele é possível a empresa determinar seu segmento:

1. *Consumo*: design, arquitetura, moda e publicidade;
2. *Mídias*: editorial e audiovisual;
3. *Cultura*: patrimônio e artes, música, artes cênicas e expressões culturais;
4. *Tecnologia*: pesquisa e desenvolvimento, biotecnologia e tecnologias da informação e comunicação (TIC).

As empresas que atuam dentro desses segmentos, seja de forma individual ou coletiva, fazendo tudo que uma empresa costuma produzir (gerar renda, emprego, lucros, entre outros) fazem parte da Economia Criativa. Por isso é tão importante conhecer bem o cliente e como se comunicar com ele, pois são alvos que possuem capacidade imaginativa e engenhosa, exigindo estratégias para prender atenção desses públicos.

É um mercado em que a empresa e consumidores pensam além do que é ensinado nas faculdades. São negócios que inovam e que conquistam cada vez mais espaço na sociedade e com desempenhos que crescem anualmente. Perante um cenário com tantas crises, a inovação e a criatividade impulsionam o mercado, e para isso acontecer, de maneira eficiente, é necessário investir em uma boa comunicação que alinhe o propósito da marca com a linguagem do público, aproveitando as oportunidades e tendências que surgem desses segmentos.

## **II. A REVISÃO DE TEXTO NAS EMPRESAS**

A revisão de texto é uma das etapas fundamentais antes de se publicar um trabalho. Por mais que seja considerado, muitas vezes, como complemento, a revisão trará inúmeros benefícios à marca e ao leitor e, por isso, essa etapa é tão essencial para qualquer empresa, principalmente às de Economia Criativa.

A revisão vai muito além da revisão linguístico-gramatical. É importante que o profissional domine a gramática da língua portuguesa, entre outras línguas, e sua morfologia, com o intuito de tornar o conteúdo bem redigido, claro e adequado ao gênero textual que se deseja alcançar, porém, é importante saber que o trabalho de um revisor não termina por aqui.

Revisar determina conhecimentos específicos, não apenas da língua em si, mas do tipo de público que consome a informação. É necessário que o profissional se informe e mantenha-se atualizado a respeito de como o público-alvo se comunica, quais os canais que eles utilizam para interagir, conhecer os tipos de linguagens de cada veículo de comunicação e adaptá-las para todas as mídias disponíveis.

A atividade de revisão requer conhecimentos gerais, bem como conhecimentos específicos sobre o determinado segmento empresarial em que o revisor atenderá. Para Malta (2000, p. 31), “só gramática não basta. Só redigir ou reescrever bem também não é tudo”. É preciso que revisor esteja bem informado e atualizado sobre tendências, a respeito dos temas da atualidade e sobre as tendências do segmento para a empresa contratante.

*[...] a revisão de textos constitui uma atividade relacionada com as questões de linguagem, presentes em várias instâncias da vida humana, como trabalhos escolares e acadêmicos, jornalísticos e publicitários, jurídicos e legislativos, em âmbito público, e ainda nas relações familiares, nas conversas entre amigos, nas conversas ao telefone, entre outras, em âmbito privado. (Oliveira 2010, p. 17)*

Revisar textos antes das empresas publicarem, independente do canal que será utilizado, trará benefícios à entidade e ao leitor. A empresa ganhará uma visibilidade melhor, o conteúdo e a marca terão mais credibilidade, passarão aos leitores o cuidado, a clareza e uma comunicação mais objetiva. Enquanto ao leitor, este terá mais confiança na fonte, interpretará a mensagem de acordo com o que é transmitido e sentirá mais conforto ao ler, pois a linguagem estará adaptada à realidade dele.

Mensagens mal escritas podem trazer danos irreparáveis à empresa, por isso a revisão não é um processo simples ou meramente complementar, mas de

extrema responsabilidade e importância para que haja qualidade e uma boa transmissão de ideias entre a marca e o consumidor da informação.

### III. CONHECER OS SEGMENTOS E PARA QUEM REVISARÁ

Atualmente, os meios de comunicação estão presentes em diversos canais e com um único objetivo: informar. Como a Economia Criativa trabalha com públicos e interesses diferentes: música, moda, artes, publicidade, tecnologia, cultura e entre outros, é fundamental conhecer o segmento, bem como a empresa que publicará determinada mensagem.

Para desenvolver uma mensagem é importante entender o passo-a-passo dos elementos do processo de comunicação e compreender que a revisão de texto é essencial, pois interfere em todas as seguintes fases:

1. *Emissor*: quem envia a mensagem, utilizando um canal e um código;
2. *Mensagem*: é o conteúdo enviado pelo emissor ao receptor;
3. *Receptor*: quem receberá a mensagem enviada;
4. *Canal*: meio utilizado pelo emissor para que a mensagem chegue ao seu destino.
5. *Código*: conjunto de sinais estruturados. É a linguagem em si.

Ao compreender o propósito do emissor (que é a empresa), revisar o conteúdo e fazer com que a mensagem seja interpretada em sua literalidade; conhecer o público que consumirá a informação e suas linguagens; saber desenvolver a mensagem em diferentes canais e meios de comunicação, a finalidade de estruturar o código entre o emissor e receptor será mais fácil e concreta.

*A familiaridade com a escrita se faz necessária até mesmo nos discursos orais [...] anúncios publicitários, notícias e reportagens [...], os quais, antes de serem expostos ao público, passam pelo processo de reescritura. Isso mostra a necessidade de o revisor estar atento às peculiaridades e singularidades dos diversos gêneros discursivos que circulam nas diferentes*



*atividades humanas.* (Oliveira 2010, p. 138)

*necessário [...].* (Sandmann 2001 p.12)

Como afirma Squarisi (2011, p. 143), “Quem liga o rádio ou a tevê espera ouvir uma língua correta. Correta não significa rebuscada ou exibida. Significa apenas o elementar respeito a flexões, concordâncias, regências, pronúncias.” Importante ressaltar que a mensagem da autora vai além do rádio e da televisão. A revisão serve para qualquer canal e mídia, seja digital, online ou impresso.

Ao concluir, o dizer da autora, Oliveira (2010, p. 138), aborda o significado de prestar atenção em todos os aspectos do texto, desde a sua estrutura até o sentido, pois a atividade humana é diversa e se encontra em diferentes formas. Na Economia Criativa percebemos fortemente que cada segmento possui sua linguagem, bem como cada empresa possui seu público, assim como cada público possui seu vocabulário, regionalismo e singularidades.

#### IV. A REVISÃO DE TEXTO NAS REDAÇÕES PUBLICITÁRIAS E JORNALÍSTICAS

A redação publicitária é uma técnica utilizada na comunicação para vender, chamar atenção, persuadir e divulgar ideias. É uma forma criativa de transmitir uma mensagem de maneira simples e eficiente, demandando do profissional conhecimentos e técnicas para emitir corretamente o que se deseja informar. O discurso publicitário pode ser encontrado em diferentes meios de comunicação de massa, como: televisão, rádio, jornais, revistas e internet. Além desses veículos, é possível encontrar em panfletos, postagens em redes sociais, mala direta, cartazes, outdoors e muito mais. Tantos meios com a única finalidade, disseminar informativo.

*Tendo conseguido que o comunicatário se ocupe com determinado texto, convencê-lo ou levá-lo em consequência à ação, possivelmente são tarefas ou desafios menores. Prender a atenção do leitor ou ouvinte parece ser a porfia maior. Por isso, a criatividade incansável do propagandista ou publicitário na busca incessante de meios estilísticos que façam com que o leitor ou ouvinte preste atenção ao seu texto, chocando-o até se for*

Diante de um trabalho que exige extensa criatividade, o trabalho do revisor de texto passa a ser fundamental para que a mensagem possa ser transmitida em sua totalidade e sem desvio de interpretação. Claro que o revisor não pode alterar o objetivo texto, principalmente os de redação publicitária que já são propositalmente curtos e subjetivos para brincar com a mente dos consumidores. Por isso, é importante sua participação na construção da campanha, no *brainstorm* e na criação gráfica para direcionar a finalidade da campanha ao caminho certo, sem faltar com a ética, moral e a responsabilidade que a publicidade traz consigo.

Mais uma vez o revisor, juntamente com o redator, necessita conhecer perfeitamente o público a quem se destina a comunicação, pois a publicidade possui características únicas e muitas vezes intencionais. Dependendo do intuito da mensagem, a publicidade admite erros ortográficos, linguagens coloquiais e até mesmo termos comuns à cultura, idade, classe social a qual o público-alvo pertença. Para Tamanaha, (2006, p.63) “[...] a internet capaz de desmoralizar a mídia conservadora e aumentar a expansão de forma direta e objetiva, aproximando as pessoas da marca com mais facilidade.”

Já o texto jornalístico, este está se aprimorando diariamente às novas tecnologias para atender suas funções de comunicação. Mesmo com as transformações culturais, existem características que não mudam no texto e uma delas é a coesão e a coerência das redações. Antes de qualquer produção textual é indispensável estruturar o texto e estabelecer uma sequência lógica de ideias para difundir uma comunicação clara e objetiva e, após esse processo, submeter ao revisor para alinhar a correção e o real entendimento do texto.

A revisão de texto no jornalismo é diferente do publicitário, pois o texto jornalístico demanda de uma redação mais detalhada, observando a correção, tipos de linguagem (objetiva e subjetiva), termos (denotativo e conotativo) e, principalmente, com ambiguidades. O redator e o revisor precisam estruturar o texto de forma clara e direta para que a comunicação não falhe e torne a mensagem frustrante, tanto para quem escreve, tanto para quem consome a informação.

*[...] há um pensamento errôneo de que o computador, com seus editores de textos, possa substituir o trabalho do revisor. E, nessas condições, é necessário o conhecimento*

*e o entendimento sobre a revisão de texto, que é uma atividade imprescindível à qualidade das notícias dos jornais. (Espíndola 2014, p.42)*

A importância da revisão de texto para jornais, revistas, rádios e portais de notícias é fundamental para preservar a credibilidade da marca perante leitores, ouvintes e internautas. Segundo Tamanhaha (2006, p.58) “exige instrução e renda para ser consumido. Destina-se a um público exigente, crítico, formador de opinião e, quase sempre, fiel ao veículo pela afinidade com sua postura editorial.”

O texto jornalístico possui inúmeras peculiaridades para ser escrito. Não são difíceis de se produzir, mas exige que o autor tenha conhecimentos sobre os assuntos que serão transcritos, tipo de público, características dos veículo e mídias, estruturação e no tipo de texto que será trabalhado, como:

1.*Notícias*: trabalham com matéria factual, sem a presença de opinião e possui caráter meramente informativo.

2.*Editorial*: caráter opinativo, possui textos curtos, simples e objetivos.

3.*Narrativa*: utiliza-se o passado subjetivo para ilustrar o texto, além de apresentar uma redação com diferentes tipos de discurso: direto, indireto e indireto livre, em casos excepcionais).

4.*crônicas*: são textos que relatam acontecimentos do cotidiano. Muito utilizado no jornalismo literário, praticado com recursos da literatura, com uso de metáforas e que auxiliam na hora de exemplificar uma situação de difícil compreensão. Nesse tipo de texto é necessário ter o cuidado com a superficialidade e figuras de linguagem (como a ironia e as metáforas).

Por se falar em tipos de textos, o jornalismo trabalha com diferentes tipos gêneros textuais que servem para atender, exclusivamente, grupos de leitores com determinadas características e, até mesmo, o padrão de desenvolvimento textual de algumas revistas, jornais, editoras de livros ou portais na internet. Entre os principais gêneros textuais estão:

1.*Opinativos*: como o próprio nome já introduz, emite a opinião de quem escreve. É o tipo de gênero que nem sempre é permitido, porém, quando liberado, o autor usa argumentos em cima de fatos reais, de maneira educada e objetiva, sobre determinado assunto, além de exigir muito conhecimento sobre o tema tratado. Muito utilizado em crônicas, editoriais e artigos.

2.*Informativos*: aqui o autor não pode fazer interferências pessoais como no opinativo, mas sua característica principal é informar de maneira clara e direta, prezando pela simplicidade e objetividade. Esse tipo de gênero é bastante utilizado para desenvolver notas, notícias e releases.

3.*Interpretativo*: utiliza-se de uma linguagem descritiva e detalhista. Foca nos personagens, nas suas falas e muitas vezes no cenário. É uma linguagem importantíssima, pois gera mais conteúdo e explicação para quem vai consumir a informação. Muito utilizada em reportagens.

O revisor precisa estar atento, também, à pirâmide invertida (do assunto mais importante ao mais simples), clássica para vender o texto e a ideia, mas ainda assim, carece de cuidados para não transformar o título e o lide em linguagem sensacionalistas e frustrar o público após a leitura de uma redação superficial. Oferecer valor ao texto e ao veículo é papel de jornalistas, redatores e revisores que tem como intuito, trazer bons frutos tanto para quem escreve, quanto para quem consumirá a informação.

O jornalismo é uma das profissões mais importantes para tratar da liberdade de expressão e noticiar acontecimentos. Os veículos utilizados pelo jornalismo são importantes pois atingem grande número de pessoas em um curto período de tempo, conhecidos também como veículos de comunicação de massa, fundamentais para formação de opinião pública e conhecimento sobre acontecimentos. Desta forma, por abranger grandes proporções de leitores, ouvintes e telespectadores, o jornalismo exige a presença do revisor para qualificar o material. Para Espíndola (2014, p.19) “é importante ressaltar que falas de jornalistas, apresentadores de telejornais e demais profissionais que trabalham com televisão e rádio originam-se de textos elaborados por escrito, e também necessitam de revisão.”

## V. OS PRINCIPAIS CUIDADOS AO CORRIGIR TEXTOS

Os meios de comunicação são instrumentos que ajudam a transmitir informações, o que não significa apenas o envio de uma mensagem ao destinatário, e sim, desenvolver todo o processo de comunicação. Para Sampaio (1999, p.82) “[...] é qualquer meio de comunicação que leve uma mensagem publicitária do anunciante aos consumidores, seja um simples boletim de associação de amigos de bairro até uma rede nacional de televisão.”

O revisor possui habilidades não só de escrita, mas principalmente de interpretação sobre o assunto debatido, com capacidade de propor uma

correção direta e objetiva. Para isso, é necessário que o revisor estabeleça limites perante as modificações, como: evitar utilizar termos de sua preferência, ajustes caprichados que exprime pensamentos próprios, correções equivocadas por não conhecer vocábulos específicos de uma cultura e trocas desnecessárias de palavras ou expressões para não prejudicar a originalidade do texto. “[...] Às vezes o revisor também comete erros. E não só por um cochilo, quando não percebe um erro já existente, mas, o que é pior, por provocar um erro novo” (PINTO, 1993, p. 128)

Além do poder linguístico que o revisor possui, é necessário que o profissional atue com responsabilidade e ética, por isso é imprescindível sua participação nas fases de criação do texto para compreender melhor o conteúdo a ser desenvolvido. Não apenas para corrigir, o revisor também tem o poder de orientar o texto para que o autor saiba desenvolver os argumentos e escritas adequadas, acelerando o processo de criação e reformulação ao final do processo. De acordo com Coelho Neto (2008, p.107) “Os poderes do revisor de sugerir ou intervir no texto – e até na diagramação –, apontando construções gramaticais mal concebidas, falta de clareza, de correção etc., vão variar sempre de acordo com cada cliente e cada situação.”

*Um revisor não preparado e/ou inexperiente corre o risco de [...] de forma a alterar a ideia e a intenção que o autor/escritor pretende transmitir a seu leitor. O ato mais grave é intervir no estilo próprio do autor. Portanto, para que deslizes desse tipo não aconteçam, o revisor precisa estar preparado e ciente dos procedimentos apropriados a sua atividade. (Espíndola 2014, p.42)*

Ao concluir, o revisor precisa ter o autoconhecimento e autocontrole para exercer sua função, preservando boas condutas e a originalidade do trabalho e ofício do autor, sem prejudicar a ideia proposta ou características da comunicação com público-alvo.

## VI. AS FERRAMENTAS UTILIZADAS PELOS REVISORES

É comum que o ser humano cometa erros e falhas, e por mais que a profissão de revisor evite a todo custo qualquer tipo de deslize, é uma profissão em constante aprendizado. É por esse motivo que o revisor precisa ter

treinamento, qualificação, conhecimento sobre o segmento em que trabalha e, claro, adotar ferramentas que auxiliarão na correção do texto.

Antes de ser somente uma profissão, ser revisor é mais do que isso. Revisar textos é um estilo de vida em que o profissional precisa se atualizar constantemente, ler diariamente e adquirir uma intimidade, não só com o texto, mas com a empresa em que trabalha e tendências linguísticas, também.

Atualizar-se sempre, isso significa não só estar por dentro de eventuais mudanças na gramática e em acentuação ou ortografia, mas também observar novos usos de palavras já existentes, os neologismos, as palavras que não possuem tradução ou aportuguesamento, novas locuções etc. (MALTA, 2000, p. 28)

Para adotar esse estilo de vida, o revisor precisa separar materiais adequados para analisar textos, e com ele aprender junto. Entre eles estão:

1. *Gramáticas*: não se pode excluir as gramáticas normativas e descritivas nos trabalhos de revisão. Por mais exótico que seja a linguagem utilizada pela empresa e a cultura linguística de um determinado público-alvo, a gramática é essencial para manter a coesão e coerência das redações, partindo do princípio de que a revisão não é apenas ortográfica, mas também interpretativa.
2. *Dicionários*: é impossível conhecer todas as palavras da língua portuguesa, por mais que a pessoa seja brasileira nata. O revisor também não tem essa obrigação, por mais que tenha a obrigação de se atualizar e aprender novos termos constantemente. O dicionário é indispensável e é necessário tê-lo à disposição para garantir o enriquecimento do texto, de sua estrutura e tirar dúvidas que possam surgir ao longo do desenvolvimento.
3. *Manuais de redação*: os manuais atuam como guias resumidos para obter uma redação objetiva e desenvolvida em tempo reduzido. É um material importante pois cada veículo de comunicação possui sua própria forma de escrever e de divulgar o conteúdo. Normalmente servem de modelo, mas tendem a complementar o material de consulta.
4. *Internet*: é o recurso mais utilizado por conta da facilidade, rapidez e disponibilidade, mas assim como os autocorretores, é imprescindível o cuidado em sua utilização. A internet ajudará caso o revisor tenha contato com sites especializados, dicionários online, obras de

confiança. É importante também verificar a procedência do texto e suas fontes para evitar plágios e processos jurídicos por ausência de créditos ou caso o autor tenha conhecimentos muito específicos sobre o segmento dentro do setor de Economia Criativa que possa atrapalhar ou criar obstáculos de entendimento durante a análise textual.

Sobre esse último tópico, Oliveira defende:

*Particularmente no cotidiano profissional, a interação entre autor e revisor é fundamental para subsidiar o trabalho de revisão. A troca de conhecimento que ocorre nesse processo exerce o importante papel de afastar os obstáculos que se interpõem a uma análise linguística bem-sucedida, o que implica trabalhar a linguagem nas situações discursivas as mais diversas. (Oliveira 2010, p. 47)*

Por fim, cada revisor e cada segmento de Economia Criativa trabalha de forma específica e é essencial que o revisor separe as ferramentas mais adequadas para analisar os textos de maneira objetiva e eficiente. Cabe ao revisor, também, estabelecer junto com a empresa, sua forma de trabalhar, verificando a disponibilidade de manuais e guias para evitar “choque de ideias” e até mesmo de linguagem, facilitando o desenvolvimento do texto e de uma comunicação fluida.

## VII. OS DESAFIOS DO REVISOR NA ECONOMIA CRIATIVA

Enquanto houver mídia, haverá revisores de texto trabalhando na qualidade e na credibilidade dos materiais publicados. Atualmente, existem revisores atuando em editoras de livros, revistas, jornais, sites de notícias, blog, materiais publicitários e até mesmo em televisões e rádios, que necessitam de textos prontos para transmitir informações. A revisão é uma área ainda em expansão no mercado e, a cada dia, as empresas percebem sua importância no processo de comunicação, junto com a necessidade de se contratar um profissional qualificado para analisar tecnicamente os textos.

Para os revisores, faz parte do desafio encontrar oportunidades. Apesar da expansão no mercado, não são todas as empresas que investem nesses profissionais, passando o papel de revisor para outras pessoas sem

especialização na área. Grandes empresas de veículos de comunicação são exemplos de Economia Criativa que incluem o revisor como parte da equipe, porém, outros segmentos, como pequenas e médias agências de publicidade, ainda estão em processo para contratar profissionais da categoria, passando muitas vezes essa função a um jornalista sem pós-graduação ou um publicitário com conhecimentos em social media, mas ambos raramente com especialização em revisão textual.

Outro desafio é justamente fazer com que as empresas do meio criativo entendam que revisar texto não é gasto ou perda de tempo, e sim um investimento necessário para empresas de todos os portes e segmentos. Para Cavalcante, vai além da correção de texto.

*[...] o principal da profissão é justamente a riqueza e a possibilidade de fazer pesquisas. É por meio dela que se consegue analisar a linguagem, percebendo-se se ela está adequada ao objetivo e à mensagem do autor, assim como por meio dela é possível verificar o seu sentido. (CAVALCANTE 2011, p. 55).*

Para finalizar, outro desafio é compreender que o revisor não trabalha sozinho e sim em dupla ou em equipe. Não necessariamente com outro revisor, mas com o autor ou editor do texto. Fazer parte do processo de criação do texto, entender a mensagem que o criador deseja passar ao público é fundamental para que a transmissão da mensagem cumpra com a sua finalidade.

## VIII. COMENTÁRIOS FINAIS

Após demonstrar as fundamentações teóricas do objeto de estudo, com o objetivo de destacar a relevância da revisão de texto para empresas de Economia Criativa, é possível perceber a necessidade de valorizar os profissionais da área e estabelecer estratégias para executar perfeitamente a profissão na prática.

Foi possível compreender que o mercado de economia, um mercado em constante expansão e composto por diferentes segmentos necessita da presença de revisores para alinhar seus textos antes de destiná-los ao público, entre esses segmentos estão: consumos, mídia, cultura e tecnologia, que exigem desses profissionais a necessidade de participar ativamente do processo de criação e de sua permanente relação com autor/criador da redação para compreender as linguagens, o serviço, a proposta real de comunicação, com a finalidade de obter excelentes resultados.

Também foi possível constatar que a revisão de texto é fundamental para todas as empresas, independente do ramo e do mercado de atuação, mas destaca-se a Economia Criativa por ser um setor que abrange grande segmentação de produtos e serviços, logo, diferentes tipos de público, com variações linguísticas e meios distintos de comunicação para se propagar uma mensagem.

Com esse trabalho foi possível perceber, também, a necessidade que o revisor necessita de conhecer bem o nicho para o qual trabalha e estabelecer tarefas conjuntas com autor/criador para compreender a linguagem específica do mercado e como utilizar isso a favor da comunicação, estabelecendo vínculo entre emissor, mensagem, receptor, canal e código.

Da mesma forma, independentemente do tipo de redação a ser otimizada, seja publicitária, jornalística ou administrativa, considerar que o autor do texto é dono da produção, compreendendo que o revisor precisa respeitar as ideias do texto, seu gênero e sua estrutura textual, alterando apenas o necessário para garantir a coesão e coerência às normas gramaticais, junto com sua fiel interpretação para que a mensagem passe exatamente o que o autor deseja, evitando ambiguidades e demais falhas de comunicação.

Concluindo, este artigo comprovou o poder da revisão ao demonstrar a importância desses profissionais para dar credibilidade às marcas e desenvolver uma linguagem apropriada nos diferentes meios de comunicação, já que cada meio possui suas peculiaridades e demanda eficiente abordagem de comunicação. Foi perceptível os desafios que essa profissão propõe aos trabalhadores da área com a finalidade de que a revisão seja valorizada nas empresas de Economia Criativa, bem como o seu processo de revisão que demanda conhecimento, estudos, dedicação diária a novos aprendizados.

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# Association between degree of pulmonary impairment due to ground-glass opacification and clinical and laboratory findings in patients with COVID-19 at hospital admission: a cross-sectional study

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**Keywords**— *Coronavirus disease 2019, Ground-Glass opacities; Tomography, X-Ray Computed, Biomarkers, Quantitative analysis, Severity.*

**Abstract**— *Objective: To investigate the clinical and laboratory parameters correlated with increased pulmonary involvement of ground-glass opacity in patients with coronavirus disease 2019 (COVID-19) at the time of hospital admission.*

*Methods: This is a cross-sectional study with a total of 74 patients with COVID-19 and ground-glass opacification (GGO) visualized on chest computed tomography. Physical examinations, laboratory tests and computed tomography of the chest were performed during the first 2 days of hospitalization. Patients were divided into two groups: GGO ≤ 50% (n = 43) and GGO > 50% (n = 31). All parameters were evaluated for comparison and association between groups.*

*Results: Patients with higher GGO were more commonly male (p = 0.035), with lower saturation (p = 0.038), with more dyspnea (p = 0.020), with a positive correlation with all these parameters (p < 0.05). Lactic dehydrogenase (LDH) (p < 0.001), ferritin (p = 0.001), C-reactive protein (CRP) (p < 0.001), white blood cell count (p = 0.006), neutrophil count (p = 0.003), percentage of neutrophils (p = 0.025) were higher in the GGO group > 50% and the percentage of lymphocytes was lower (p = 0.014). All laboratory parameters increased in the GGO group > 50% showed correlation (p < 0.05).*

*Conclusion: The factors associated with the more diffuse presentation of ground-glass opacification were: male gender, less saturation, dyspnea, greater DHL, greater ferritin, greater PCR, greater WBC count, greater count and percentage of neutrophils and lower percentage of lymphocytes.*

## I. INTRODUCTION

Chest tomography (CT) has proved to be important for determining the medical conduct of patients admitted to the health service with the disease caused by the SARS-CoV-2 virus (COVID-19), assisting to make decisions about hospitalization of patients in wards or in intensive care units, as well as to choose the most appropriate therapeutic intervention<sup>1</sup>. Ground-glass opacity (GGO), an increase in the attenuation coefficient of parenchyma, with preservation of bronchovascular markings, is the most common CT finding of patients with COVID-19. This type of lesion has a pooled prevalence between 64.6% (95% CI: 57.6-71.4)<sup>2</sup> and 83.31% (95% CI: 69.43-93.35)<sup>3</sup>, varying according to the meta-analysis.

GGO can be present in any phase of COVID-19<sup>4,5</sup>, but it is more common in the pre-symptomatic and initial symptomatic phase with isolated presentation. The progression of the disease can entail an increase in the number and size of GGO and an association with other radiological findings<sup>4</sup>. GGO may be related to a worse outcome when there is pulmonary impairment greater than 40%<sup>6</sup> or when it is associated with other radiographic findings of diffuse pulmonary impairment at the time of hospital admission<sup>7</sup>. Therefore, the CT quantification of pneumonia lesions in the first days of hospitalization makes it possible to predict the progression to severe disease<sup>8</sup>.

An aspect that draws attention in studies of GGO prevalence consists of the different clinical and laboratory manifestations in similar contexts<sup>2,3,9</sup>. Therefore, the aim of this paper is to investigate the clinical and laboratory parameters correlated with increased pulmonary involvement of ground-glass opacity in patients with COVID-19 in the time of hospital admission.

## II. MATERIAL AND METHODS

### Study design, setting and population

This is a cross-sectional, descriptive and analytical, single-center study, with data analysis of the first two days of admission of all patients admitted between June 2, 2020 and August 18, 2020 at the State Field Hospital, located in the city of Teresina, capital of the state of Piauí, Brazil, who tested positive for SARS-CoV-2 in a reverse transcriptase polymerase chain reaction (RT-PCR) test of a nasopharyngeal swab sample, with clinical staging classified as moderate or high severity, and who underwent high-resolution computed tomography (CT) of the chest, showing ground-glass opacity (GGO)

images. Participants whose CT reports did not reveal the degree of pulmonary impairment were excluded.

### Data collection

HCEV has been planned since its establishment to be a health institution for research purposes. Therefore, the data collection instruments used were specific for this work, where the hospital team was previously trained. Patient demographic, clinical, laboratory and CT data were recorded. Double entry was made in the database to avoid typing errors, and all data were reviewed by a team of experienced medical. The symptoms and illnesses collected were self-reported and vital signs were checked by the staff nurses. Laboratory and CT scans were under the responsibility of a single experienced company in the market, and all information was passed on in full. It is underlined that all information was collected within 48 hours of patient admission.

### Statistical analysis

For quantitative variables, the D'Agostino-Pearson normality test was performed. The results were expressed as mean and standard error of mean. In the case of normal distribution, the values were compared with the Student's t-test. When not normal, the values were compared with the Mann-Whitney U test. For qualitative variables, data were presented in absolute frequency and percentages, and then compared using the Pearson's Chi-square test or the Fisher's exact test. The percentages of the contingency tables were calculated in the columns. In inferential analysis, the dependent variable was defined as the presence of ground-glass pulmonary involvement. Associations with quantitative variables were expressed using the point-biserial correlation coefficient ( $r$ ) and those with nominal qualitative variables were expressed using the Phi coefficient ( $\phi$ ). No imputation was made for missing data. Comparisons and associations with p-value less than 0.05 were considered statistically significant. The study data were processed in Statistical Package for the Social Sciences (IBM®) software, version 27.0.

### Ethical aspects

This study was conducted in accordance with the Helsinki Declaration. The study was approved by the Research Ethics Committee of the University Hospital of the Federal University of Piauí (Approval Number: 4.083.222). All research participants agreed to participate and signed the Free and Informed Consent Form.

## III. RESULTS

Age, severity of the disease at the time of admission and time from the first day of symptom to hospitalization did not differ between the group with

ground-glass opacity greater than 50% (GGO>50%) and the group with equal ground-glass opacity or less than 50% (GGO≤50%). Greater pulmonary impairment was found in male participants (77.42%; p=0.035), with a weak positive correlation (r=0.245; p=0.035). The most frequent comorbidities in the studied sample were obesity, systemic arterial hypertension and diabetes, but there was no difference between the groups, nor any correlation, as well as the number of all reported comorbidities. The body mass

index, the values of heart rate, respiratory rate and mean arterial pressure were not different between the degrees of pulmonary impairment, but the saturation was lower (94.57%; p=0.038) in the GGO group>50 % and with a weak negative correlation (r=-0.254; p=0.038) (Table 1). With regard to symptoms, only the frequency of dyspnea was significantly higher (93.55%; p=0.020) in the group with the highest GGO, and a weak association was found (φ=0.270; p=0.020) (Table 2).

Table 1 – Relationship between clinical characteristics and degree of opacification in ground glass

Parameter	Comparison between groups				Association		
	≤50% GGO (n=43)		>50% GGO (n=31)		p value	r or φ	p value
	Mean or frequency	95% IC	Mean or frequency	95% IC			
Age – years	61.60 ± 2.64	56.26 – 66.93	61.80 ± 3.17	55.32 – 68.28	0.891 <sup>m</sup>	0.006	0.961
Male	23 (53.49%)	-	24(77.42%)	-	<b>0.035<sup>q</sup></b>	0.245	<b>0.035</b>
Severe illness	31 (72.09%)	-	23 (74.19%)	-	0.593 <sup>q</sup>	0.063	0.593
Days of symptoms until hospitalization	10.31 ± 1.08	8.11 – 12.50	9.96 ± 0.75	8.41 – 11.51	0.527 <sup>m</sup>	-0.031	0.810
BMI – m <sup>2</sup> /Kg	30.53 ± 1.41	27.67 – 33.39	30.23 ± 1.22	27.43 – 32.74	0.572 <sup>m</sup>	-0.019	0.880
Obesity	14 (38.90%)	-	13 (41.50%)	-	0.629 <sup>q</sup>	0.060	0.629
SAH	25 (58.14%)	-	16 (51.61%)	-	0.577 <sup>q</sup>	-0.065	0.577
Diabetes	15 (34.88%)	-	14 (45.16%)	-	0.372 <sup>q</sup>	0.104	0.372
Smoking	7 (53.85%)	-	8 (57.14%)	-	0.863 <sup>q</sup>	0.033	0.863
Number of comorbidities	1.58 ± 0.17	1.24 – 1.93	1.84 ± 0.28	1.26 – 2.42	0.689 <sup>m</sup>	0.097	0.413
Heart Rate - bpm	86.33 ± 2.42	81.44 – 91.23	87.69 ± 2.76	82.00 – 93.38	0.720 <sup>t</sup>	0.044	0.720
Respiratory frequency – RI/min	20.21 ± 0.41	19.38 – 21.05	19.54 ± 0.36	18.81 – 20.28	0.244 <sup>t</sup>	-0.157	0.244
Mean blood pressure - mmHg	98.39 ± 3.43	91.46 – 105.30	99.48 ± 2.04	95.30 – 103.70	0.848 <sup>m</sup>	0.030	0.806
Oxygen saturation – %	95.72 ± 0.34	95.03 – 96.40	94.57 ± 0.43	93.69 – 95.46	<b>0.038<sup>t</sup></b>	-0.254	<b>0.038</b>

The comparison data were presented with mean ± standard error of mean or with absolute frequency (percentage) and the correlation data were presented using the point-biserial correlation coefficient (r) or the Phi coefficient (φ), as appropriate. Legend: SAH: systemic arterial hypertension; BMI: body mass index; t: Student's t test; m: Mann-Whitney U test; q: Pearson's chi-square test.



Table 2 – Relationship between symptoms and degree of opacification in ground glass

Parameter	Comparison between groups				Association		
	≤50% GGO (n=43)		>50% GGO (n=31)		p value	r or φ	p value
	Mean or frequency	95% IC	Mean or frequency	95% IC			
Fever	29 (67.44%)	-	24 (77.42%)	-	0.348	0.109	0.348
Cough	33 (76.74%)	-	26 (83.87%)	-	0.452 <sup>q</sup>	0.087	0.452
Fatigue	9 (20.93%)	-	4 (12.90%)	-	0.371 <sup>q</sup>	-0.104	0.371
Dyspnea	31 (72.09%)	-	29 (93.55%)	-	<b>0.020<sup>q</sup></b>	0.270	<b>0.020</b>
Myalgia	29 (67.44%)	-	16 (51.61%)	-	0.169 <sup>q</sup>	-0.160	0.169
Anorexia	5 (13.16%)	-	3 (9.68%)	-	0.130 <sup>q</sup>	-0.176	0.130
Sore throat	13 (30.23%)	-	4 (12.90%)	-	0.080 <sup>q</sup>	-0.203	0.080
Headache	16 (37.21%)	-	9 (29.03%)	-	0.523 <sup>q</sup>	-0.075	0.523
Chest pain	12 (27.91%)	-	4 (12.90%)	-	0.139 <sup>q</sup>	-0.173	0.139
Anosmia	7 (16.28%)	-	7 (22.58%)	-	0.451 <sup>q</sup>	0.088	0.451
Ageusia	8 (18.60%)	-	5 (16.13%)	-	0.831 <sup>q</sup>	-0.025	0.831
Diarrhea	15 (34.88%)	-	7 (22.58%)	-	0.290 <sup>q</sup>	-0.124	0.290
Nausea / vomiting	5 (11.63%)	-	3 (9.68%)	-	1.000 <sup>f</sup>	-0.026	0.827
Number of symptoms	5.05 ± 0.38	4.28 – 5.81	4.55 ± 0.36	3.82 – 5.28	0.301 <sup>m</sup>	-0.108	0.359

The comparison data were presented with mean ± standard error of mean or with absolute frequency (percentage) and the correlation data were presented using the point-biserial correlation coefficient (r) or the Phi coefficient (φ), as appropriate. Legend: t: Student's t test; m: Mann-Whitney U test; q: Pearson's chi-square test.

As for laboratory parameters (Table 3), (lactic dehydrogenase) (LDH) (p<0.001), ferritin (p=0.001), CRP (p<0.001), white blood cell count (p=0.006) and neutrophil count (p=0.003) were significantly higher in the group with GGO>50%, with a moderate positive correlation for all variables (r=0.435; r=0.390; r=0.405; r= 0.302; r=0.302; all with p<0.05; respectively). The percentage of neutrophils was higher in the GGO group>50% (p=0.025), and there was a weak positive correlation (r=0.268; p=0.024), while the percentage of lymphocytes showed a

significantly lower percentage of lymphocytes (p=0.014) and weak negative correlation (r=-0.294; p=0.013). When stratifying the results of AST, ALT, ferritin and hemoglobin by gender, as recommended by the laboratory responsible for the analysis of blood samples, a moderate positive correlation (r=0.319; p=0.031) was found between ferritin and GGO values in male patients, with significantly higher levels in the group with greater pulmonary impairment (p= 0.032). No difference was found for these variables among female patients.

Table3 – Relationship between laboratory characteristics and degree of opacification in ground glass

Parameter	Comparison between groups				Association		
	≤50% GGO (n=43)		>50% GGO (n=31)		p value	r or φ	p value
	Mean or frequency	95% IC	Mean or frequency	95% IC			
Capillary glycemia – mg/dL	185.30 ± 20.01	141.20 – 229.3	249.50 ± 43.97	145.50 – 353.50	0.154 <sup>t</sup>	0.331	0.154

ALT – IU/L	55.55 ± 9.27	36.81 – 74.29	67,61 ± 12.58	41.80 – 93.42	0.215 <sup>m</sup>	0.097	0.433
ALT in women – IU/L	55.83 ± 16.42	21.18 – 90.48	45.20 ± 9.44	19.00 – 71.40	0.587 <sup>m</sup>	-0.072	0.743
ALT in men – IU/L	55.32 ± 10.55	33.38 – 77.25	72.48 ± 15.06	41.24 – 103.70	0.296 <sup>m</sup>	0.140	0.360
AST – IU/L	52.73 ± 5.38	41.83 – 63.62	71.86 ± 18.71	33.47 – 110.20	0.462 <sup>m</sup>	0.138	0.261
AST in women – IU/L	57.28 ± 9.00	38.28 – 76.27	56.80 ± 6.02	40.09 – 73.51	0.587 <sup>m</sup>	-0.006	0.979
AST in men – IU/L	49.00 ± 6.54	35.40 – 62.60	75.13 ± 22.78	27.89 – 122.40	0.394 <sup>m</sup>	0.163	0.286
Creatinine – mg/dL	0.90 ± 0.07	0.76 – 1.04	0.91 ± 0.08	0.74 – 1.08	0.796 <sup>m</sup>	0.008	0.949
Urea – mg/dL	46.24 ± 3.05	40.08 – 52.40	54.62 ± 5.79	42.76 – 66.48	0.186 <sup>m</sup>	0.165	0.170
LDH – UI/L	339.30 ± 19.19	300.50 – 378.00	442.10 ± 30.49	379.60 – 504.50	<0.001 <sup>m</sup>	0.340	<b>0.004</b>
Lactate – mg/dL	4.30 ± 0.28	3.74 – 4.86	4.53 ± 0.25	4.01 – 5.05	0.234 <sup>m</sup>	0.076	0.568
Ferritin – ng/dL	935.60 ± 104.50	724.60 – 1147.00	1697.00 ± 221.40	1243.00 – 2151.00	<b>0.001<sup>m</sup></b>	0.385	<b>0.001</b>
Ferritin in women – ng/dL	618.20 ± 86.74	436.00 – 800.40	910.70 ± 322.00	16.56 – 1805.00	0.581 <sup>t</sup>	0.261	0.219
Ferritin in men – ng/dL	1198.00 ± 158.60	868.90 – 1527.00	1868.00 ± 248.40	1353.00 – 2383.00	<b>0.032<sup>m</sup></b>	0.324	<b>0.028</b>
CRP – mg/L	5.92 ± 0.44	5.04 – 6.80	7.96 ± 0.39	7,17 – 8.76	<0.001 <sup>m</sup>	0.367	<b>0.001</b>
Sodium – mmol/L	137.90 ± 0.71	136.4 – 139.3	137.50 ± 0.85	135.80 – 139.20	0.741 <sup>m</sup>	-0.039	0.750
Potassium – mmol/L	4.67 ± 0.12	4.44 – 4.91	4.84 ± 0.13	4.57 – 5.11	0.343 <sup>t</sup>	0.114	0.343
Red Blood Cells – 10 <sup>3</sup> cells/ mm <sup>3</sup>	4.77 ± 0.08	4.60 – 4.94	4.76 ± 0.10	4.55 – 4.97	0.788 <sup>m</sup>	-0.011	0.931
Hemoglobin – g/dL	13.97 ± 0.25	13.47 – 14.47	13.83 ± 0.25	13.33 – 14.34	0.838 <sup>m</sup>	-0.045	0.712
Hemoglobin in women – g/dL	13.6 ± 0.19	13.19 – 14.00	12.73 ± 1.24	11.43 – 14.03	0.095 <sup>m</sup>	-0.370	0.063
Hemoglobin in men – g/dL	14.31 ± 0.44	13.40 – 15.22	14.12 ± 1.21	13.6 – 14.64	0.946 <sup>m</sup>	-0.057	0.709
Hematocrit - %	42.08 ± 0.73	40.62 – 43.55	41.57 ± 0.78	39.97 – 43.17	0.815 <sup>m</sup>	-0.057	0.639
White Blood cells – cells /mm <sup>3</sup>	8548.00 ± 467.80	7604.00 – 9493.00	10784.00 ± 652.80	9447.00 – 12121.00	<b>0.006<sup>t</sup></b>	0.326	<b>0.006</b>

<b>Neutrophiles – cells / mm<sup>3</sup></b>	6753.00 ± 419.40	5906.00 – 7600.00	8896.00 ± 561.70	7745.00 – 10047.00	<b>0.003<sup>t</sup></b>	0.352	<b>0.003</b>
<b>Neutrophiles – %</b>	77.83 ± 1.33	75.15 – 80.52	8896.00 ± 561.70	7745.00 – 10047	<b>0.025<sup>m</sup></b>	0.280	<b>0.018</b>
<b>Eosinophiles – cells / mm<sup>3</sup></b>	42.81 ± 8.48	25.69 – 59.93	44.17 ± 10.28	23.12 – 65.23	0.914 <sup>m</sup>	0.072	0.651
<b>Eosinophiles – %</b>	0.57 ± 0.11	0.35 – 0.79	0.45 ± 0.09	0.25 – 0.64	0.627 <sup>m</sup>	-0.097	0.422
<b>Basophiles – cells/ mm<sup>3</sup></b>	18.67 ± 5.53	7.49 – 29.84	12.28 ± 7.50	-3.09 – 27.64	0.182 <sup>m</sup>	-0.023	0.886
<b>Basophiles – %</b>	0.24 ± 0.07	0.10 – 0.37	0.10 ± 0.06	-0.01 – 0.22	0.152 <sup>m</sup>	-0.171	0.154
<b>Lymphocytes – cells / mm<sup>3</sup></b>	1035.00 ± 80.94	871.80 – 1199.00	946.30 ± 94.37	753.00 – 1140.00	0.374 <sup>m</sup>	-0.085	0.479
<b>Lymphocytes – %</b>	13.31 ± 1.13	11.03 – 15.59	9.51 ± 0.91	7.65 – 11.39	<b>0.014<sup>m</sup></b>	-0.281	<b>0.018</b>
<b>Monocytes – cells / mm<sup>3</sup></b>	509.1 ± 45.13	418.00 – 600.30	536.00 ± 47.07	439.60 – 632.40	0.559 <sup>m</sup>	0.048	0.689
<b>Monocytes – %</b>	6.17 ± 0.49	5.17 – 7.16	5.03 ± 0.37	4.27 – 5.80	0.153 <sup>m</sup>	-0.199	0.096
<b>Platelets – cells / mm<sup>3</sup></b>	227824 ± 12415	202752 – 252896	245379 ± 16397	211791 – 278967	0.388 <sup>t</sup>	0.104	0.388

The comparison data were presented with mean ± standard error of mean and the correlation data were presented using the point-biserial correlation coefficient (r) or the Phi coefficient (φ), as appropriate. Legend: ALT: alanine aminotransferase; AST: aspartate aminotransferase; LDH: lactic dehydrogenase; CRP: C-reactive protein; PT: prothrombin time; t: Student's t test; m: Mann-Whitney U test; q: Pearson's chi-square test.

ALT and AST in women, as well as LDH, lactate, ferritin, CRP, percentage of neutrophils and prothrombin time (PT) in male and female patients were above the laboratory reference values in groups with GGO > 50% and ≤ 50%. Urea and neutrophil count were higher only in the group with greater pulmonary impairment. The count and percentage of eosinophils and the percentage of lymphocytes were significantly lower than expected in both groups.

#### IV. DISCUSSION

In this study, the clinical parameters that were correlated with a higher degree of GGO were: male gender, presence of dyspnea and lower oxygen saturation. With regard to laboratory parameters, there was a positive correlation between GGO and increased LDH, ferritin and CRP values, WBC count, neutrophil count and percentage, as well as negative correlation with leukocyte percentage. It is underlined that these factors are directly or indirectly

linked to the body's immune reaction against SARS-CoV-2<sup>10</sup>. The correlation between the higher GGO and the male gender can be justified, at least in part, because men seem a little more susceptible to the infection, i.e., have a greater chance of developing a more serious and more lethal form of the disease. These aspects related to gender may be related to genetic, hormonal and other biological factors<sup>11</sup>. As for the other clinical and laboratory correlations, the pathophysiology of SARS-CoV-2 infection can help explain them, as detailed below: after SARS-CoV-2 enters the host cells of the respiratory system and accelerates viral replication, the integrity of the epithelial-endothelial barrier is undermined. This virus accentuates the inflammatory response and stimulates the migration of monocytes and neutrophils. The result of this reaction is interstitial mononuclear inflammatory infiltrates and edema<sup>12</sup>. Concomitantly, pulmonary edema increases, there is formation of hyaline membrane, rupture of the endothelial barrier and dysfunctional alveolar-capillary oxygen transmission, changes that cause the clinical

manifestation of acute respiratory distress syndrome (ARDS). These changes are visualized through CT in GGO, decreased saturation, dyspnea and possible changes in inflammation markers and leukocytes<sup>12,13</sup>.

Another study conducted with similar characteristics and clinical condition, which evaluated the correlation between laboratory parameters and pneumonia severity on initial CT, showed a strong correlation between diffuse pulmonary impairment and increased LDH and CRP, with the predominant radiographic finding being GGO<sup>14</sup>. CRP, produced by the liver in response to inflammatory mediators, is a non-specific marker of the acute phase of inflammatory diseases. CRP levels are significantly higher during the early periods of severe cases of COVID-19 and may reflect the development of the disease<sup>10</sup>. LDH is a glucose metabolism enzyme responsible for the conversion of pyruvate into lactate and its secretion is triggered by cell membrane necrosis, resulting from viral infection or lung lesion<sup>10</sup>.

Like CRP, ferritin can be used as a non-specific marker of the acute phase of inflammatory conditions, and it is also used as a marker of therapeutic response. Furthermore, there are indications that this factor may actively contribute to the cytokine storm, which is typical of COVID-19. Ferritin is higher the greater the gravity of COVID-19<sup>15</sup>. Regarding the relationship with the cells of the immune system, in the study by Sun et al. (2020), in a study conducted with patients with laboratory-confirmed COVID-19, who underwent chest CT without contrast at the time of hospital admission and laboratory tests 1 day before or after of the imaging exam, found positive correlations in relation to the ratio between GGO and the total radiographic lesion in critically ill patients with the percentage of neutrophils, and negative with the count and percentage of lymphocytes, but found no correlation with WBC<sup>16</sup>. Similarly, Li et al. (2020), in a study with patients who underwent a series of chest CT and laboratory exams on the same day, tested and found these same correlations; however, with chest CT severity scores<sup>17</sup>. Although high WBC count is associated with an underlying infection, this parameter is not reliable as a biomarker for COVID-19, since the use of glucocorticoids and concomitant infections may influence its outcome<sup>10</sup>[10].

The main limitation of this study was the possible selection bias. A study that includes patients with a condition classified as mild could contribute to improving the quality of the results. Moreover, the cross-sectional and temporal cut does not allow establishing a relationship between cause or consequence of a higher GGO; however, it is possible to raise hypotheses and search for justifications in the scientific literature to explain the

factors associated with it. Nevertheless, this is a pioneering study in the state, which was conducted at the first field hospital that started operating with services for people from all regions of the state capital and also from cities in the metropolitan area.

## V. CONCLUSION

The factors associated with the more diffuse presentation of ground-glass opacity are those involved in the pathophysiology of pulmonary involvement caused by COVID-19: male gender, lower saturation, dyspnea, higher LDH, higher ferritin, higher CPR, higher WBC count, higher neutrophil count, higher percentage of neutrophils and lower percentage of lymphocytes. Therefore, the identification of these factors at the time of hospital admission can help in predicting pulmonary impairment.

## VI. CONFLICTS OF INTEREST STATEMENT AND FUNDING

The authors declared no conflict of interest. This research was funded by the authors themselves.

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# Intentional replantation as a last resort in the treatment of endodontic failures: Literature Review

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**Keywords**— *Dental replantation, Endodontics,  
Intencional Replantation.*

**Abstract**— *One of the main objectives of endodontic treatment is the decontamination of root canal systems visando alcançar o sucesso clínico com o paciente sem sinais e sintomas. However, sometimes endodontic treatment fails, causing a periradicular inflammatory lesion to persist. Given this, there are several treatment options, including non-surgical endodontic retreatment and apical microsurgery. Sometimes these options are unfeasible, and intentional reimplantation appears as the last therapeutic option for dental element extraction. The main objective of the present study was to analyze the effectiveness of intentional replantation as a last resort in the treatment of endodontic failures. As an inclusion criterion, articles from the PubMed, Google Scholar and SciELO database were used. In PubMed, 61 articles were found, 08 were selected. In Google Scholar, 131 articles were found, 8 of which were selected for the research. In SciELO, 2 articles were found, were 2 were selected. Also 4 articles were included by cross-research. Thus, a final sample of 23 articles inserted in the work was obtained. It is concluded that intentional reimplantation is a viable alternative, but the lack of a preestablished clinical protocol makes it difficult to practice the procedure.*

## I. INTRODUCTION

Teeth are vital sensory organs that contribute to our daily activities (CLARK; LEVIN, 2018), such as speech, food and aesthetics in addition to assisting in living together in society. Teeth can be lost for a variety of reasons, although dental trauma and caries are the most frequent causes (CLARK; LEVIN, 2018).

According to Park (2019) when any other organ in the human body presents a high injury, a great effort is made to try to recover that organ, in contrast, and this is not observed so intensely in dentistry. This is a negative phenomenon, because the more teeth a person has, the greater the probability of having a better quality of life (PARK et al., 2019). Chewing is an important role that teeth play, and the ability to chew food is directly associated with an individual's quality of life (YAMAMOTO; SHIGA, 2018).

The intentional reimplantation is a procedure that is part of the endodontic arsenal and, like the apical endodontic microsurgery, it has technical-scientific basis and is indicated to try to save teeth (KATAOKA; GONDIM, 2020). Intentional reimplantation is indicated in cases of post-treatment periapical pathology, in which non-surgical endodontic retreatment and/or apical surgery are impractical or failed later (GRZANICH et al., 2017).

Conventional endodontic retreatment may be unfeasible either because of a complex coronary restoration that hinders access to the root canal, or because of an obstruction of the canal system that prevents access to the apical foramen, or because of the existence of a perforation whose intracanal repair is inaccessible (BECKER, 2018).

Currently, intentional reimplantation procedures involve atraumatic tooth extraction techniques, root resection and preparation, extraoral tooth manipulation for

the shortest period possible and retrofilling with biomaterials (CHO et al., 2016; GRZANICH et al., 2017).

This technique has been presented as an excellent therapeutic option, since all dental surfaces can be completely visualized and instrumented, without damaging the adjacent periodontal tissues, contributing to the reestablishment of the health of the periapical tissues. (GRZANICH et al., 2017).

**Indications**

In the literature several clinical indications for this technique have been presented:

1. Persistent symptomatic apical periodontitis in situations where orthograde retreatment is complicated or has failed (ASGARY et al., 2014; MAJD et al., 2014).
2. Surgical treatment has either failed or is contraindicated due to anatomic or accessibility limitations (HERRERA et al., 2006)
3. Correction of overextended root filling material with persistent disease where periapical surgery is not possible (ASGARY et al., 2014)
4. Management of resorption defects that cannot be accessed conventionally
5. Drilling in areas not surgically accessible (KATAOKA; GONDIN, 2020)

**Contraindications**

In the literature there are some clinical contraindications for this technique:

1. Intentional reimplantation is contraindicated if the tooth has divergent, flared and/or curved roots (ASGARY et al., 2014)
2. Tooth with vertical root fracture, presence of periodontal disease with marked mobility, insufficient clinical crown

height to allow stable application of forceps and complex root anatomy (NAGAPPA et al., 2013)

3. Use of bisphosphonate (KATAOKA; GONDIN, 2020)
4. Traumatized teeth (dental avulsion) have a high chance of developing root resorptive processes, increasing the chances of intentional reimplantation failure (KATAOKA; GONDIN, 2020).

**Prognostic factors**

Several critical parameters for success have been identified, including case selection, aseptic operating conditions, atraumatic extraction, extra-alveolar time, preservation of PDL cells via avoidance of chemical and mechanical trauma, initial tooth stability while maintaining the physiological movement of biocompatible root end filling material, such as mineral trioxide aggregate (MTA) and Biodentine, may enhance periapical healing (ASGARY et al., 2014).

In the literature, many authors emphasize the importance of following the following steps to increase the chances of a favorable prognosis for the patient: Minimally atraumatic extraction, maintenance of the periodontal ligament in the handling of the tooth in extraoral time, dental reimplantation, containment and stabilization of the dental element, postoperative recommendations, removal of the suture and preservation (CHO et al., 2016; CUNLIFFE et al., 2020; KATAOKA & GODIM, 2020).

However, systematic reviews and metaanalyses have indicated a survival rate of 88%-89.1% in teeth treated by IR (TORABINEJAD et al., 2015; MAINKAR, 2017). In the following table, Torabinejad et al., (2015) compare survival rates in multiple studies, resulting in an average percentage of 88% for intentionally reimplanted teeth (TORABINEJAD et al., 2015):

Table.1: Survival of the intentionally reimplanted tooth. Torabinejad et al. 2015 (TORABINEJAD et al., 2015)

**TABLE 1.** Evidence Table Summarizing Survival of Intentionally Replanted Teeth

Author [year] (reference)	Number of teeth	Percentage survival	95% CI lower limit	95% CI upper limit	z value	P value	Percentage resorption
Grossman [1966] (18)	45	80	67	91	14.8	<.001	18
Emmertsen and Andreasen [1966] (30)	100	81	73	88	22.4	<.001	31
Kingsbury and Wiesenbaugh [1971] (31)	149	97	93	99	33.7	<.001	5
Koenig et al [1988] (32)	177	82	76	87	30.1	<.001	4
Bender and Rossman [1993] (33)	31	81	65	93	12.4	<.001	19
Raghoobar and Vissink [1999] (34)	29	86	71	97	12.8	<.001	14
Abid [2010] (35)	20	90	72	100	11.1	<.001	35
Choi et al [2014] (36)	287	95	92	97	45.6	<.001	7
Total	838	88	81	94	24.8	<.001	11

CI, confidence interval.

**II. MATERIALS AND METHODS**

In order to produce a literature review, the research was carried out in databases such as Pubmed (Medical Publications), SciELO and Google Scholar. The articles

were attached in different folders by the name of the database. In PubMed the keywords (Dental replantation, Endodontics, Intencional Replantation) were used, where 61 articles were found being selected 08. In SciELO the keywords were used (Dental replantation, Endodontics,

Intencional Replantation), where 2 articles were found and 2 were selected. In Google Scholar the keywords were used (Dental replantation, Endodontics, Intencional Replantation), where 131 articles were found and 8 were selected. Also 4 articles were included by cross-research. As an inclusion criterion, a scientific article were included that contained the keywords delimited from the year 2011 until the year 2021, no language restriction.

**III. RESULTS**

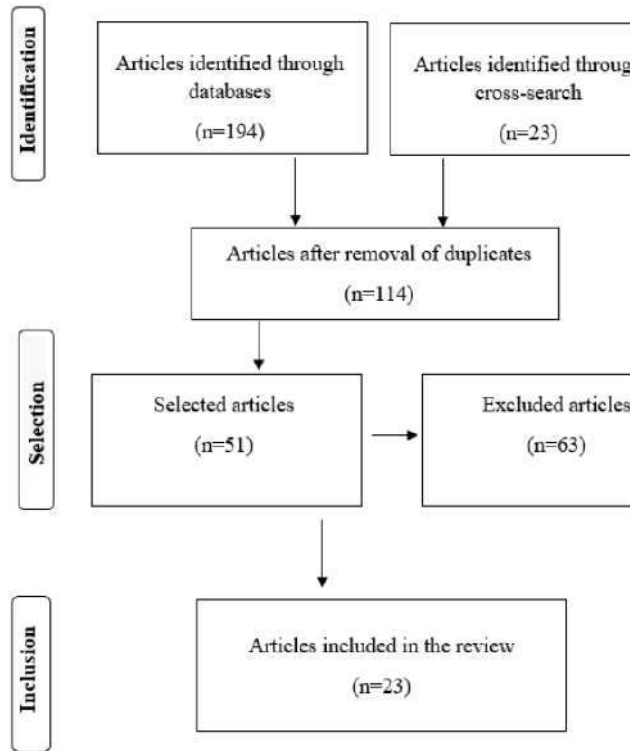


Fig.1: Articles selection process is represented in the flow diagram.

After removing the duplicates, 114 articles were obtained, from which the title and abstract were read, resulting in a total of 51 articles for full reading. From which only 19 were included, 4 articles were subsequently added by cross-reference.

**IV. DISCUSSION**

Intentional reimplantation is indicated in cases of post-treatment periapical pathology, in which non-surgical endodontic retreatment and/or apical surgery are impractical or failed later (GRZANICH et al., 2017).

Despite high success rates of up to 85% for primary root canal treatment, failure may still occur and new pathosis develop (NG et al., 2011). Nair (2006) discussed

predisposing factors that lead to persistence of periapical lesions following primary root canal treatment, namely: microbial intraradicular infection which might result from inadequate disinfection or coronal leakage, microbial extraradicular infection, including actinomycosis and Propionibacterium that can not be disinfected by conventional means, non-microbial non-radicular irritation (cholesterol crystals), exogenous non-root foreign body reaction, the true cystic lesion and surgical scar tissue Yan et al. (2019) presented 3 case reports involving type II or type III palatogingival grooves on lateral maxillary incisors that were treated with re-intentional replantation, in all cases, the diagnosis of a combined periodontal-endodontic lesion with periodontal breakdown was made. The authors concluded that intentional replantation with a 2-segment restoration is a good therapeutic choice.

In 2015, Torabinajed et al reported in their systematic review, a survival rate of 88% of intentionally reimplanted teeth, at two years. In this systematic review, the author compared the survival of intentionally reimplanted teeth, reported in 8 articles, with the survival of implant-supported single crowns, reported in 27 articles.

In 2016, Cho et al., also carried out a prospective study with 159 patients, mostly female and under 40 years of age, in which the majority of intentionally reimplanted teeth were second molars that presented apical radiotransparency, adequate filling and absence of fistula, most of which were retrofilled with intermediate restorative material (IRM) and reimplanted in less than 15 minutes. In this study, the author reported a cumulative retention rate of 93%, at 12 years, and a cumulative clinical and radiographic healing rate of 91%, at 6 months, which decreases to 73%, at 3 years.

In 2017, Mainkar reported a survival rate of 89.1%, in a systematic review that compared not only the survival, but also the cost-effectiveness of intentionally reimplanted teeth compared to single implants, suggesting that this is better in cases of intentional reimplantation. Furthermore, authors like Choi, Lee and Kim evaluated the effect of orthodontic extrusion provided to intentional reimplantation and its influences on survival. They observed that the survival rate of intentional replantation in its results (91%) amounted to a statistically significant way (up to 98%) with preoperative orthodontic extrusion. For the rejected part, this done in had influence on further development resorption root (CHOI et al., 2014). Therefore point out this performance as a possible improvement of the prognosis of the redeployed tooth.

According to data obtained from case reports and literature reviews, all authors point out how crucial the need for the surgical act is to be minimally atraumatic,



minimizing damage to periodontal ligament (CHO et al., 2016; CUNLIFFE et al., 2020; PORTILLA et al., 2021; KATAOKA; GONDIM, 2020). The tooth must be gripped firmly using forceps holding the crown above the CEJ (CUNLIFFE et al., 2020) and dislocation should be done gently in the vestibulolingual/palatine direction, with slight rotational force to perform tooth extraction (KATAOKA; GONDIM, 2020).

The maintenance of the tooth during its extraoral time is directly related as the success of the IR, some complications have been reported after IR treatment, such as root resorption or ankylosis; a high rate of

complications may be associated with extra-oral preparation time exceeding 15 minutes (CHO et al., 2016). Kataoka and Gondim (2020) suggest an extraoral working time of 7 to 10 minutes associated with irrigation with the solution irrigation with the balanced solution of Hanks or Pedialyte for removal of the lesion, apicectomy, retropreparo and insertion of the MTA.

In the literature there is no standardization of a correct time for the preservation of intentional reimplantation, Cho et al., (2016) dissertation on for more than a majority of complications occurred within the first year after replantation.

Table.2: Adapted from Plotino et al, 2020 (PLOTINO et al., 2020). Intentional reimplantation in clinical studies: clinical success rate comparison

Author	Number of patients	Success rate and follow-up period
Grossman, 1996	45	80% / 5.6 years
Emmertsen & Andreasen, 1996	90	34% / 1 year
Koenig et al., 1988	192	82% (seguimiento de 6 a 51 meses)
Bender And Rossman, 1993	31	80,6% / 1 day to 22 years of follow-up
Choi et al., 2014	285	89,5% / mean follow-up of 25.4 ± 9.3 months
Asgary et al., 2014	20	90% / follow-up of 15.5 months
Cho et al., 2016	196	93% / 12 years
Jang et al., 2016	41	83,4% in 4 years and 73,0% in 11 years
Cho et al., 2017	103	89% in 1 year and 68% in 4 years

## V. CONCLUSION

It can be concluded in this literature review that intentional reimplantation is a viable alternative and presents a good cost-benefit.

Despite a pattern followed by the authors in the ir achievements lack of a standard protocol for performing the procedure, further research is suggested to adapt a gold standard clinical protocol aiming at achieving the best possible prognosis.

Furthermore, it is essential that a clinician has both the knowledge, skills and equipment to undertake this procedure with safety to ensure the best possible prognosis to the patient.

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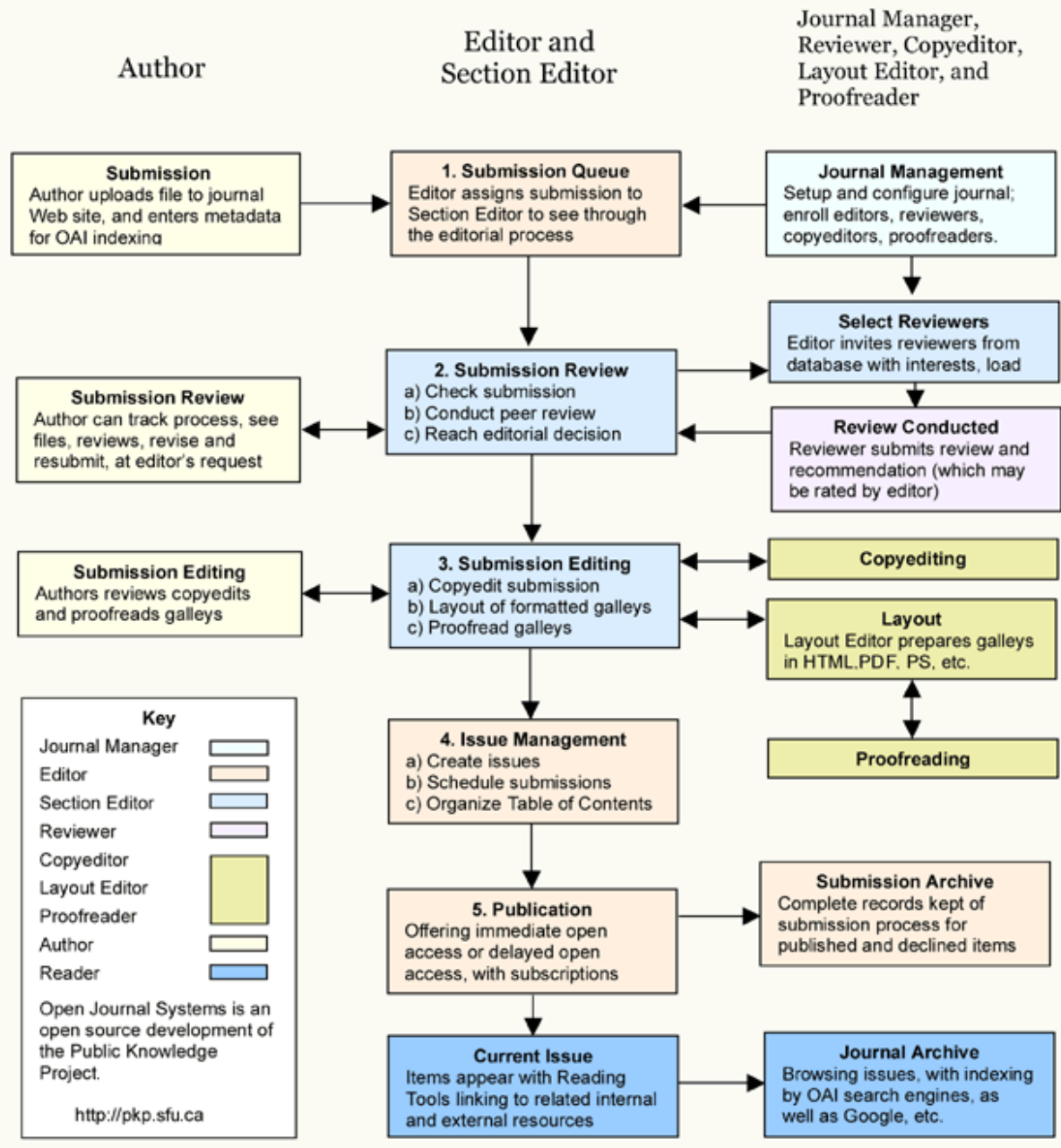
To my parents and friends, I am immensely grateful for all of their patience, support and encouragement. Without you none of this would be possible.

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