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FOREWORD

I am pleased to put into the hands of readers Volume-7; Issue-7: 2020 (July, 2020) 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

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A Robust Deep Learning-Based Fault Diagnosis Method for Rotating Machinery

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Abstract— In the recent years, intelligent data-driven fault diagnosis methods on gearboxes have been successfully developed and popularly applied in the industries. Currently, most of the machine learning techniques require that the training and testing data are from the same distribution. However, this assumption is difficult to be met in the real industries, since the gearbox operating conditions usually change in practice, which results in significant data distribution gap and diagnostic performance deteriorations in applying the learned knowledge on the new conditions. This paper proposes a deep learning-based domain adaptation method to address this issue. The raw current signals are directly used as the model inputs for diagnostics, which are easy to collect in the real industries and facilitate practical applications. The maximum mean discrepancy metric is introduced to the deep neural network, the optimization of which guarantees the extraction of generalized machinery health condition features across different operating conditions. The experiments on a real-world gearbox condition monitoring dataset validate the effectiveness of the proposed method, which offers a promising tool for cross-domain diagnosis in the real industries.

Keywords—Fault diagnosis, deep learning, domain adaptation, gearbox, current signal.

I. INTRODUCTION

In the past decades, rotating machines have been widely used in a large number of industries, such as manufacturing, aero-space industry, automotive etc. Gearbox is one of the key components in rotating machines for delivering torque and offering speed conversions. Effective and timely fault diagnosis of gearbox is of great importance in the real industries, which can optimize maintenance schedule, enhance operational safety and reduce economic costs [1]. Traditionally, many model-based signal processing methods have been used for the fault signal analysis of gearbox [2]. While effective diagnosis results have been obtained, the model-based approaches generally rely on good expert knowledge, and require much human labor on model development. Therefore, they are less efficient for applications in the real industrial scenarios. Moreover, smart manufacturing initiative has established a consistent method for data access across different enterprises helping predictive manufacturing and fault diagnosis to advance in a rapid pace [3,4]. In general, high diagnosis accuracy and fast implementation can be achieved [5]. Furthermore, little prior expertise on signal processing and dynamics model of

gearbox is generally required, which largely facilitates the industrial applications. In the literature, the popular data-driven methods include artificial neural networks (ANN), random forest (RF), support vector machines (SVM) and so forth. Recently, deep learning has been emerging as a highly effective algorithm for data processing, which is promising to further improve the performance of the existing data-driven approaches [6]. Basically, the deep learning methods are capable of efficiently capturing the underlying relationship between input and output data, through multiple linear and non-linear data transformations [7]. Specifically, with respect to fault diagnosis problems, the machinery health states can be well predicted using the collected condition monitoring data, despite the high dimensions of the signals [8,9]. Authors in [10] proposed using convolutional neural network (CNN) for gearbox fault diagnosis and achieved a significantly better classification accuracy compared to the classical machine learning methods. A fault diagnosis method for wind turbine gearbox based on stacked auto-encoder and multi-class SVM was proposed in [11]. A Deep Belief Network fault diagnosis method based on manually extracted time and frequency domain features was proposed in [3] for

gearbox and bearing applications. These studies emphasize the significant improvement in gearbox fault diagnosis performance by using deep learning based methods compared to the conventional data-driven methodologies. It should be pointed out that while promising diagnosis performance has been obtained using deep learning, the main assumption lies in that the training and testing data are supposed to be from the same distribution. That means the labeled training data and unlabeled testing data should be collected in the similar operating conditions of gearbox. However, the working scenarios such as load, rotating speeds etc. usually change in different practical industrial tasks. That results in significant distribution discrepancy between training and testing data, which deteriorates the data-driven model generalization performance [12]. In order to address this problem, transfer learning algorithms have been proposed in the recent years [10,13], which aim to generalize the data-driven knowledge learned from the training condition, denoted as source domain, to the testing condition, denoted as target domain. Specifically, the domain adaptation (DA) techniques have been popularly developed in the fault diagnosis field [14,15], which assume the training and testing data share the same label space. That is consistent with the machinery health condition identification problems [16]. The domain-invariant features across different conditions are expected to be learned with the domain adaptation methods, and stronger model generalization ability can be achieved. A framework for gearbox domain adaptation was proposed in [17] based on deep neural network, where only the source domain data and healthy data from the target domain were used to accomplish the DA tasks. In [18], a DA approach for fault diagnosis of low-speed bearing was proposed. The authors used acoustic spectral imaging technique to convert time-domain acoustic emission signal to representative images for different health conditions. These images were used in a DA model for predicting labels of target domain dataset. A deep CNN-based DA method for gearbox fault diagnosis was proposed in [19] based on vibration signal. In their approach, the raw time-domain vibration signal was converted to gray-scale images and used as input to the CNN model. The authors firstly trained a CNN model on the source dataset and then fine-tuned it using the target domain samples. In general, the deep learning-based domain adaptation methods have shown great potential in bridging the domain gap in different working conditions [20,21]. In the current literature, the machinery vibration data are mostly focused for fault diagnosis [22], since the vibration signal is representative of the behavior of periodic events in the gearbox and it is expected the behavior of the gearbox would change in case of any kind

of mechanical abnormality. For different kinds of signals, the application of the torque measurement has been seldom investigated. The authors in [23] discussed torsional vibration analysis as a potential approach for fault diagnosis in fixed shaft gearboxes. Using torque signal in fault diagnosis of planetary gearboxes was discussed in [24] and the authors proposed a diagnosis method based on the demodulated spectra of amplitude envelope and instantaneous frequency. The study by Qiao et al. [25] on wind turbine mechanical components pointed out the usefulness of the torque signal in detecting gearbox faults. Furthermore, Mohanty et al. [26] stated that the current signal of the induction motor driving the gearbox is useful for the fault diagnosis investigations, and the motor current signature analysis (MCSA) can be largely improved using the proposed demodulation method. The effectiveness of MCSA in rotating machinery fault diagnosis problems was also validated in [27,28]. Therefore, it is feasible and promising to explore the current signals for gearbox health identification, which are easy to collect in the real industries. However, it should be pointed out that the existing methods are mostly complicated and require sophisticated domain knowledge on gearbox modeling and signal processing skills, which are difficult to be implemented in different applications. This paper proposes a deep learning-based domain adaptation method for the gearbox fault diagnosis. An end-to-end diagnostic framework is built, which takes the raw collected data as input and directly outputs the results. The current signals are investigated in this study, which are generally easier to collect than the popular vibration data in the real industrial scenarios. The maximum mean discrepancy metrics introduced to measure and minimize the data distribution distance between different domains, and the generalized diagnostic features of different machinery health condition can be extracted. Experiments on real-world gearbox datasets are implemented for validations, and the proposed method is capable of effectively diagnosing gearbox faults across different operating scenarios. The remainder of this paper starts with the preliminaries in Section II. The proposed fault diagnosis method is shown in Section III, and experimentally validated and investigated in Section IV. We close the paper with conclusions in Section V.

II. PRELIMINARIES

A. Deep Convolutional Neural Network

In the past years, deep learning also denoted as deep neural network has achieved great success in different applications. Besides the basic multi-layer perceptron (MLP) structure, the convolutional neural network (CNN) architecture has been more efficient on feature extraction and the high-dimensional machinery data can be well processed [7]. Basically, multiple convolutional layers are stacked in the CNN structure to model the relationship between input and output. Specifically, the one-dimensional CNN is adopted in this study, which is well suited to process the measurement signals of gearboxes. Together with convolutional operations, pooling is usually implemented after the convolutional layers. The averaging-pooling and max-pooling operations are popularly adopted, which are able to learn the average and maximum values from the local data respectively. In this way, the most

To bridge the gap between different data distributions on machine learning, transfer learning techniques have been successfully developed and widely used in the applications³⁰. Specifically, the domain adaptation method in transfer learning has been receiving increasing attention in the fault diagnosis studies, since the machinery health condition label spaces are usually identical. In general, the domain adaptation approaches aim to learn domain-invariant features from different conditions, that facilitates the fault diagnostic knowledge generalize in different cases [31]. In this paper, the maximum mean discrepancy (MMD) metric is adopted, which measures the distance between the distributions of source and target domains. The optimization of MMD is able to achieve domain fusion in the high-level representation sub-space in deep neural networks, and thus extract generalized features for diagnosis¹⁵. The MMD metric is defined as the squared distance between the kernel embeddings of data marginal distributions in the reproducing kernel Hilbert space

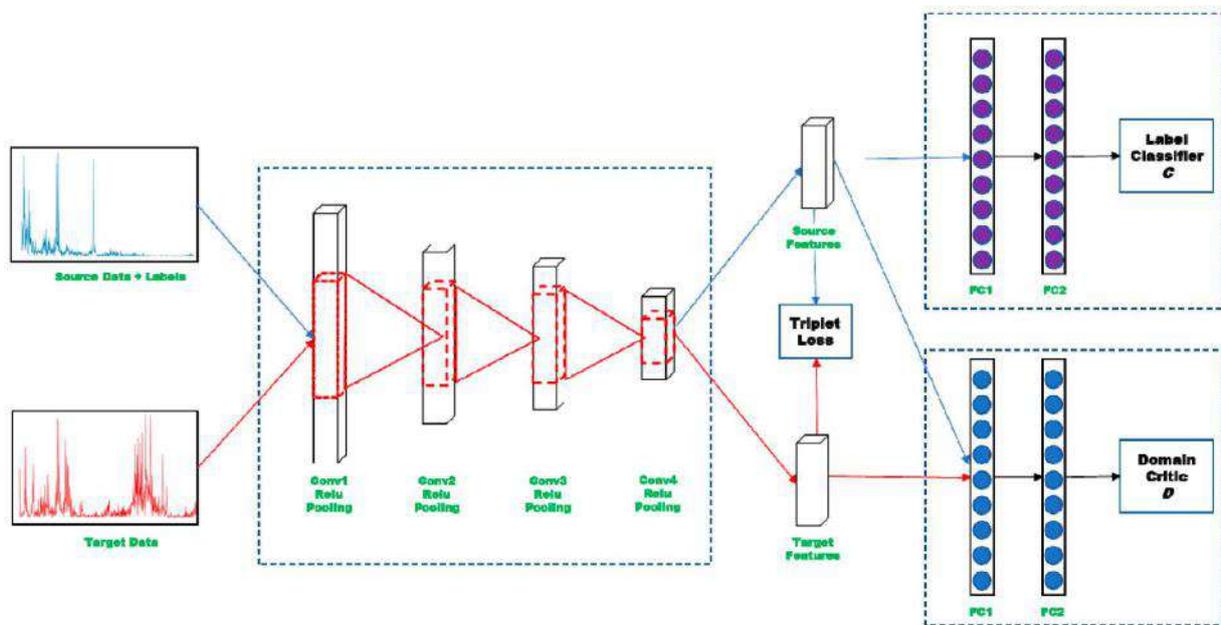


Fig.1 Flowchart of the proposed fault diagnosis method

significant features can be extracted and the data dimensions can be reduced, which increases the computing efficiency of deep learning. By exploiting the convolutional and pooling operations, the high-level features from raw data can be obtained, and they can be used for the final task afterwards, i.e. machinery fault diagnosis. Readers are referred to [7,29] for more descriptions of CNN.

B. Domain Adaptation

(RKHS) as

$$MMD_k(P, Q) \triangleq \|E_P[\phi(x^s)] - E_Q[\phi(x^t)]\|_{\mathcal{H}_k}^2, \quad (1)$$

Where \mathcal{H}_k denotes the RKHS endowed with the characteristic kernel k . Based on the current understanding of MMD [32], kernel choice is one of the key factors in domain adaptation, since different kernels can embed the probability distributions in different RKHSs and different orders of the statistics are explored. Therefore, multiple kernels in MMD are employed in this paper to leverage

different kernels and achieve improved performance. In the implementations, N_k RBF kernels are used as [33],

$$k(\mathbf{x}^s, \mathbf{x}^t) = \sum_{i=1}^{N_k} k_{\sigma_i}(\mathbf{x}^s, \mathbf{x}^t), \quad (2)$$

Where k_{σ_i} denotes a Gaussian kernel with bandwidth coefficient σ_i . In this study, three kernels are adopted, and the bandwidth parameters are selected as 2, 4 and 8

III. PROPOSED FAULT DIAGNOSIS METHOD

The proposed method is described in Figure 1 and consists of four individual steps. In each step, the key functionalities are presented and discussed in detail

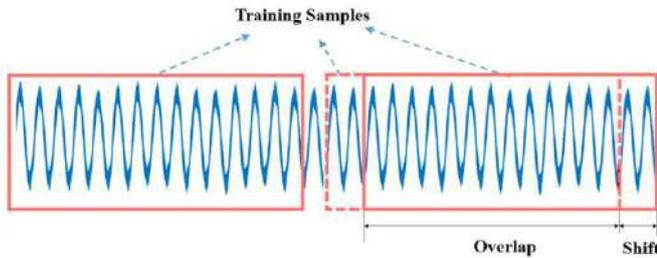


Fig. 2: data augmentation with overlap.

A. Data Partitioning

In the first phase, the raw time-domain sensor data collected from a gearbox is partitioned into two sets (a) source domain data (labeled data) and (b) target domain data (unlabeled data). The target domain data is also further partitioned into training and testing sets, where one of the unlabeled subset is used in training the CNN model and the other subset is used for testing the trained model.

B. Data Modeling

There are two major steps for modeling the data prior to training the diagnosis model, which are presented as follows. 1) Data augmentation In order to increase the number of training samples, a windowing method has been used. As depicted in Figure 2, a window with a fixed sample size moves over a time series signal and generates multiple samples. For example, a signal with 1000,000 points can provide the 191 training samples with length 50,000 when the shift size is 5000 points. 2) Fast Fourier Transform (FFT) In order to eliminate the impact of the supply line frequency, the FFT technique is applied to each sample generated from the augmentation process. It is expected that fault signatures appear as sidebands around the supply line frequency (or running frequency) in the FFT spectrum [34]. All samples after FFT are directly used

in the deep learning model for feature learning and fault diagnosis.

C. Deep Learning Model Formulation

For the network optimization, two terms are generally included in the objective, i.e. source-domain classification loss and domain discrepancy loss. First, following the typical machine learning paradigm, the empirical health condition identification errors on the source domain are supposed to be minimized, and the cross-entropy loss function L_s is adopted in this study, which is defined as,

$$\min L_s = -\frac{1}{n_s} \sum_{i=1}^{n_s} \sum_{j=1}^{N_c} 1\{y_i = j\} \log \frac{e^{x_{i,j}}}{\sum_{m=1}^{N_c} e^{x_{i,m}}}, \quad (3)$$

Where n_s denotes the number of the source-domain training samples. $x_{i,j}$ is the j th element of network output vector, taking as input the i th labeled source-domain sample, and y_i is the label of the i th source-domain sample. N_c represents the number of the concerned machinery health conditions. Besides the basic supervised learning part, the source and target domain discrepancy should be minimized, and the MMD metric is adopted to measure and optimize the domain gap in this study as described in Section II-B. Specifically, the MMD loss L_d is defined as,

$$\min L_d = \text{MMD}_k(P_S, P_T), \quad (4)$$

where P_S and P_T denote the distributions of the high-level representations of the source and target-domain data respectively in the last fully-connected layer of the network. In summary, the losses in Equations (3) and (4) can be combined, and the final optimization objective L_{opt} can be expressed as,

$$\min L_{opt} = L_s + L_d, \quad (5)$$

the unlabeled testing target-domain data are used for fault diagnosis and performance of the proposed method is reported.



Fig. 3: The experimental setup of the test rig [35]

IV. EXPERIMENTAL STUDYA.

A. Test Rig

A validation study has been conducted on a dataset acquired from a gearbox prognostic simulator (GPS) built by the Spectra Quest Company³⁵, as is shown Figure 3. Two confronted electrical motors are used in the test rig; one motor is used for drive and the other one for resistance/load. Both motors are three-phase induction motors with 10 Hp and two pair of poles. A current sensor (HTA 100) was installed on the drive motor and was used in our analysis for fault diagnosis. The data was recorded using a computer with a National Instruments acquisition card (NI 4472 series) at a sampling rate of 50ks/sec. The monitored gearbox is composed of four spur gears (Figure 4). The first gear, as it comes from the motor that drives the test bench, has 32 teeth. It is the one substituted by gears in different health states, leaving the rest unchanged. It is followed by a gear with 80 teeth. In the same axle, a gear with 48 teeth is found, connected to a gear with 64 teeth, resulting in a global transmission relationship of 3.33.

In this study, the torque load applied to the gearbox was gradually increased by 40%, 80%, and 100%. In each load, the operational speed was kept constant at 1500 rpm and each run was repeated 15 times to reduce the impact of randomness and uncertainties. Table I summarizes the experimental studies and a comparison between raw motor current measurements and the corresponding FFT spectra for different loads and in healthy condition is given in Figure 5. Accordingly, by increasing the load condition, amplitude of raw current signal and FFT spectrum increase significantly. Figure 6 shows the five health conditions examined in this paper and the impact of FFT analysis in distinguishing different faults at 0% load is given in Figure 7. As shown, raw motor current measurements do not show significant differences between different health conditions, however, they are clearly distinguishable from the FFT spectrum. The proposed method is tested for six transfer tasks, i.e

A summary of data segmentation for different tasks is given in Table II. N_{source} and N_{target} represent the number of samples from each class of source and target domain datasets respectively. All experiments are performed on a PC with 16-GB RAM, Core i5 CPU, and NVIDIA GeForce TX 2080 Ti. The programming is done in Tensorflow and GPU computing is used to reduce the model training time.

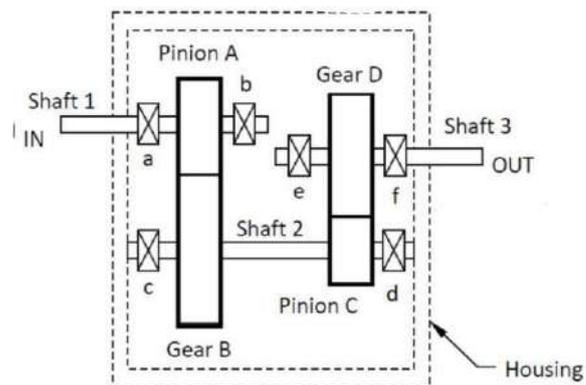


Fig. 4: Illustration of the gear disposition inside the experimental gearbox.

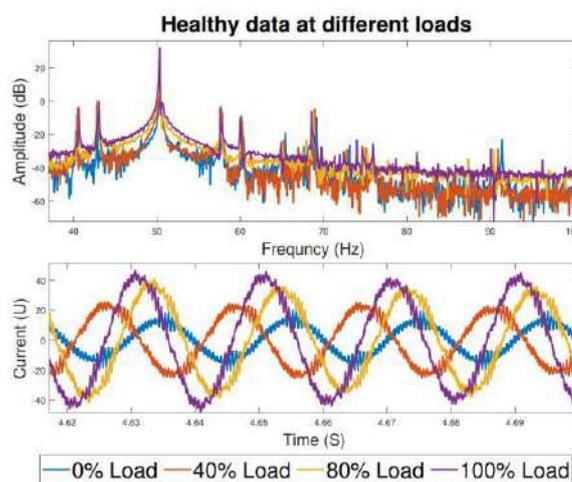


Fig. 5: Comparison between healthy data at different load conditions.

B. Model Architecture Design

As shown in Figure 8, the first step is to design a CNN architecture and tune the network parameters. In this study, a stack of four convolutional and pooling layers and a max-pooling layer are used for model training. The impact of filter size (F_s) and filter number (N_f) on the cross domain diagnosis performance and for task T1–2 is shown in Figure 9. Generally, a larger value for N_f and F_s leads to a higher diagnosis accuracy, but this improvement by larger values is relatively limited. Moreover, by increasing N_f and F_s , the training time increases significantly. Therefore, $N_f = F_s = 20$ was selected for the final model. Batch size (N_b) is another tuning parameter that may significantly affect the diagnosis accuracy. For our dataset, selection of low batch size leads to the worst diagnosis results and a too large batch size would create a big cumulative descent in updating the parameters especially when MMD loss is integrated in the model and therefore the prediction

accuracy drops for too large batch sizes. Therefore, it is important to choose a reasonable tradeoff value for Nb. Consequently, Nb= 64 was selected for the final diagnosis model. The confusion matrix corresponding to the final diagnosis results in task T1-2 is illustrated in Figure 10. It is observed that only two classes ‘eccentricity’ and ‘missing tooth’ are slightly misclassified and all other classes are precisely classified.

Table I: Experimental details.

Experiment Number	Load	Speed (rpm)
1	0%	1500
2	40%	1500
3	80%	1500
4	100%	1500

C. Results and comparison

In this section, different implementations are used to evaluate the performance of the proposed method and comparison with the latest related works is also presented.

1) Effects of training sample size

Performance of the final model in different tasks, i.e.T1-2, T1-3, T1-4, T4-3, T4-2and T4-1and for different source domain sample size, N source, is illustrated in Figure11. In this study the number of target samples, N target, is kept constant at 300. With increasing N source, the testing accuracy increases and prediction uncertainty (measured by the standard deviation) reduces significantly. The proposed CNN-based domain adaptation method provides acceptable testing accuracy even with small training source samples, N source. As presented in Figure 11, the achieved testing accuracy in some tasks like T1-2and T4-3is higher than other tasks. This observation is due to the nature of data and the similarity between the distribution of source and target domain. For instance, the load variation from experiment #1 to experiment #2 is 40% which is smaller than that between experiment#1 and experiment #4 (i.e. 100%). Therefore, the transfer of learned features from experiment #1 to experiment #2 is easier. In addition, achieving the high accuracies in different tasks from low to high operational loads and vice versa indicates that the proposed method performs well bidirectional between different domains. The achieved results for different tasks also clearly illustrate the effectiveness of the motor current measurement signal for cross-domain fault diagnosis. As presented, by increasing the number of training samples, the diagnosis performance improves as well which follows the same pattern as the classical fault diagnosis methods.

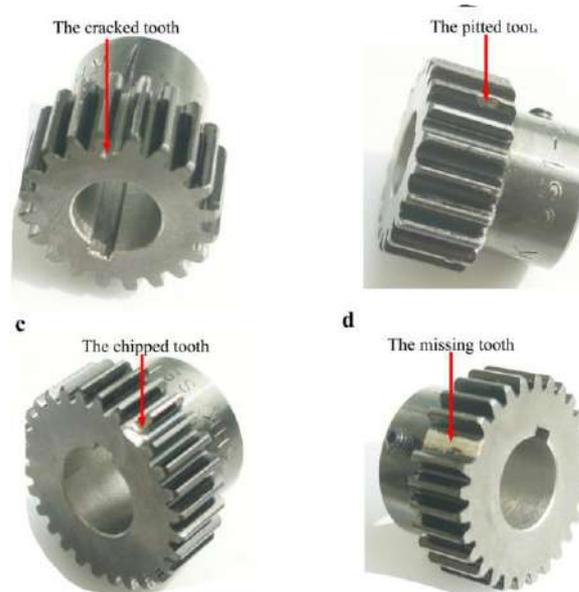


Fig. 6: Different health conditions examined in this paper.

2) Classification Results and Comparison

Performance of the proposed transfer learning methodology is compared with two groups of fault diagnosis tools as summarized below:

Group A- Supervised classification methods such as:

- 1) LDA [36]- Linear Discriminant Analysis is a supervised algorithm that uses a linear transformation matrix to project features from parametric space to feature space.
- 2) SVM [37]- Support Vector Machines are supervised machine learning algorithms that can be employed for both regression and classification problems. SVMs are designed based on Structural Risk Minimization criteria in the statistical learning theory. SVMs work on a simple idea: to identify a hyper-plane which separates the training data into two distinct classes.
- 3) CNN Without Domain Adaptation (No-DA) - A deep learning method that automatically extracts features from the raw signal measurement. A typical classification is obtained by only considering the classification loss in Equation (5). This trained model is directly used for testing on the target dataset.

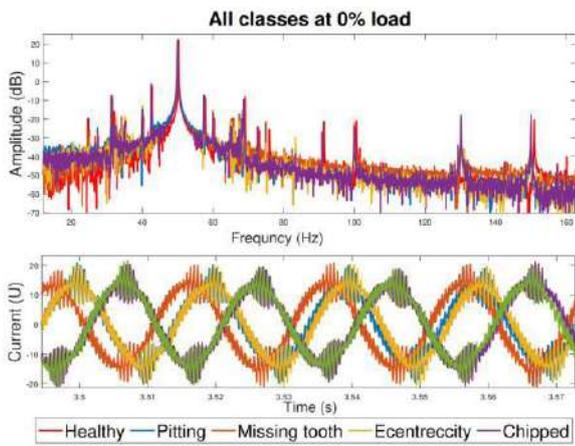


Fig. 7: Different health conditions indicated in raw time domain and frequency spectrum.

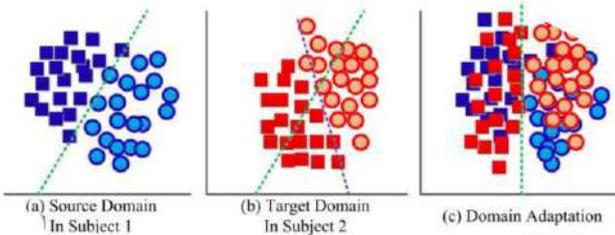


Fig. 8: The proposed deep neural network architecture

Group B- Transfer learning methods including:

- 1) TCA [38]- Transfer Component Analysis is used to find a feature subspace in the domain adaptation field. In the subspace created by transfer components, the source and target data distribution are similar. When the subspace is created, a SVM classifier is trained with the labeled source domain dataset and acquire the accuracy of the target domain.
- 2) JDA [39]- Joint Distribution Adaptation is a modification of TCA. It is able to simultaneously adapt the conditional and marginal distributions during the dimensionality reduction process.
- 3) GFK [40]- Geodesic Flow Kernel is an unsupervised domain adaptation technique wherein the source and target domain data are projected into a linear subspace while the shortest line path connects the two original domains.
- 4) BDA [41]- Balanced Distribution Adaptation aims to automatically balance the significance of marginal and conditional distribution discrepancies and therefore it can effectively adjust for a specific transfer task.

5) T-S [42-] This method suggests performing adaptation by learning a target-specific network from the source-specific network.

Table II: Data segmentation for transfer tasks.

Transfer Task	Source Sample Number	Target Sample Number
T ₁₋₂	$5 \times N_{source}$	$5 \times N_{target}$
T ₁₋₃	$5 \times N_{source}$	$5 \times N_{target}$
T ₁₋₄	$5 \times N_{source}$	$5 \times N_{target}$
T ₄₋₃	$5 \times N_{source}$	$5 \times N_{target}$
T ₄₋₂	$5 \times N_{source}$	$5 \times N_{target}$
T ₄₋₁	$5 \times N_{source}$	$5 \times N_{target}$

In Group A, three classification methods are used to learner presentative features from the training source data in a supervised process and then the trained classifier is used on the target domain data for testing and the achieved results are reported. Hand-crafted time and frequency domain features such as standard deviation, mean, peak to peak, kurtosis, frequency amplitude and energy etc. are used as an input to LDA and SVM methods. For No-DA, raw frequency-

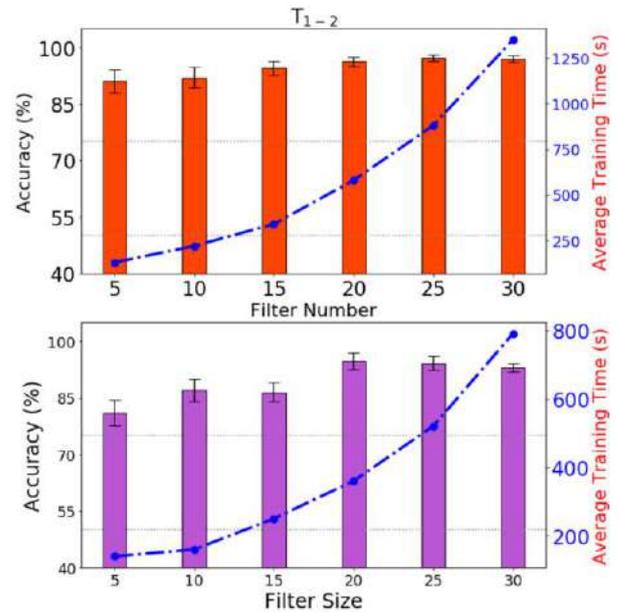


Fig. 9: Impact of filter size and filter number on the testing accuracy for task T1-2.

domain data is utilized. Because these methods inherently do not consider domain variation between the source and target datasets, therefore a low classification performance is highly expected. In Group B, the extracted time and frequency features are used for domain adaption tasks and the achieved results are compared with the proposed method. Analyses are conducted on 300 samples obtained from the source and target dataset and the obtained

diagnosis results on the testing (target domain) data are visualized in Figure 12. In contrast with other methods, the proposed approach provides the highest accuracies in all six transfer tasks, and basically, the accuracies are higher than 91%, which illustrates the effectiveness of the proposed transfer learning approach. The average performance improvement for the proposed method is 57.46%, 55.68%, 39.3%, 36.62%, 35.87%, 34.5%, 26.67%, 2.75% compared with LDA, SVM, GFK, JDA, TCA, BDA, No-DA, and T-S. The second-best performance is obtained from T-S and No-DA is ranked in the third place. Overall, domain adaptation methods discussed in Group B outperform the classical diagnosis methods in group A but they are not as promising as the proposed method.

		Confusion Matrix					
Output Class	Chipped tooth	300 20.0%	0 0.0%	0 0.0%	0 0.0%	0 0.0%	100% 0.0%
	Eccentricity	0 0.0%	288 19.2%	0 0.0%	33 2.2%	0 0.0%	89.7% 10.3%
	Healthy	0 0.0%	0 0.0%	300 20.0%	0 0.0%	0 0.0%	100% 0.0%
	Missing tooth	0 0.0%	12 0.8%	0 0.0%	267 17.8%	0 0.0%	95.7% 4.3%
	Pitting	0 0.0%	0 0.0%	0 0.0%	0 0.0%	300 20.0%	100% 0.0%
			100% 0.0%	96.0% 4.0%	100% 0.0%	89.0% 11.0%	100% 0.0%
		Target Class					
		Chipped tooth	Eccentricity	Healthy	Missing tooth	Pitting	

Fig. 10: The confusion matrix for the classification results in task T1-2.

The performance of different diagnosis methods for the low number of training samples e.g. $N_{source}= 60$ and $N_{target}= 300$, is illustrated in Figure 13. As expected, using low number of labeled data for training deteriorates the testing diagnosis accuracy for all evaluated methods. This observation is consistent with the previous studies conducted on deep learning methods that larger training data leads to a better diagnosis performance and transfer learning based diagnosis methods also follow this pattern. Moreover, comparing the results obtained from methods in Group A (without domain adaptation) with the diagnosis results obtained from methods in Group B and the proposed method, shows the significant impact of cross-domain adaptation on fault diagnosis performance. T-S

which provides an alternative way for domain adaptation, shows good performance with large training sample size. However, with a low sample size, its performance deteriorates significantly because this method minimizes the distribution discrepancy between the target dataset and the learned representations from the source training network. The achieved results illustrate the effectiveness of motor current signal for cross-domain fault diagnosis.

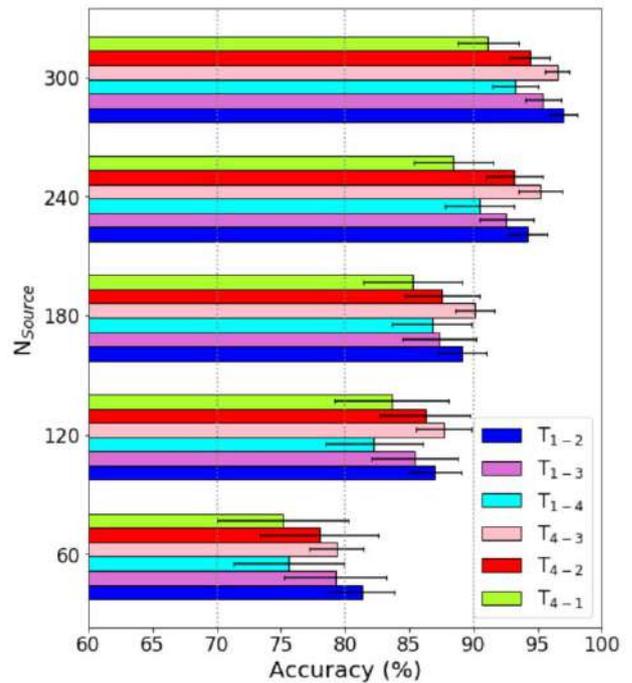


Fig. 11: Performance of the proposed method at different tasks and for different training sample size.

3) Visualization of the learned features

In order to illustrate the effectiveness of our approach, T-distributed Stochastic Neighbor Embedding (t-SNE) technique is adapted in visualizing the high-level feature representation by mapping them from the original feature space into a 2-Dspace map. The visualization is performed on task T1-2 for the proposed method and also for CNN without domain adaptation (No-DA method).

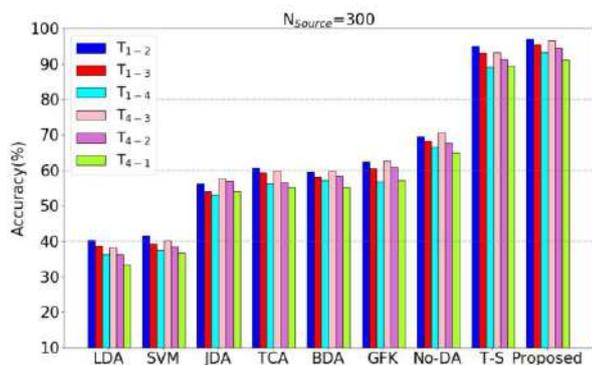


Fig. 12: The achieved testing accuracy for different comparative methods and in all six transfer tasks.

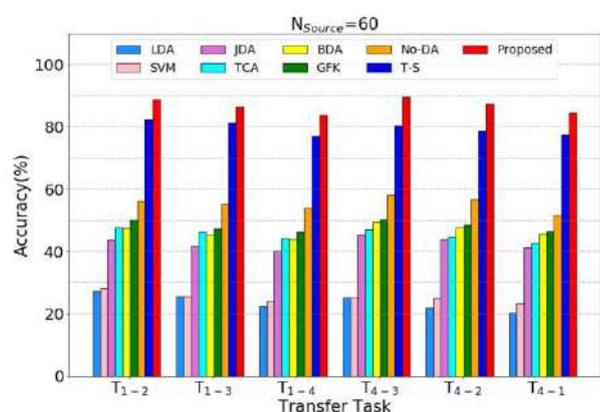


Fig. 13: Fault diagnosis results with the low number of source domain samples in all six transfer tasks.

Figure 14 illustrates the virtualization of learned features in the fully connected layer of the source domain classifier without domain adaptation. As observed, without domain adaptation, samples from each identical class in the source or target data cluster together. However, for some labels there is a notable distribution discrepancy between the source and target domain samples. Since the feature space is divided into several regions associated with different labels, it is expected to obtain a low diagnosis performance in the target domain data. Therefore, it is necessary to bridge the distribution discrepancy between the source and target data to improve classification results on the target data. By using domain adaptation, as is shown in Figure 14, the source and target domain features are projected into the same region as the model is trained. Accordingly, the distribution discrepancy has reduced significantly between the source and target domains and samples from different conditions are separated clearly. These two requirements a) minimal distribution discrepancy between two domains and b) clear differentiation between different health conditions in both domains would guarantee achieving an

accurate cross-domain fault diagnosis. As illustrated, the cross-domain invariant features obtained by the proposed method are clustered well where features from different classes are separated clearly and only a small amount of overlapping is observed between classes ‘Eccentricity’ and ‘Missing tooth’ faults in the source and target domains.

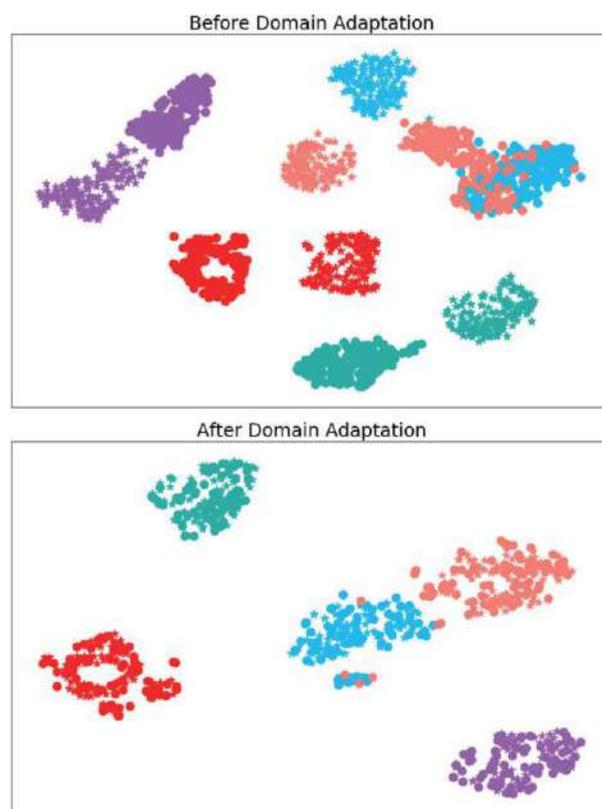


Fig. 14: Extracted features in the fully connected layer are visualized for task T1-2 at N_{source} = 300. Both the scenarios before and after domain adaptation are presented.

V. CONCLUSION

In this paper, a deep learning-based domain adaptation fault diagnostic method for gearboxes is proposed. An end-to-end diagnostic model is established, which takes the raw motor current data as inputs, and directly outputs the predicted health conditions. The maximum mean discrepancy metric is used to bridge the distribution gap between different gearbox operating conditions. Experiments on a real-world gearbox condition monitoring dataset are carried out for validations, and promising cross-domain fault diagnosis performance is achieved by the proposed domain adaptation method. This study offers a new perspective on enhancing fault diagnosis model generalization ability in different operating scenarios of gearboxes. The high data requirement of vibration signals

by most existing methods is also alleviated, and effective diagnostic performance can be obtained using only the easily-collected current data. However, it should be pointed out that the main limitation of this study lies in the assumption of the target-domain data during training. Further research works will be carried out on developing robust fault diagnosis models for different scenarios without the availability of the target-domain data in advance.

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Responsibility Crime: Criminal or Constitutional Offense

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Abstract —Brazil has been undergoing major changes in its policy, leading its population to become more involved in government issues. Brazilians have frequently observed the conduct of their representatives and frequently identified the responsibility crime, which is carried out by political agents. The present work aims to analyze and present a brief discussion about the crimes of responsibility and to identify as a criminal infraction or just a constitutional infraction in face of several positions found in the Brazilian legal system, including the position of the Supreme Federal Court. To this end, bibliographic research was carried out on books, articles, normative provisions, summaries and laws present in Brazilian legislation, in order to present the concept of responsibility crime, its applicability in criminal law with the Superior Federal Court binding legal precedent⁴⁶ and identify a position through its possible punishments, whether such a crime falls within the criminal or constitutional scope. The denomination responsibility crime emerged as a way to reduce criminality in Brazilian politics, committed by those who represent us so much, the political agents. The identification of this crime, which can be reported by any citizen, is imperative to prevent and even combat the unwanted associations of those who represent us. According to the consulted bibliographic, the crimes of responsibility are nothing more than administrative irregularities of a political nature, in which their punishments does not affect the freedom of the agents who practiced them, not configuring a criminal offense, but rather a constitutional offense.

Keywords —Criminal Law, Criminal Offense, Constitutional Offense, Responsibility crime.

I. INTRODUCTION

This scientific article aims to analyze if the responsibility crime should be considered a criminal offense or a constitutional violation.

On one hand, we have art. 85 of the 1988 Federal Constitution, which clarifies that the acts of the President of the Republic that violate the Federal Constitution and its precepts, listed by the Constituent in the following 7 items, are considered responsibility crime. Also, not only for the President, but now regarding the Ministers of State, Ministers of the Supreme Federal Court, the Republic's General Attorney and the Governors, Law N°. 1.079/1950

applies, almost all compatible with the Federal Constitution/1988¹, which brings the typification, processing and judgment of the responsibility crime. There is also Law No. 7.106/83, which states responsibility crimes committed by the Federal District Governor and Secretaries, and Decree-Law No. 201/67, which deals with responsibility crimes committed by Mayors and Municipal Secretaries.

On the other hand, we have in our legal system the Supreme Federal Court binding legal precedent No. 46,

¹ Writ of mandamus 21.564/DF.

which, indirectly, fits the responsibility crime into the criminal legislation, as it defines that these type of crimes and their processes and judgments are Union's private legislative competence.

It is noteworthy that the Penal Code Introduction Law (Decree-Law 3491/41) considers a crime as it follows:

Article 1. A criminal offense is considered a crime those which the law imposes a penalty of imprisonment or detention, either alone, or alternatively or cumulatively with the fine penalty; misdemeanor, the criminal offense which the law imposes, in isolation, a simple prison sentence or a fine, or both, alternatively or cumulatively. (Decree-Law 3491/41, art. 1).

We note that in the criminal sphere, to consider a certain conduct as a crime, it is necessary to impose an imprisonment or detention punishment.

In contrast, the responsibility crime punishments, according to the special laws mentioned above, are political and administrative sanctions, such as impeachment.

Given these many discussions, it is worth asking whether the responsibility crime would be a criminal offense or a constitutional offense. This is what we will discuss later on.

II. METHODOLOGY

In the present work, bibliographic research was carried out on books, scientific articles, normative provisions, legal precedents and laws present in the Brazilian legislation, in order to present the responsibility crime concept, its applicability in criminal law taking into account the Supreme Federal Court binding legal precedent No. 46 content and identify a position through its possible punishments, if such crime falls within the criminal or constitutional scope.

III. THEORETICAL FRAMEWORK

3.1 Responsibility Crime

3.1.1 Constitutional scope

The responsibility crime is a subject that is quite addressed nowadays, due to the focus received after government changes undergone by Brazil in the last decades, which leads us to wonder if the referred crime is a criminal or constitutional offense.

According to the 1988 Federal Constitution, a responsibility crime is understood as any type of action that is politically contrary to the rules established by it,

committed by political agents. So, it is a political infraction, considered a proper crime, in other words, a crime that the active agent is determined, having a special condition/quality.

In the legal literature, the understanding is that responsibility crime concept has already been brought up by the Original Constituent. Nevertheless, Minister Alexandre de Moraes ponders in his book about the responsibility crime legal nature, explaining that it is a political-administrative offense, and after that, he analyses the legal definition brought by the national system. Observe:

Responsibility crimes are political-administrative infractions defined in federal legislation, committed during the function performance, which undermine the existence of the Union, the free exercise of State Powers, the country's internal security, the Administration's probity, the budget law, the political rights, individual and social rights and compliance with laws and judicial decisions. (MORAES, 2007, p. 458).

Similarly, Joseph Cretella Junior teaches:

The responsibility crime can be incurred by the Republic President and any State Minister, within the sphere of the Union, but must, however, be defined in a special law, according to the principle of *nullum crimen nulla poena sine lege* (JÚNIOR, 1991, p. 2,932).

In this light, Federal Constitution's article 85, in an objective manner, points out what a responsibility crime is when practiced by the President of the Republic.

Art. 85. It is Responsibility crime the Republic President acts that violate the Federal Constitution and, especially, against: I - the existence of the Union; II - the free exercise of the Legislative Power, the Judiciary Power, the Public Prosecutor and the Federal units' constitutional Powers; III - the exercise of political, individual and social rights; IV - the country's internal security; V - probity in administration; VI - the budget law; VII - compliance with laws and judicial decisions. Paragraph. These crimes will be defined in a special law, which will establish the procedure's rules and judgment. (art. 85 of the CF)

Following the constitutional command provided by the art. 85's paragraph cited above, there are two special laws and a decree-law, which brings to the infra-constitutional scope the responsibility crime's classification, processing and judgment applied to each political agent. These laws are Law No. 1.079 of April 10, 1950, applied to the President of the Republic, the Ministers of State, the

Ministers of the Supreme Federal Court, the Republic's General Attorney, and the Governors and Secretaries of States; Law No. 7.106/83, applied to the Federal District Governor and Secretaries and the Decree-Law No. 201/1967, applied to Mayors and Councilors.

In all of the aforementioned normative acts, the responsibility crime has a political-administrative infraction's legal nature, as there is a combination of punishments such as the loss of function, disqualification for a determined time so that he or she can exercise a public function again, the revoke of the elective mandate, among other measures. All of these sanctions, on the other hand, do not fall under Article 1 of Decree-Law No. 3.914 of December 9, 1941, the Penal Code Introduction Law (Decree-Law No. 2,848, of 7-12-940) and of the Criminal Misdemeanor Law (Decree-Law No. 3.688, of October 3, 1941), which, when conceptualizing what is a crime, establish that "a criminal offense is considered a crime those which the law imposes a penalty of imprisonment or detention either alone, or alternatively or cumulatively with the fine penalty".

Therefore, it is not possible to consider that the responsibility crime is a criminal offense, since those punishments do not go against the freedom of the individual, through imprisonment or detention, as is clear in the Penal Code Introduction Law. However, it is a real political-administrative infraction, since they attack the republican unity, administrative probity, the use of public money and even the budget, by political acts, which consequently causes the necessary loss of the public function or even revocation of the elective mandate, in addition to political rights suspension.

3.1.2 Penal scope

On the other hand, there is in our legal system the Supreme Federal Court binding legal precedent No. 46, approved on April 9, 2015, as a result of the already published binding legal precedent 722:

Supreme Federal Court binding legal precedent No. 46 – The responsibility crime definition and establishment of the respective procedure and judgment rules are Union's exclusive legislative competence.

The Supreme Federal Court makes it clear, through the aforementioned statement, that only the Union can legislate about a responsibility crime.

The Federal Constitution brings on its article 22, that "the Union is exclusively responsible to legislate on: I - civil, commercial, criminal, procedural, electoral, agrarian, maritime, aeronautical, space and labor law".

Considering that only the Federal Government has the competence to legislate on matters in the criminal sphere (private jurisdiction), and that the STF binding legal precedent n°. 46 states that only the Federal Government has the competence to legislate on responsibility crimes, the Federal Superior Court through its precedent indirectly framed the responsibility crime into the criminal scope.

However, as we saw above by the constitutional determination, the responsibility crime must be defined in a special law. And the legislator, both in Laws 1.079 and 7.106/83, and in Decree-Law No. 201/1967, did not refer to a criminal offense, but to political-administrative violations.

Damásio de Jesus (2010), reinforces this position by stating that Law No. 1.079/50, as highlighted, does not address crimes, but political-administrative infractions. Therefore, using the term criminal action would be inappropriate. He also affirms that it can be manifested after a popular complaint, which is not allowed in a public criminal process, as this is the Prosecutor's role.

So, the STF binding legal precedent n°. 46, which states that only the Union has the competence to legislate on responsibility crimes, is not enough to fit this kind of act into the criminal scope, since it is the special laws that should be responsible for it. And, in all legislation available in our system, nothing is said about crime in a criminal sense, but only political-administrative infractions.

3.1.3 Impeachment

Impeachment, which means impugnation, deals with the process that can culminate in the Executive Branch's leaders mandate termination and also people who hold high political positions. This mandate impugnation can start due to a responsibility crime and has been among us since a long time ago, as we will see in a brief historical account.

The impeachment's development was marked by two major historical scopes, the criminal and the political. Originated in England, at the time it was turned to criminal proceedings, but it lost that effect as soon as it was introduced in the United States, where it became a strictly political procedure, as explained by Sérgio Resende de Barros.

[...] Typical of Western law, impeachment was born in England as a criminal case. From there, it passed to the United States, where it lost its criminal nature, becoming a strictly political procedure. These countries marked its development, generating two historical impeachment types: the criminal and the political. [...] Among the English, the impeachment's origins date back to the 13th and 14th centuries, when it emerged as

a means of instituting an investigation in parliamentary houses aiming to punish someone who was accused by the public outcry. In 1283 there was a procedure - that some point to as the pioneer - against a certain David, known as "Llewellyn's brother". Others followed, such as that of Thomas, Earl of Lancaster, in 1322, that of Roger Mortimer and that of Simon of Beresford, in 1330, and that of the Archbishop of Canterbury, John Stratford, who was charged before the Parliament in 1341, based on notoriously defamatory reports. These pioneering cases were not yet the impeachment itself. But then it would appear. [...] More typical cases took shape in the second half of the 14th century. In 1350, that of Thomas de Barclay. In 1376, the proceeding against a London merchant named Richard Lyons reached William, Lord Latimer, which - in addition to giving the institute much greater repercussion - initiated a feature that was later reaffirmed and persisted: the impeachment defendants are political. Furthermore, this was the first case in which the Parliament houses rationalized impeachment, converting it into a definitive process and trial, with the Commons as accusers and the Lords as judges. (BARROS, 2003, chap. 4).

It is possible to realize that throughout the impeachment historical formation process, in the middle of the 12th and 14th centuries in England, the institute had a criminal feature. Only after its incorporation into the legislative and constitutional system of the United States of America it came to present a political scope.

Impeachment, despite centuries past, still deals with accused and accusers, in other words, the accused known as the politicians and the accusers the people, and it is exactly this characteristic that allows any individual to interpose the impeachment process against a politician. In the same way that, in this case, the people are the ones who elect them, they are also the ones who can remove them, making it clear what the Federal Constitution in its article 1, paragraph, tells us: "All the power emanates from the people, that exercise it through elected representatives or directly, under the terms of this Constitution".

Law No. 1.079/50 recognizes that any individual can submit to the National Congress a request for impeachment against a political authority, based on a responsibility crime that he may have committed.

Art. 14. Any citizen is allowed to denounce the President of the Republic or Minister of State, for a responsibility crime, before the Chamber of Deputies. Art. 41. Every citizen is allowed to denounce before the Federal Senate, the Ministers of the Supreme Federal

Court and the Republic's Attorney General, for the responsibility crimes they commit (articles 39 and 40). Art. 75. Every citizen is allowed to denounce the Governor before the Legislative Assembly, or a responsibility crime. (Law 1.079 / 50, in Art. 14, 41 and 75).

3.1.3.1 Impeachment procedure

According to Pedro Lenza, the impeachment procedure is observed in two phases, in other words, it has a biphasic procedure, constituted by the admissibility judgment and the process and judgment procedure. This is what Law No. 1079/50, art. 80, states.

Art. 80. When the President of the Republic and the Ministers of State commits a responsibility crimes, the Chamber of Deputies is the pronouncement court and the Federal Senate, the court of judgment; When the Ministers of the Supreme Federal Court or the Republic's Attorney General commits a responsibility crimes, the Federal Senate is simultaneously a court of pronouncement and judgment. (Art. 80 of Law 1079/50)

So, the admissibility judgment is made by the Chamber of Deputies, described in the article mentioned above as Court of Pronunciation and the Federal Senate, court of judgment. In the case of a STF Minister or Republic's Attorney General cassation procedure, the Pronunciation Court is the Federal Senate, therefore, it will be both the Pronunciation and the Judgment Court.

When it comes to the President of the Republic and the Ministers of State, the process and judgement trial is carried out by the Federal Senate, described in the article mentioned above as the Judgment Court.

It starts with the presentation of a complaint before the Chamber of Deputies, which can be made by any citizen, as we saw above. The Chamber has the prerogative to declare the complaint well-grounded or unfounded. If declared well-grounded, the process goes to the Senators, to be, finally, analyzed if there was or not a responsibility crime.

With the complaint accept, the Deputies Chamber's leader conducts his or her preliminary analysis, and dispatches it to a special commission, which has the function of offering an opinion on the complaint that must be read in plenary, in order to assist the federal deputies in voting on the cassation request. This special commission formation cannot exceed the period of 48 hours, and its composition must be proportional to the number of representatives of each political party.

The quorum required to authorize the process is 2/3 of the Chamber of Deputies members, in order to be processed and judged, after that, by the Federal Senate.

The Federal Senate receives the accusation and initiates the process against the President of the Republic, aiming to verify if there are political-administrative infractions that correspond to a responsibility crime. The impeachment document is then received and read at the next session and, in the same session, a committee will be elected. The elected commission is made up of 1/4 of the Senate composition, and must obey the proportionality of the House.

After all this procedure, the Federal Senate becomes a Political Court with a heterogeneous collegiate body, as the judgment will be chaired by the Minister President of the Supreme Federal Court. When the process starts, the President of the Republic is suspended from his duties for 180 days. It is important to note that if the judgment is not concluded within this time, the suspension is not extended. In this case, the President of the Republic must return to his activities, the process keeps running.

Note that impeachment is an essential institute for the protection of the Constitution itself, as a way of curbing the self-interests of political representatives.

IV. ANALYSIS AND RESULTS

The political-administrative “typification” of the responsibility crime was introduced in the legal system as a mechanism for republican protection aiming to prevent possible political desideratums. The responsibility crime can be reported to the National Congress (in the case of acts practiced by the President of the Republic, Ministers of State, Members of the Supreme Federal Court and the Republic’s Attorney General), by any citizen. The primary objective of this complaint is to combat and, mainly, to prevent the practice of acts that put, the Union and the administrative probity as a whole, at risk, by those political agents who should serve as examples to the country’s citizens, since they occupy the highest positions in the civil service hierarchy.

In this bibliographic research, it was observed that the responsibility crime tends to be a constitutional infraction, brought by Laws 1.079, 7.106/83 and Decree-Law 201/1967. In the analysis of these normative acts, it is clear that the conduct is treated as a political-administrative infraction, and not as criminal offence. This is because their punishments do not harm the political agent’s freedom, or predict any corporal sanction.

V. CONCLUSION

This work aimed to provide information regarding the responsibility crime, allocating it as a constitutional infraction, even though there are opposite jurisprudential positions, such as the Supreme Federal Court’s, described at the binding legal precedent n°. 46.

With the utmost respect, this position is not compatible with the first article of Decree-Law No. 3.914, of December 9, 1941, Penal Code Introduction Law (Decree-Law No. 2.848, of 7-12-940) and the Criminal Misdemeanors Law (Decree-Law No. 3.688, of October 3, 1941), which considers a criminal offense to which the law imposes a penalty of imprisonment or detention as a crime.

Furthermore, considering the conduct defined in art. 85 of the Constitution, and those brought by Law No. 1.079, of April 10, 1950, Law No. 7.106/83, and Decree-Law No. 201/1967, where the sanctions revolve around the function loss, prohibition of exercising a public function for a certain time, among other measures, the political and administrative legal nature of the offense is now crystal clear.

Therefore, it is concluded that, although the Supreme Federal Court seeks to equate the legislative responsibility crime competence with the criminal offense, as stated in the binding legal precedent n°. 46, it should be noted that such an interpretation is not sufficient to equalize the themes, since the responsibility crime’s concept and legal nature are nothing alike criminal offenses themselves.

Therefore, the responsibility crime, despite being extremely serious for standing up against the commonwealth, should not be considered a criminal offense, as it has its own specific rules and sanctions, typical of this kind of political and administrative violation.

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Criminality and the new information and communication technologies

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Abstract—This work aims to present concepts related to crime in the face of new information and communication technologies. Methodologically, articles and books were used in addition to the legislation dealing with the matter, in particular the Brazilian Penal Code and Law 12.737/12 (Carolina Dieckmann Law). The increasing advance of technology, in addition to providing convenience to people, has expanded the possibility of commitment of crimes. Some already covered by traditional legislation, others needing new classification. In this context, after presenting fundamental notions to understand the topic — such as the concept of computer crime, classification, subjects and applicable legislation —, we sought to analyze some of the main computer crimes, especially the crime of computer device invasion. It was concluded that Criminal Law, in its purpose of protecting the most important legal assets, must act in order to curb the practice of computer crimes. In addition, despite the legislation covering a large part of the crimes committed on the network, the law must continue to update itself in the face of new threats, and the criminal offense of computer device invasion must be improved. Finally, it is addressed the difficulties related to the criminal investigation of this type of crime.

Keywords —Cybercrime, Criminal Law, Law 12.737/12.

I. INTRODUCTION

Criminal law, as the other branches of law, seeks to keep up with changes in society. However, the challenge of the Law in accompanying them - notably what regards to positivation - has become increasingly difficult, especially in recent decades, due the fast pace that technological development has been taking.

In this scenario, information technology (particularly the internet) brought several conveniences through a large amount of tools and services, such as banking transactions; online shopping (from companies or even between individuals); communication services (WhatsApp, social networks), with the possibility of video calls and conferences; huge possibility of data storage, such as documents, videos, photos, music; transport services

(Uber, 99Taxi) and even the legal environment was impacted through judicial process, conference calls, articles, books and video classes distributed online. Anyway, the possibilities are countless, and new tools emerge every day. In fact, we have it all, literally, in the palm of our hands, through the smartphones.

However, this wide range of possibilities also has its negative aspects. The internet stands out as a fertile ground for committing crimes - from crimes already typified, which only use computer devices as a means of practice, to new criminal types. This is due to the increasing spread of access to these technologies, accompanied by the great increase of transactions and communications carried out through the internet, which increases the number of potential victims, as well as the goods that circulate

because of it, and, consequently, the incentive to commit crimes. Thus, it is up to the State to suppress these conducts, reducing the insecurity of the digital environment.

Due this perspective, this work aims to briefly present the concept and classification of computer crimes and the applicable legislation in Brazil. In addition, an attempt was made to carry out an analysis of some of the most common crimes committed by computer devices, especially the crime of breaching a device. And, finally, address the difficulties encountered in the criminal prosecution of computer crimes, in view of their peculiarities.

II. METHODOLOGY

Several academic publications that address the subject in reference were used to prepare this work: books by renowned jurists to support the main theme of the article, in addition to the legislation dealing with the matter, mainly the Penal Code and Law 12735/12, as well as publications in the press that exemplify the topic addressed.

Thus, the research methodology used in this work was documentary research, since it allows the use of primary sources that provide data and information that have not yet been treated scientifically or analytically, and subject's bibliographic review, with scientific publications consults in periodicals, books, conference proceedings, among other means, in order to better clarify the subject in question, since it typifies crimes of computerized nature, committed through different devices, towards the new information and communication technologies, is not yet a simple task and requires an accurate analysis, precisely because of the lack of similar jurisprudence to clarify this issue. In addition, data and legislation relevant to the topic were also sought.

III. THEORETICAL FRAMEWORK

3.1 The internet and the Law

A computer network (a term that has become obsolete given the number of new devices that interconnect) is composed of several interconnected computers that exchange information with each other. The internet can then be defined as a network of networks that interconnects billions of devices worldwide. (KUROSE, 2010)

The creation of the internet dates back to the 1960s in the United States, driven by the Cold War, led the country to develop a national communication network aiming to exchange information between different computers. This network would prevent the interruption of the country's

chain of command in the event of an attack, in addition, it would prevent the important information concentration on a single machine (NETO, 2010). From there, the internet developed and spread around the world.

In Brazil, the internet originated from the National Research Network Project - RNP -, created in 1989 by MCT (Ministry of Science and Technology), but it was only in 1991 that it began to be disseminated as a national network interconnecting several networks across the country. Furthermore, it was only in 1995 that it was possible to open the Internet to companies and individuals of the Brazilian population, ceasing to be an exclusively academic network (BRASIL, 2016).

Initially, there were beliefs that the internet, due to its decentralized character, could not be regulated by the State, and that there would be absolute freedom in this environment. However, constitutional principles push these beliefs away, bringing the State and the Law to the sphere of information technology, among them: inviolability of intimacy to private life, honor, people's image (art. 5, X, CF), inviolability of communications (art. 5, XII, CF), non-obviation of Judiciary jurisdiction (art. 5, XXXV, CF) (ARAS, 2001).

In addition, despite the functionalities and facilities brought by the internet, it is also an useful tool for illicit acts perpetration – allowing, not only new crimes to be committed but potentialize conventional crimes - because, as João Araújo Monteiro Neto (2003) highlight:

[...] the existing means for the practice of computer-related crimes are numerous and given the characteristics of these infractions, the traces left are minimal, which makes the repression and the pursuit of these acts an arduous task. (MONTEIRO NETO, 2003, p.43)

It is observed then that the crime's fields also expand with the evolution of society and, therefore, the field of law must also keep up with this evolution, as Vladimir Aras (2001) points out: "if society (or part of it) migrated virtually to cyberspace, there must also go the Law. *Ubisocietas, ibi jus*".

In this context, it is up to the Criminal Law to act, also, in the scope of information technology, taking into account its purpose of protecting the legal assets most valuable to society.

3.2 Computer-related crimes

3.2.1 Concept

The crimes committed by computer devices have different names, among which stands out: computational offenses, information technology crimes, computer crimes,

cybercrimes, electronic crimes, virtual crimes, telematic crimes, information crimes, cyber offenses crimes.

The precise definition of computer crime is not yet consolidated in the doctrine, because of the modernity of this phenomenon. However, in a concise way, it can be said that computer crimes "are all typical, anti-legal and culprit conducts practiced against or with the use of computer systems." (SCHMIDT, 2015).

It is an unquestionable fact that the internet has become part of people's lives, whether through social networks (Instagram, Facebook, Skype, LinkedIn, Twitter, among others), or through applications (apps) or by consulting various sites that aims to make daily life easier, but, at the same time it is used for the positive side, there is also the use on the negative side, such as the installation of a mobile spy application that can hack all data and messages sent or received through WhatsApp, which today is one of the most widely used applications for exchanging messages and communication in audio and video over the internet, for example. In this regard, if any individual takes or receives data without consent and uses it in an improper way, he or she will be committing a crime of this nature.

3.2.2 Classification

Due to its fragmentary character, Criminal Law seeks to suppress only the most serious actions against the most important legal assets, hereof Rogério Greco teaches:

The legal system is concerned with an infinity of private and collective interests and assets. [...] However, in this legal system, **criminal law has the smallest role regarding the protection of these assets**. It should be noted that by its fragmentary nature, not everything matters to the Criminal Law, but only a small part, a limited portion of assets that are under its protection, but that, undoubtedly, at least in these, **are the most important and necessary for the relief of society** (GRECO, 2017, p. 140 emphasis added)

By using a computer device, the criminal faces several possibilities for committing crimes, in other words, to violate fundamentally important legal assets. These assets may already be protected by traditional Criminal Law, or not, due to the lack of specific legislation.

According to the offended legal asset, the cybercrime may be classified as proper or improper. Thus, improper cybercrime occurs when the computer is used only as a mean to execute a common crime, producing naturalistic results, threatening or damaging legal assets other than information technology (ARAS, 2001). Thereby, the computer is not essential for the crime's perpetration,

which could be practiced even without its help, it is the case of fraud, theft through fraud (embezzlement of bank account money, payment of bills by credit card improperly), crimes against honor, possession of child pornography, etc.

In the other hand, for the proper computer crimes, the computer is essential for the practice of the crime, considering that the legal object protected by these crimes is the computer system itself, the security of these systems and their data, for example (SCHMIDT, 2015). Examples are: invasion of a computer device (art. 154-A of the CP), insertion of false data in the public administration information system (art. 313-A of the CP).

3.2.3 Active and Passive Subjects

When it comes to computer crimes, the active subject that first comes to most people's minds is the mythical hacker - an expert in the operation of computers and computer systems, who uses his skills to invade those systems. However, João Araújo Monteiro Neto (2003) highlights that:

One time previously the profile of the cybercriminal was this. Currently, with the facilities caused by the development of Softwares and Hardware, as well as the innumerable information available on the network about the subject, any individual who has the minimum notions of how to operate a computer can be considered a potential computer criminal. (MONTEIRO NETO, 2003, p.41)

The wide spread of communication technologies, such as smartphones, computers and tablets, guarantees access to millions of people in services such as SMS, e-mails and instant messages, because of that, the number of potential victims today is huge. In this scenario, criminals can use social engineering¹ to mislead people and gain advantages for themselves, without the need of advanced technical knowledge.

Furthermore, regarding the large number of today's social networks users, added to the feeling of anonymity and impunity that the internet brings, everyone has the potential to commit crimes against honor, for example.

¹"Social engineering is a popular way for cybercriminals to discover users' personal information - such as passwords or bank details - without having to exploit security breaches in systems. In general, the strategy is hacking users, not their devices, in order to convince them that they are giving information to trusted people or services. The tactics used include e-mail messages and fake pages or psychological tricks to distract victims" (KURTZ, 2016)

Finally, given the wide range of computer crimes, any person - physical or legal - can be a victim of one of these crimes, if this person has, for example, his assets misappropriated, his property damaged or his information breached (ALMEIDA, MENDOÇA, *et al.*, 2015)

3.3 Brazilian legislation

The Legality Principle, a major advance in criminal law, is enshrined in art. 5, XXXIX, of the Federal Constitution: "there will be no crime without a previous law that defines it, nor a penalty without prior legal agreement." In this circumstance, in spite of the criminals' use of new communication technologies, a large part of the crimes committed using these technologies are already typified in the Penal Code of 1940, thus classified as improper cybercrimes.

For the Judiciary, 95% of the crimes committed electronically are already typified in the Brazilian Penal Code because they characterize common crimes practiced through the internet. The other 5%, for which there would be no legal framework, cover transgressions that only exist in the virtual world, such as the distribution of electronic viruses and DDoS² attacks. (CASSANTI, 2014, p. 24 APUD FILGUEIRAS, *et al.*, 2015, p.3)

It is not, it should be noted, legislative gaps being filled by analogy - since Brazilian criminal law does not allow the use of this integration technique in *malam partem*, due to the principle of legality (GRECO, 2017b) -, but an innovation while committing the crime. On this point, the understanding of STF Minister Sepúlveda Pertence, in HC:

"Computer Crime": child sex scene publication (ECA, art. 241), through insertion in a BBS / Internet network of computers, attributed to minors: typicality: expert evidence necessary to demonstrate authorship: HC partially accepted. [...] 2. It is not the case, therefore, to fill a gap in the incriminating law by analogy: once it is understood the typical decision of the criminal conduct,

² O DDoS (*Distributed Denial of Service*) is a type of virtual attack, in which "the master computer enslaves several machines and makes them access a given resource on a given server all at the same time. Thus, all zombies access together and uninterruptedly the same resource as a server. Taking into account that web servers have a limited number of users that can be served at the same time, this large number of traffic makes it impossible for the server to be able to fulfill any request. The server can restart or even hang depending on the resource that was victimized" (CANALTECH).

the technical means employed to carry it out may even be of a later invention to the edition of the penal law: **the invention of gunpowder did not demand redefinition of homicide to make explicit the death given to others by means of a firearm is a homicide.** (STF, 1998 emphasis added)

Regarding proper computer crimes, the two main laws that regulate the subject, in the criminal sphere, are laws 12,735 / 2012 and 12,737 / 2012. (BORTOT, 2017). The first changed item II of §3 °, of art. 20 of Law 7.716 / 1989, which "defines crimes resulting from prejudice of race or color".

Art. 20 of the law has as its type "to practice, induce or incite discrimination or prejudice of race, color, ethnicity, religion or national origin". The combination of paragraphs 2nd and 3rd, of article 20, establishes that if any of the crimes established in the caput is committed through the media or publication of any nature, the judge may determine, according to item II, of § 3rd, "the cessation of the respective radio, television or electronic transmission or publication by any means". The part of the provision item II, which allows the judge to determine the cessation of electronic broadcasts or publication by any means, is a law innovation, since the previous type only foresaw the radio and television broadcasts, without making reference to electronic broadcasts. In other words, the amendment came "to allow a request for the removal of discriminatory content to be made by the Judge, not only on radio, TV or the Internet, but in any possible way." (BORTOT, 2017, p. 350)

Beyond that, Law 12.735/2012 determined, in art. 4th, that the judicial police must create structures, sectors and teams specialized in combating computer crimes.

IV. ANALYSIS AND RESULTS

4.1 Most common computer crimes

Taking into consideration all the theory presented, a brief analysis of some of the most common computer crimes is carried out. Among them, we highlight the fraud (art. 171, CP) and theft qualified by fraud (art. 155, §4, II, CP), which despite being similar are not the same. In both, the criminal uses fraud - cunning, insidious means, in order to make the victim incur or be kept in error (GRECO, 2017a) - to obtain an illicit advantage. However, in the first one, the victim, induced in error, voluntarily disposes of his assets, while in the second one, fraud is used to evade the victim's surveillance, while the perpetrator subtracts his assets without his knowledge (DE OLIVEIRA JÚNIOR, 2015). They are classified as improper computer crimes.

Examples of these crimes are abundant and widely reported in the press, such as sending SMS, e-mails, WhatsApp messages posing as banks, cell phone operators or other institutions, in order to obtain information (names, CPFs, passwords, security codes) in order to obtain financial benefits (embezzling money from a bank account, for example) or even requesting cash deposits from third parties, posing as the victim.

It is noteworthy that during the pandemic times the internet use became much more intense with many people performing frequent banking operations, working remotely, and also shopping, making all their data available on the network, and with more people using the internet, more virtual crimes were committed and many users, either through misinformation or through identical/cloned applications, or due to the persuasion on the part of criminals, end up being victims of these crimes, which have already been carried out previously. It is evident that offenders take advantage of the pandemic itself, a period of vulnerability of the population, in order to convince the victims, as is happening in many cities in the country where, data are requested by people who pass themselves off as Ministry of Health officials to apply frauds by telephone.

In this manner, recently, a practice that has been alerted by the press is WhatsApp hijacking. The crime can occur in several ways: posing as an employee of an institution and then requesting the WhatsApp access code directly from the victim (NOGUEIRA, 2020); through SIM Swap³; or by QRLjacking⁴. After gaining access to the victim's WhatsApp, the fraudster starts to send messages to his contacts requesting loans from the victim's friends and family who, because they trust him, end up making bank deposits in the agent's account, as happened with the nutritionist JanaínaGoston who was the victim of virtual scam, as reported by the news.

³ “[...] consists of transferring the phone line to a SIM chip other than the one on your cell phone. It can be done in some ways that almost always involve social engineering: criminals pretend to be the victim and, with their personal information, get the operator to activate the phone number elsewhere.” (JUNQUEIRA, 2020).

⁴ “[...] technique capable of cloning QR codes to capture the credentials of the user who wants to login. The hacker just needs to convince the target to use his own cell phone to scan the cloned image on a fake website. When the strategy is successful, the criminal gains access to the victim's complete conversation history without arousing suspicion” (ALVES, 2019).

Another crime that he found on the Internet and other technologies as a means of dissemination and storage is child pornography, typified in Article 241-A and 241-B of the Child and Adolescent Statute (ECA).

Art. 241-A. Offer, exchange, make available, transmit, distribute, publish or disseminate by any means, including by means of a computer or telematics system, photography, video or other record containing explicit sex scene or pornographic sex scene involving a child or adolescent:

Penalty - imprisonment, from 3 (three) to 6 (six) years, and a fine.

Art. 241-B. Acquire, own or store, by any means, photography, video or other form of record that contains explicit sex scene or pornographic sex scene involving a child or adolescent:

Penalty - imprisonment, from 1 (one) to 4 (four) years, and a fine.

Analyzing the criminal types, it is possible to infer that the legislator decided to criminalize both the agent who distributes child pornography and the agent who acquires or even stores it, the second one, however, incurs into a lesser penalty. It should be noted that this crime can be committed by any means, and is therefore classified as an improper cybercrime.

Finally, as previously mentioned, Law 12.737/12 (Carolina Dieckmann Law), innovated Brazilian legislation by creating the criminal type of computer device invasion, inserting art. 154-A in the Penal Code, a proper cybercrime, considering that the legal object protected is the third party's computer device, with the consequent protection of its data and information.

Art. 154-A. Invade someone else's computer device, connected or not to the computer network, through an undue violation of a security mechanism and with the purpose of obtaining, tampering or destroying data or information without the express or tacit authorization of the device owner or installing vulnerabilities to obtain an illicit advantage:

Penalty - imprisonment, from 3 (three) months to 1 (one) year, and a fine.

§ 1º The same penalty applies to those who produce, offer, distribute, sell or broadcast a device or computer program in order to allow the practice of the conduct defined in the caput.

§ 2º The penalty is increased from one sixth to one third if economic damage results from the invasion.

§ 3° If the invasion results in obtaining content from private electronic communications, trade or industrial secrets, confidential information, as defined by law, or the unauthorized remote control of the invaded device:

Penalty - imprisonment, from 6 (six) months to 2 (two) years, and a fine, if the conduct does not constitute a more serious crime.

§ 4° In the case of § 3, the penalty is increased by one to two thirds if there is disclosure, commercialization or transmission to third parties, in any capacity, of the data or information obtained.

§ 5° The penalty is increased from one third to half if the crime is committed against:

I - President of the Republic, governors and mayors;

II - President of the Supreme Federal Court;

III - President of the Chamber of Deputies, the Federal Senate, the State Legislative Assembly, the Legislative Chamber of the Federal District or the City Council; or

IV - top manager of the direct and indirect federal, state, municipal or Federal District administration.

The aforementioned penal type requires the following elements: a) the invasion; b) someone else's computer device; c) connected or not to the computer network; d) through an undue violation of the security mechanism; e) for the purpose of obtaining, tampering with or destroying data or information without the express or tacit authorization of the holder of the device; f) or install vulnerabilities to obtain an illicit advantage (GRECO, 2017a).

It should be noted that for the crime to occur the object under protection (computer device) cannot belong to the author. "So, for example, if someone puts information on someone else's computer and the owner of the device is accessing the data inserted there, the offense under study will not be characterized" (GRECO, 2017a, p.765).

In addition, it does not matter whether the device is connected to a computer network or not - like the internet, for example. In other words, if someone, realizing that a friend forgot his computer at this person's home and he or she decide to invade it, if other elements of the type were present, the crime of 154-A will be perpetrated (GRECO, 2017a).

However, there is still a criticism to be made to the text of the Law. As it constitutes an element of the type, the need for the conduct to occur through an undue violation of the security mechanism, in case that there is an improper entry into another device, but without the breach of any

security device (login and password, for example), the conduct cannot be considered typical.

It is not uncommon that people avoid place access passwords, for example, on their computers, allowing anyone who has access to them to access their data. However, even without the existence of a password, no one is allowed to break into another's computer, unless the owner expressly or tacitly gives permission. However, for purposes of typical configuration, regarding the requirement contained in the penal type under analysis, there will only be a criminal infraction if there is an undue violation of the security mechanism by the invading agent. (GRECO, 2017a, p.766 emphasis added)

Finally, the agent's conduct must be carried out in order to obtain, tamper with or destroy data or information without the express or tacit authorization of the device owner or to install vulnerabilities to obtain an illicit advantage. Therefore,

[...] it is not the simple invasion, by itself, through the undue violation of the security mechanism that matters in the practice of the criminal offense [...] but, it must have a special purpose, that is, what called special purpose of action, which consists of obtaining, tampering or destroying data or information without the express or tacit authorization of the device owner. (GRECO, 2017a, p. 766)

Anyone can be an active subject of this crime, with the exception of the owner of the computer device. Meanwhile, the victim will be the owner of the hacked device, or anyone else who has data or information stored at that device. (GRECO, 2017a)

It is essential to point out that the penalty imposed is from three (3) months to one (1) year of detention, and a fine. The qualified modality, under the terms of §3°, increases the penalty for imprisonment, from six (6) months to two (2) years. There are also special causes that increase the sentence defined in §§2°, 4° and 5°. As so, the jurisdiction for the judgment of this crime lies with the Special Criminal Court, except in cases when the application of the qualifier and special causes that increase penalty causes the maximum penalty exceed the limit of two (2) years, under the terms of art. 61, of Law 9.099/95. Besides, it is possible to apply the conditional suspension of the process, pursuant to art. 89 of the same legislative diploma. In this context, it is important to note that the crime of invading a computer device is considered a less offensive potential crime.

4.2 Computer crimes' criminal investigation

Finally, it is essential to highlight the difficulties encountered in investigating computer crimes, which are diverse. Unlike other crimes, in computer crimes it is not possible to identify the agent visually or through documents, often the criminal uses false identification, or, as pointed out above, is impersonating other people. Furthermore, evidence of the materiality of the crime is extremely volatile and can be easily erased or lost (SCHMIDT, 2015).

This way, criminal prosecution in this type of crime requires specialized expertise to demonstrate the materiality and authorship of the crime and as pointed out by Schmidt (2015): "Often, for the proper materiality verification, it is necessary to intercept the flow communications carried out through a computer".

Beyond that, data recorded by internet service providers or application providers (such as social networks, e-mails and instant messaging programs, hosting providers) is essential to provide the IP address, date and time of access to its services, referring to the moment of the crime, which will only be provided by court order (SHIMABUKURO, 2017). The combination of the three data is necessary when requesting information from the connection provider, in order to identify where a certain illegal conduct arose, considering that the IP is dynamically allocated - to each computer access to the internet, a new IP is assigned to it (SCHMIDT, 2015).

It is important to point out that this procedure should be carried out as soon as possible, based on the criminal action identification, because despite the Marco Civil da Internet turning mandatory for providers to keep this information, highlights Adriana Shimabukuro (2017):

Decree No. 8.771/2016, which regulated the Marco Civil da Internet Law, determines that connection and application providers must delete user data as soon as the retention period ends. Considering that the deadlines are short, 6 (six) months for application providers and 1 (one) year for connection providers, the authorities now have another challenge to comply with the law.

After identifying the criminal action origin's place, the next step is to comply with search and seizure warrants issued by the competent courts, aiming to collect computer devices in general, including hard drives, memory cards and flash drives, in order to search for digital traces, materiality and authorship evidence of the crimes. For that, dedicated tools are used for this purpose, as added by Márcio Rodrigo de Freitas Carneiro (2017): "The complete

and detailed storage media processing requires dedicated tools that normally take considerable time [...]".

Among the main functions performed by these tools, we highlight: a process that alert the presence of known files or to ignore common system files; files categorization based mainly in the common formats used; text indexing extracted from file types; thumbnails provision and video frames selection to speed up responses and analysis; system's deleted files recovery; explicit image detection, implemented to categorize possible images, including pornography, to aid child pornography exams (CARNEIRO, 2017).

It should be noted, however, that when the device seized is a smartphone, there are extra difficulties:

a) Commonly, passwords are used to block the device, which by default automatically lock after a short time not using the equipment. There are many models that make it impossible to access data without a password and there are no known breaking methods.

[...]

b) Access to internal storage media is not simple and straightforward as with computers and notebooks. Cell phones' internal Flash memories are soldered to the device's printed circuit, and all access is limited through the USB communication port. (CARNEIRO, 2017 p. 51).

Finally, as explained above, this whole process starts from the agent's IP identification, however it is possible to hide or even change this identifier through tools such as proxies and services such as TOR (The Onion Router) (SHIMABUKURO, 2017). Adriana Shimabukuro (2017, p. 25) states that this last tool can "use up to 3 (three) fake addresses in different countries, making tracking almost impossible."

TOR is one software used to access the Dark Web or Darknet, which is a closed network, used to share content anonymously, composed of non-indexed data, in other words, it cannot be detected by search engines like Google or Bing (SHIMABUKURO, 2017).

Having this in mind, the difficulties of investigating these crimes remains evident, since the authorities still encounter several obstacles to effectively perform their functions.

V. CONCLUSION

The evolution and dissemination of communication and information technologies brought ease and convenience to people due the large number of tools and services

available. However, considering the neutrality of these technologies, it is also used as a tool for committing and enhancing crimes.

So, as seen, it is a Criminal Law function - in the constitutional and penal principles' view, such as the jurisdiction unfeasibility and fragmentation – to protect the legal assets most dear to society, wherever it may be, whether in the physical or virtual world.

In this regard, traditional criminal law already covers a large part of crimes committed at the Internet, given that many of them are common crimes with new execution means. It is important to have in mind, always, that it is not a case of using analogy in the classification of these crimes, which is emphatically prohibited by criminal principles. In the other hand, others criminal facts lack their own typification, as a result of having been created along with technological innovation.

As an example of these crimes, we highlight fraud, qualified theft through fraud, child pornography and the computer device invasion. It is noteworthy that this last crime is a recent creation in the Penal Code, considered a pure cybercrime. And, although it deserves applause for its innovation, there are criticisms against this new penal type because it demands that the conduct must occur through an undue violation of the security mechanism, which ends up weakening it, for leaving other harmful conducts outside the criminal law's scope.

Finally, it should be noted that harmful conducts, such as DDoS attacks and virus's distribution, still exists and are not covered by the current legislation, and deserve a legislator analysis in order to seek for protection over the legal assets guarded by the Criminal Law. In addition, it is mandatory to increase the investments in the investigative area related to these crimes, given the difficulty and the need for technical training, for the criminal prosecution of this crime's type.

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Effects of an Aerobic Physical Exercise Program on Blood Glucose Levels in Type-2 Diabetic Subjects, Associated with Pharmacotherapy and Diet Therapy

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Abstract— The objective of this study was to investigate the changes caused by an aerobic exercise program, scientifically methodized, in the glycemic values of individuals with Type 2 Diabetes Melitus (DMT2), initiating pharmacological treatment and diet therapy. The sample consisted of 39 sedentary subjects, of both sexes and with DMT2, who formed 2 study groups: a) An Experimental Group (EG), composed of 22 individuals who during the experiment were regularly submitted to the exercise program physical (Age: 58.2 ± 9.42 ; Body weight: 75.2 ± 5.99 ; Height: 170.7 ± 5.93); and b) A Control Group (CG), composed of 17 subjects also with the same criteria, who did not undergo any physical exercise routine during the study (Age: 51.2 ± 7.30 ; Body weight: 69.9 ± 5.53 ; Height: 164.5 ± 7.85). The experiment lasted 8 weeks in which the SG was submitted to aerobic physical exercises controlled by the perceived effort index, during which 3 weekly training sessions were performed, each lasting 60 minutes and performed on alternate days (2nd, 4th and 6th) between 06:00 and 07:30 in the morning. The measurement of the glycemic index (GI) was performed individually and fasting, using the Flash Glucose Monitoring System, brand "FreeStyle Libre", with the data collection taking place immediately after the end of the training session. In the analysis of the results, descriptive statistics were performed to characterize the sample, and subsequently, to find significant differences in the scores related to the physical characteristics of the SG and CG, the Student "t" test was applied for independent samples, and

finally, in order to compare the IG values of the groups studied between the pre and post-tests, the Student's "t" test was used for dependent samples. At the end of the experiment, it was found that the GI scores of the subjects composing the SG and CG showed a level of statistical significance of $p < 0.05$, with the average value of the IG in the SG being reduced by 29.53 mg / dl and the of the GC decreasing only 14.67 mg / dl. These scores represent a percentage variation of 20.52% in the SG and 11.41% in the CG, indicating between the pre and post-test more significant improvements in the SG of the SG, and thus suggesting that an aerobic physical exercise program, built scientific basis, can be a valuable complementary tool in non-pharmacological therapy for DMT2. Student's "t" test was used for dependent samples. At the end of the experiment, it was found that the GI scores of the subjects composing the SG and CG showed a level of statistical significance of $p < 0.05$, with the average value of the IG in the SG being reduced by 29.53 mg / dl and the of the GC decreasing only 14.67 mg / dl. These scores represent a percentage variation of 20.52% in the SG and 11.41% in the CG, indicating between the pre and post-test more significant improvements in the SG of the SG, and thus suggesting that an aerobic physical exercise program, built scientific basis, can be a valuable complementary tool in non-pharmacological therapy for DMT2. At the end of the experiment, it was found that the GI scores of the subjects composing the SG and CG showed a level of statistical significance of $p < 0.05$, with the average value of the IG in the SG being reduced by 29.53 mg / dl and the of the GC decreasing only 14.67 mg / dl. These scores represent a percentage variation of 20.52% in the SG and 11.41% in the CG, indicating between the pre and post-test more significant improvements in the SG of the SG, and thus suggesting that an aerobic physical exercise program, built scientific basis, can be a valuable complementary tool in non-pharmacological therapy for DMT2. At the end of the experiment, it was found that the GI scores of the subjects composing the SG and CG showed a level of statistical significance of $p < 0.05$, with the average value of the IG in the SG being reduced by 29.53 mg / dl and the of the GC decreasing only 14.67 mg / dl. These scores represent a percentage variation of 20.52% in the SG and 11.41% in the CG, indicating between the pre and post-test more significant improvements in the SG of the SG, and thus suggesting that an aerobic physical exercise program, built scientific basis, can be a valuable complementary tool in non-pharmacological therapy for DMT2.

Keywords— Diabetes Melitus, Glycemic Index, Physical Exercise.

I. INTRODUCTION

Diabetes Melitus (DM) is a syndrome that covers a group of metabolic disorders, which share the phenotype of blood hyperglycemia. This phenomenon results from the physiological failure of the pancreas in the hormonal production of insulin, a hormone responsible for the transport of glucose molecules from food intake, from inside the blood vessel to the cellular interstitium, where after a series of chemical chain reactions is produced energy intended to meet both vital organic physiological needs, as well as to enable activities related to daily life.

The blood hyperglycemia as physiological phenomenon occurs when the kidney threshold exceeds its critical level of glucose absorption, and thus a significant proportion of it becomes eliminated in the urine

(glycosuria). This fact occurs when the concentration of glucose in the blood exceeds values approximately 180 mg / dl, causing the individual an osmotic diuresis (polyuria), which in turn results in the dehydration of tissue cells (polydipsia).

This is because glucose, due to the inadequate amount of insulin present in the bloodstream, does not diffuse easily through the pores of the cell membrane, and so the osmotic pressure is increased in the extracellular fluid causing the transfer of water out of the cells, promoting extra dehydration and also intracellular. This fact can contribute significantly to the occurrence of circulatory shock, requiring, in order to recover homeostasis, a greater fluid intake by the affected subject.

For Guyton (1998), most of the pathological characteristics of DM can be attributed to one of the following main effects resulting from the lack of insulin: a) Less use of blood glucose as an energy substrate by the body's cells, resulting in an increase in its concentration of 300 to 1,200 mg/dl; b) Increased mobilization of fats from adipocytes, causing an abnormal lipid metabolism and facilitating the deposition of cholesterol in arterial walls, causing atherosclerosis; and c) Abnormal protein depletion in body tissues, due to its high conversion to carbohydrates.

There are several types of DM, all caused by a complex interplay of genetic and phenotypological factors related to environmental aspects and the individual's lifestyle, the most common being Types 1a (DMT1a) and 1b (DMT1b), Type2 (DMT2), and also the Gestational Type (DMTG) (SOCIEDADE BRASILEIRA DE DIABETES - SBD, 2016). Other types of DM are less common, among which are the situations of genetic defects in beta cells, in the action of insulin, also in the exocrine pancreas, infections, and even chemically induced DM or other genetic syndromes (LIMA et al., 2010).

DMT1a (autoimmune) is the result of immune destruction of pancreatic beta cells, rendering the pancreas incapable of producing the hormone insulin and thus increasing the susceptibility of the subject affected by blood ketoacidosis, which can lead to coma and death. The destruction of beta cells is usually caused by an autoimmune process, which can be detected by circulating autoantibodies such as "anti-glutamic acid decarboxylase" (anti-GAD), "anti-islets" and "anti-insulin", the same being sometimes associated with other autoimmune diseases such as "Hashimoto's thyroiditis", "Addison's disease", and even "myasthenia gravis" (BERTONHI & DIAS, 2018).

For the authors mentioned above, this type of DM is diagnosed mainly in childhood or adolescence, with a prevalence rate of around 5-10% of the identified cases, with its peak incidence occurring in individuals between 10 and 14 years of age, or even slowly progressive in adults, in this case being called "LADA" - *latent autoimmune diabetes in adults*. DMT1b (idiopathic) has no defined cause and corresponds to cases in which there is no presence of immune markers (MOREIRA & CARVALHO, 2016).

DMT2 is characteristic of subjects whose pancreas normally produces insulin, but due to the decrease in its action, their cells are unable to use it properly, and this condition is characterized as insulin resistance. That is, there is no effective hypoglycemic action of insulin, and thus there is a decrease in glucose uptake by cells, resulting in increased hepatic glucose production, which further

contributes to the increase in blood glucose and is associated with high insulin levels. in the blood (FIGUEIREDO & RABELO, 2009).

This type of DM corresponds to approximately 90-95% of diagnosed cases and manifests itself mainly in adults, with its main causes being related to obesity and the sedentary lifestyle of the symptomatic individual (SOCIEDADE BRASILEIRA DE DIABETES, 2016).

DMTG is defined as the change in plasma glucose levels of pregnant women, almost always manifesting itself in the second or third trimester of pregnancy, with this hyperglycemic condition tending to disappear after delivery, but with high probabilities of its return later. The prevalence of this condition varies between 1 and 14% of pregnancies, with excessive weight gain during pregnancy being one of the risk factors for its development, which can cause problems for both the mother and the fetus (SOCIEDADE BRASILEIRA DE DIABETES - SBD, 2009).

Regardless of its typological classification, DM is one of the most relevant chronic non-communicable diseases today, with its prevalence increasing over the last decades due to factors such as: a) Sedentary lifestyle; b) Expanded urbanization; c) Obesity; d) Inadequate food; and e) Population aging, among other issues (SCHMIDT et al., 2009).

According to the Brazilian Diabetes Society - SBD (2016), about 382 million people have DM worldwide and these numbers are expected to reach 471 million in 2035. In 2015 in South and Central America, 247,500 people died from diabetes (122,100 men and 125,400 women), with over 42.7% of these deaths occurring in people under the age of 60, and more than half of these deaths (130,700) occurred in Brazil (INTERNATIONAL DIABETES FEDERATION - IDF, 2015).

Based on data from the Ministry of Health, Bertonhi & Dias (2018) published that the frequency of prior medical diagnosis of DM in Brazil is 6.9% in men and 7.3% in women, and that when comparing the data related to the theme in the period from 2008 to 2015, in seven years the incidence of DM increased from 5.8% to 7.1%, and in both sexes, this disease became more common after 45 years of age.

Thus, it is well known that DM, in Brazil and worldwide, stands out for its importance as a public health problem, as well as that its epidemiological impact is expressed by increasing population mortality and morbidity rates, the latter being associated with related sequelae to visual disturbances, blood arterial hypertension, nephropathy, neuropathy, lower limb amputation, sexual impotence,

cerebral cardiocirculatory and vascular disorders (AMERICAN DIABETES ASSOCIATION - ADA, 2000).

Although better understood, and even though new drugs have appeared for the treatment of DM in recent years, it seems that its control remains unsatisfactory both in government institutions, as there is a lack of efficient public policies, as well as by the vast majority of the population.

In this context, in order to seek to minimize or even prevent the effects of DM on the body of individuals affected by this pathology, different strategies for therapeutic interventions are increasingly proposed, among which, due to their effectiveness, low cost and minimum risk, they stand out. whether the subject's behavioral changes in relation to dietary factors and also to the practice of regular physical activity (ERIKSSOM & LINDGARDE, 1991; HELMRICH et alli, 1991; MANSON et alli 1992; LYNCH et alli, 18996; PAN et alli, 1997; ERIKSSOM & LINDGARDE, 1999; TUOMILEHTO et alli, 2001; MAYER & COSTACOU, 2001; KNOWLER et alli, 2002; Lyra et alli, 2006).

With regard to this last factor, that is, the regular practice of physical activities by symptomatic subjects of DM, when it comes to considerations about the volume, intensity, repetition and frequency of such practice, it still seems not possible to establish a definite academic opinion on the subject, making it clear that the subject still needs a greater number of investigations.

On this subject, Rodrigues de Almeida et alli (1999; 2018) warns of the importance of detailed planning of the practice of physical activity, showing four basic aspects during its execution: a) intensity or quality; b) volume or duration; c) frequency; and d) repetition of stimuli. The aforementioned author suggests that an individual's systemic functional organic condition will only be expanded when such variables are properly planned and bandaged in a scientifically methodized work system in relation to the prescription and control of training loads, which he calls "physical exercise".

This admitting, and in view of the foregoing, this research intends to collaborate for the development of non-drug strategies that prove to be efficient in the prophylaxis or therapy of DM, investigating what changes are caused by a physical exercise program scientifically methodized in the glycemic values of individuals with type-2 DM, undergoing initial pharmacological treatment and diet therapy.

II. MATERIAL AND METHODS

2.1. Population and sample

The population of this study was composed of sedentary subjects of both genders and with DM2, who, in addition to the prescribed drug treatment and the recommended diet therapy, for medical advice should also begin the regular practice of physical activities. Initially, a first personal contact was made with those interested in participating in this study, all of whom frequent a physical space open to the general public for leisure and physical activities, located in the city of Porto Velho, capital of the State of Rondônia, Amazon Brazilian, entitled "Alternative Space", to explain the relevance of the research to them, as well as requesting them to sign a free and informed consent term.

The sample consisted of 39 subjects undergoing drug treatment and diet therapy, who before starting the experimental procedure were randomly assigned to two study groups: a) an Experimental Group (EG), composed of 22 individuals who underwent regular experimentation a physical exercise program (PEF); and b) a Control Group (CG), composed of 17 subjects, who during the study were not submitted to any physical exercise routine.

III. TREATMENT OF THE DEPENDENT VARIABLE

3.1. Equipment and standardization of measures

In this study, according to the protocols detailed below, the anthropometric parameters Total Body Weight (PCT) and Height (EST) were initially measured, which together with the informed age were used only to characterize the investigated sample.

1. The PCT, understood as the result of the system of forces exerted by gravity on the total body mass (MATSUDO, 1987), was measured using an electronic scale of the brand Filizola with a capacity of up to 150kg and precision of 1g, and its values are expressed in kilograms - kg. The measurement was performed with the equipment positioned on level ground, being evaluated standing in the center of the platform, in an upright posture and with the head horizontal, the legs in slight lateral distance and the arms relaxed along the body (PETROSKI, 1999) ; and
2. EST, understood as the vertical linear length between the plantar region and the vertex (PITANGA, 2008), was measured using a portable Avanutri stadiometer and accurate to 1 mm, with its values expressed in centimeters - cm. The measurement was obtained with the subject barefoot, the heels, buttocks, the shoulder girdle and the occipital bone in discreet contact with

the perpendicular ruler. As recommended by standardization, a transverse cursor was slid by the ruler to the vertex, forming a right angle. The reading was carried out with the evaluator in maximum inspiration and with the head directed towards the Frankfurt plan (PETROSKI, 1999).

Then, the Glycemic Index (GI) was measured, the dependent variable of this study, which is understood to be the numerical value that represents the levels of glucose concentration in blood plasma (ROBERGS & ROBERTS, 2009). Measurement was made with fasting subjects using the "FreeStyle Libre" Glucose Monitoring Flash System, consisting of: a) Portable monitor powered by a rechargeable lithium-ion battery, measuring 95mm x 60mm x 16mm and weighing 65g, sample volume of 1 microliter, range for blood ketone interval from 0.00 to 80mmol / L and with measurement via scanning of values between 20 to 500mg/dl; and b) Sensor powered by a silver oxide battery and water resistant, measuring 5mm high x 35mm in diameter and weighing 5g, with a memory of up to 8 hours for storage of the measurement readings,

Data collection followed the following procedures: a) initially, before starting physical activity, using a non-allergic adhesive layer, a "FreeStyle Libre" sensor was fixed at the midpoint of the posterior region of the arm of each component subject the sample (mesohumeral point); and b) Finally, individually and immediately after the end of the training session, using the portable monitor reader, glucose measurement was carried out by scanning the sensor, in a fast and painless process that takes approximately 1 second.

In order to reduce and even avoid possible failures, during the data collection there was the collaboration of 5 Physical Education professionals, each in possession of a Flash Glucose Monitoring System, who wanted them prior to the day's work, they were responsible for checking the condition of the material to be used, as well as fixing the sensors individually to the sample components.

IV. TREATMENT OF THE INDEPENDENT VARIABLE

4.1. Physical exercise program (PEF)

Before starting the PEF, two physical training sessions were instituted to allow individuals to become familiar with the mechanical aspects of the PEF component exercises, which had a total duration of 8 weeks, during which 3 weekly training sessions were applied, each lasting 60 minutes and held at 2^a, 4^a and 6^a - trade between 7:30

a.m. and 06:00 aM, which are divided into three parts teaching as is detailed below:

Preparatory Part: Aiming to increase blood supply to muscle tissues in general, initially a dynamic stimulus of the continuous type was used, which was performed in the form of a vigorous walk for 3 minutes. Subsequently, aiming to stretch the muscle groups to be most requested during training, as well as to improve the subjects' joint mobility, stagnant exercises were used and located for 7 minutes, in which individuals voluntarily sought in the anteroposterior and lateral directions, the limit functional mobility of the joints of the wrist, elbow, shoulder, hip, knees and ankle, remaining in the borderline position for a time of 10 - 12 seconds, and repeating the procedure in each joint for 2 times sequentially and with an interval of 5 seconds between them (NUNES, 1998).

Main Part: In order to promote morphological and functional improvements in the cardiovascular system, a dynamic stimulus of the continuous type was used, which was performed in the form of vigorous walking, with the intensity of the effort being controlled by the subjective feeling of tiredness (ACSM, 1995). For this, in the first week of work during the training sessions, the subjects placed the perception of fatigue at level 6 (moderate), performing the prescribed physical activity for 30 minutes, progressing weekly in one unit until reaching level 8 and increasing the time of physical effort for 40 minutes. The workload remained with this quality of training for 4 weeks, and then, in the eighth and last week of the PEF, the rate of physical effort was raised to level 9 (strong) for 40 minutes.

Final Part: Ending the training session and in order to assist in the removal of exudates from cell combustion, immediately after the end of the 40 minutes related to the main part, without interruption the subjects continued to walk for another 33 minutes, now in a moderate way, gradually decreasing the intensity until the displacement is smooth. Subsequently, with the objective of stretching the most requested muscle groups in the training, for 7 minutes the individuals were repeated the same stagnant exercises in a localized manner used at the beginning of the training session, performing the same procedures and in the same joints.

V. DATA STATISTICAL ANALYSIS

In this experiment the data were analyzed using the following procedures:

1. initially, descriptive statistics were performed to characterize the sample;

- subsequently to detect possible significant differences in the scores related to the physical characteristics of the SG and CG, the Student's "t" test was used for independent samples; and
- finally, to compare the values of the IG between the pre and post-tests during the experimental period, the Student's "t" test was used for dependent samples. The data were processed and analyzed using the computerized statistical package "STATISTICA for windows" Version 4.3 from Starsoft Incorporation, looking for a significance of $p < 0.05$.

VI. RESULTS AND DISCUSSION

In order to characterize the sample, Table 1 presents the result of the "Student's t test for independent samples" (mean values and their respective standard deviations), for the variables: Age (ID), Height (EST) and Total Body Weight (PCT) of the experimental (EG) and Control (CG) groups, compared to each other before starting the experiment. The statistical treatment showed significant

differences between the scores of all the variables analyzed, demonstrating the heterogeneity of the sample.

Table 1: Physical characteristics of the sample.

Variables	Experimental Group	Group Control	t	P
Age years	58.2 ± 9.42	51.2 ± 7.30	2.08	0.048*
Stature (cm)	170.7 ± 5.93	164.5 ± 7.85	2.42	0.022*
Weight (kg)	75.2 ± 5.99	69.9 ± 5.53	2.45	0.020*

*Significant at $p < 0.05$

In line with the objectives of this study, Table 2 presents the analysis of the "Student's t test for dependent samples" (mean values and their respective standard deviations), of the Glycemic Index (GI) of the SG and CG, in which it is observed that the scores related to the GI presented by the subjects that are part of both groups investigated, between the beginning and the end of the experiment showed statistical significance at the level of $p < 0.05$.

Table 2: Values in mg / dl of the sample's IG at the beginning and end of the experiment.

Study Groups SG	n	Glycemic Index – GI (mg/dl)			
		Pre-Test	Post-Test	t	P
Experimental Group - EG -	22	145.88 ± 11.46	114.35 ± 9.81	9.43	0.000*
Control Group - CG -	17	123.83 ± 4.96	109.16 ± 4.60	8.94	0.000*

*Significant at $p < 0.05$

Nevertheless, it can also be seen that the mean value of the SG decreased by 29.53 mg / dl and that of the GC decreased by 14.67 mg/dl, scores that represent a percentage variation in the glycemic index of 20.52% in

the EG and 11.41% in the CG, indicating a greater functional improvement in the SG of the SG during the experiment, this fact being better visualized in the figure below.

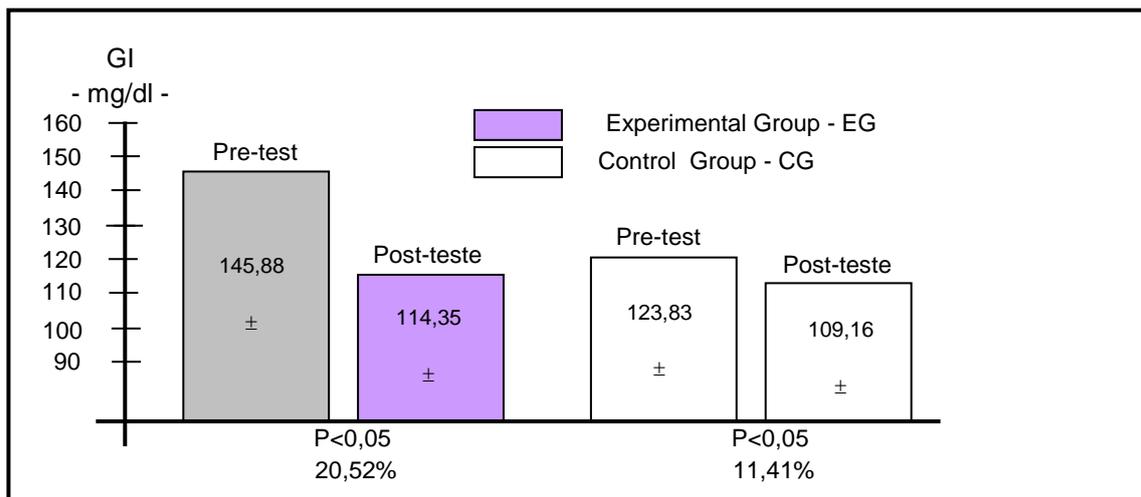


Fig.1: GI values (mg/dl) of the sample at the beginning and end of the experiment.

Thus, in view of the above, it can be assumed that the prescribed physical exercise program was responsible for the increased improvement in the GI of the subjects that make up the SGE1, which confirms the results obtained by Luciano & Bessa Lima (1997), who published about the beneficial effects of exercise and the improvement in glucose uptake that is increased during exercise, even with low insulin levels, and is also corroborated by Pratley et al (2000) who after studying for 9 months the effects of aerobic exercise in the elderly, concluded that this type of training significantly reduces insulin concentrations stimulated by glucose.

In this sense, for some time now, other authors have shown that the effects of physical exercise in type 2 diabetic individuals are characterized by the notable increase in the use of glucose for energy production, unlike individuals with the same pathology who do not practice physical activity (Gumbiner, 1999; Leong & Wilding, 1999; Dela et al, 1997); Hickner et al, 1999).

Zinker et al (1999) in a research investigating the insulin sensitivity of individuals with DMT2, carried out an experiment with 3 study groups, one group, group 1, undergoing physical exercises and without using medication to treat diabetes, and the other two groups only undergoing drug treatment (metformin and troglitazone, groups 1 and 2 respectively), and without practicing physical activity. At the end of the experiment, they observed that the best results were presented by the group that only did physical activity in contrast to the other study groups analyzed.

Silva & Lima (2001) in an experiment with symptomatic individuals of DMT2 under treatment with oral antidiabetic and insulin, submitted them to a program of physical exercises of 10 weeks duration, with 4 weekly sessions of 60 minutes each, and at the end they observed that all

subjects in the sample had a significant hypoglycemic effect ($p < 0.05$) in response to physical exercise, attesting to the importance of their daily performance for the control of the thematized pathology.

VII. CONCLUSIONS

According to the problematization of this research, as well as considering the analysis and discussion of the results found here, there is a statistically significant behavior between test and retest in the scores of both the SG and the CG ($p < 0.05$), being that the best values were found in the EG, which allows us to assume the positive effect of the independent variable of this study in reducing the GI of subjects with DMT2, a fact demonstrated by the quality of the training loads of the prescribed PEF (volume, intensity, frequency and repetition), which in association with drug treatment and food control, proved to be a valuable complementary tool in the treatment of DMT2.

In view of these findings and aiming to extend the line of research of this investigation, it is suggested to carry out further research analyzing this time the effects of resistance training on the thematized population, at different intensities of physical effort and with a larger sample grouped by range age. It also seems important to us to study the psycho-social factors presented by the population in question, which should be considered in the development of public policies aimed at comprehensive care for people with DMT2, as well as to identify pedagogical practices that are capable of motivating their adherence. individuals in intervention programs, and thus making compatible, in addition to knowledge, also efficient personal actions for health promotion.

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Building a microprocessor architecture at Computer Engineering undergraduate courses

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Abstract— *The learning process of Computer Organization and Architecture is fundamental for students of Computer Engineering and related areas. The complexity and lack of familiarity of the students with the content make it difficult to understand essential concepts for the development of fundamental skills for a computing area professional. This paper introduces a conceptual microprocessor implemented in three different courses of Computing Engineering undergraduate: Computer Organization and Architecture, Very Large-Scale Integration (VLSI) Circuit Design, and Embedded Systems Design. The overall idea is to link the fundamental concepts of Computer Organization and Architecture with hands-on opportunity to develop the blocks, such as registers or program memory, using a hardware description language, and applying this microprocessor on embedded systems design, using it as a softcore processor. Initial results showed the students get more involved in their learning process when they understand the usage and application of those concepts.*

Keywords— *Computer Organization and Architecture, Embedded Systems Design, Learning Process, Very Large-Scale Integration.*

I. INTRODUCTION

The design of an embedded system implies to choose a suitable microprocessor to achieve the features of the design in terms of power consumption, raw material cost, or memory access capacity, for instance. It means that it is essential for Computer Engineering students to understand the architecture and organization of microprocessors to design an embedded system in their future professional career properly.

We noticed that some concepts addressed in Programming Methodology and Algorithms are well understood by the students when they have the opportunity to associate these concepts with the internal organization of the microprocessor they are dealing with. Didactic microprocessors simulators have been proposed to improve the learning process. Most of them have a simplified architecture in terms of machine language, and a limited organization in terms of external interfaces, such as input and output pins, and other interfaces. These simulators are usually software applications written with high-level languages, like Java or C#. Most of them do not allow the users to make changes on them, nor integrate them with

other systems, for example, a physical or synthesizable microprocessor.

In this paper, we are suggesting the adoption of a software tool to fulfil this gap. The tool is an application that simulates a simplified microprocessor called μ PD. At this point, the tool is similar to the other ones proposed so far and is suitable for the Computer Organization and Architecture course. The advantage of this tool is its capability to generate VHDL code (acronym of Very high-speed integrated circuit Hardware Description Language). The tool generates the internal structure of the μ PD processor as components (or blocks), like registers block or memory block. The students of the VLSI Circuit Design course can connect those blocks to build an entire μ PD microprocessor and check its functionalities. It is the second opportunity that the students have to work with the microprocessor.

The third opportunity is in the Embedded Systems Design course. At this point, the students already have a softcore well tested and working, and in this course, the students plan and implement embedded systems based on this softcore. The students must do new VHDL components according to their design needs.

We organized this document in sections. Section two introduces the related work. Section three was divided into subsections and introduced the Organization and Architecture of μ PD processor, in terms of internal blocks, Instruction Set, for instance. It also introduces the two simulators developed: Text simulator and Block simulator. Section four introduces the initial evaluation done with undergraduate students of Computer Engineering. We finished this paper with some conclusions and target for future work.

II. RELATED WORK

This section introduces the main academic simulators adopted as engineering education tools. It was divided into subsections, in which the main features of those tools are outlined. At the end of this section, we introduce a table outlining the μ PD tool with the other ones previously described.

MARS

The MARS simulator was developed by [1]. It is an IDE (Integrated Development Environment) that simulates a microprocessor MIPS. Several engineering colleges adopted MIPS tool for practical experiments due to its simplicity and regularity. In other words, it has 32 registers, and each of them with 32 bits [2]. MARS has an integrated editor, featuring multiple file-editing tabs, with context-sensitive input, and colour-coded assembly syntax. All assembly files in a folder may be assembled into a single executable. It also has a command-line mode for tests and to evaluate many programs. The command-line arguments allow specifying registers and memory locations to be displayed after the program run to examine for correct contents. A differential feature of MARS is an option called "Tool" utility for MIPS control of simulated devices. The authors define a Tool utility as a program running on a separate thread with access to MARS data. An assembly program can run in MARS and interact with the tool through memory-mapped IO. Due to this feature, several pseudo-devices can be interfaced to MIPS assembly code, or extended to physical devices or hardware.

QtSPIM

QtSPIM, available at [3], is a self-contained simulator that runs programs for MIPS32. It works as a "command terminal", and the users can read and execute assembly language programs written for MIPS32 processor. QtSPIM also provides a simple debugger and minimal set of operating system services. It is a tool that implements much MIPS32 assembler-extended instruction set. Some

exceptions are the most floating-point comparisons, some rounding modes, and the memory system page tables. The MIPS architecture has several variants that differ in various ways (e.g., the MIPS64 architecture supports 64-bit integers and addresses), which means that QtSPIM will not run programs for all MIPS processors. As weakness, it does not have an IDE well elaborated with breakpoints, and other useful debug features and is not possible to execute a program step-by-step.

CPULATOR

CPULATOR, also known as "Computer System Simulator"[4] is a tool capable of simulating three architectures: Nios II, ARMv7, and MIPS. Its simulation is done as a computer system, e.g. a processor and I/O devices. To prevent issues related to the installation, those authors have built the debugger that runs in a regular web browser. It was designed as a tool for learning assembly-language programming and computer organization. As main features that may be highlighted are the debug options offered by the tool: Single-step, breakpoints, watchpoints, trace, call stack, examine disassembly, memory and registers. It's the tool with more debug features we found so far. As inputs, it accepts both assembly source code and ELF executables.

ARMSIM#

ARMSIM# [5] was conceived as a desktop application developed to run in a Windows environment (.NET3.0). It allows users to simulate the execution of ARM assembly language programs on a system based on the ARM7TDMI processor, together with collecting statistics for execution and cache usage [5]. It also can be extensible through plugins, which provide an interactive environment for I/O by simulating examples of embedded systems. The authors have implemented several plugins, and they are available for download. An important feature is the addition of graphical views, programmed as plugins, allowing execution of interactive interfaces and supporting interrupt processing. The main view included is that of a board including an ARM processor and a set of peripherals - buttons, LED lights, keyboard, small LCD screen.

CompSim

CompSim is an IDE developed by [6] to be an assistance tool for Computer Organization and Architecture course. It uses a proprietary 16 bits processor called Cariri: an accumulator-based processor with 16 instructions set. The development was done using Python v3.5 and can be run on MS Windows and GNU Linux (32 and 64 bits). The IDE has visual components that emulate the hardware, like memory and input / output pins. Some of this hardware is configurable like the RAM memory, for

instance. This memory can be configured as Direct Mapped, Fully Associative, and Set Associative.

SimusS

SimusS was proposed by [7], and it is based on a configurable processor, called Neander-X. The processor has a variable instruction size, from 1 up to 3 bytes, four addressing types and 31 assembly instruction. SimusS has a simple IDE interface emulating input and output devices. The IDE also has a text editor and an assembler integrated. It is possible to visualize the internal data path of the processor during the debug action, further the external input and output interfaces.

Bipide

Bipide was proposed by [8] as an integrated environment in which it is possible to develop an algorithm and execute in a virtual 16 bits processor, called BIP. Different from the Neander-X, the BIP processor has a regular instruction size with 16 bits. The main difference is the natural language used as the programming language. BIP was developed to be used on early stages of Computing Science and Computing Engineering when the students are taking the first algorithm programming course. The students can check the data path inside the processor graphically while the algorithm is executed step-by-step.

CESAR and RAMSES

CESAR was developed by [9] and, on the same way of the other tools we mentioned in this section, it also focuses on Computer Organization and Architecture learning. The proprietary processor has 16 bits and 41 assembly instructions. The graphical environment of this tool is simple, showing register related to the ROM memory, register related to the RAM memory, and input and output pins. The main difference of this tool to the other ones is the data representation, based on 2's complement.

RAMSES processor is an 8 bits version of CESAR processor. It has four addressing modes, while the CESAR has eight. The instruction set is also different; for the RAMSES, there are only 16 assembly instructions. The graphical interface is quite similar to the CESAR interface, only changing the registers sizes.

COCONUT

Authors [10] proposed a visual educational configurable simulator for computer architecture and organization, called COCONUT. According to them, the

students can create their own processor with an arbitrary architecture and simple organization on the register transfer level, write an assembly program to be executed on the processor and observe the instruction execution phases of the program on the processor. The students create a VHDL processor using some basic blocks and following some rules do connect them. A simulator is available to evaluate and test the implemented processor. The configurable part allows students to use the simulator for defining the instruction decoding of the processor operation unit and the content of the microprogram memory of the processor control unit.

EduMIPS64

Authors [11] proposed the visual EduMIPS64 CPU simulator as supporting to undergraduate computer architecture students. It implements a 5-stages pipeline, allowing instruction-level parallelism. As each virtual CPU cycle is executed, the user interface updates all its components to display the representation of the current program execution state. The simulator was written in Java language and its graphical interface implements, further the necessary registers and memories, some statistics on the execution, such as the number of Cycles Per Instruction and the number and class of stalls.

MarieSim

Authors [12] developed the MarieSim: a computer architecture simulator based on the MARIE architecture and designed to teach beginning computer organization and architecture. It has a graphical environment that allows students to observe how assembly language statements affect the registers and memory of a computer system. The graphical environment for MarieSim and the accompanying data path simulator was written in Java Swing, and the integrated MARIE assembler was written in Java. MARIE is the acronym of "Machine Architecture Really Intuitive and Easy"

Overview of related work

This Subsection summarizes the academic simulators reviewed in Section with Table 1 outlining the main features of each simulator. μ PD features were also included at the end of the table. Note that μ PD is the unique toolset that generates VHDL code. The code generated is used by the students on the other two courses: VLSI Circuit Design, and Embedded Systems Design.

Table.1: Overview of the academic simulators introduced above. Grey colour means the simulator has that feature.

	MA RS	QtSPI M	CPUlat or	ARMSi m#	COCO NUT	EduMIP S64	MarieSi m	CompS im	Simm uS	Bipide	Ces ar	μP D
No installation required												
Editor												
Assembler										Natural language		
Debugger		Few options										
Block simulation												
I/O interface												
Interrupt interface												
Depurator												
Data-path visible												
Based on Accumulator												
Based on Registers												
Generate VHDL code												

III. μPD SOFT PROCESSOR

Over the past three decades, the Association for Computing Machinery (ACM) and the Computer Society of the Institute for Electrical and Electronics Engineers (IEEE-CS) joined efforts to promote and upgrade a document periodically with curricular guidelines called “Computing Curricula” [14],[15]. These guidelines are defining broad knowledge areas that apply to all computer engineering programs.

According [16], the six knowledge units with five or more core hours in the Computing Curricula are: Fundamentals of computer architecture, Memory system organization and architecture, Interfacing and communication, Device subsystems, Processor systems design, and Organization of the CPU.

The three courses we are working (Computer Organization and Architecture, Very Large-Scale Integration – VLSI - Circuit Design, and Embedded Systems Design) deal with this knowledge in different

manners. So, we intended to propose a softcore simulator capable of being used by these courses and covering the knowledge units with varying levels of difficulty.

Platform Overview

According to the authors [13], a platform consists of a library of components associated with its composition rules. These standards allow the reuse of cores and the communication infrastructure, thus creating the concept of a development platform. We understand that we have to work with this target in mind: elaborate a platform based on the software processor μPD. So far, we have developed some software tools: editor, assembler, software simulation, and VHDL code generator, all of them forming a toolset. Furthermore, the VHDL code generated by one of these tools has a standard interface and connection rules, which allows the students to build large embedded systems. The standard interface and connection rules are on the way to build a future platform.

Processor Organization

The didactic processor we are proposing is a monocycle RISC (Reduced Instruction Set Computer) with 16 bits data bus. It connects to an external ROM (Read Only Memory), that contains the machine code given by the Assembler tool. To connect to other devices (or external

components), it has an input bus and an output bus, as depicted in Figure 1. The signals INT are six external interrupts supported by the processor, ADDR is an address bus, and DIN and DOUT are input data and output data, respectively.

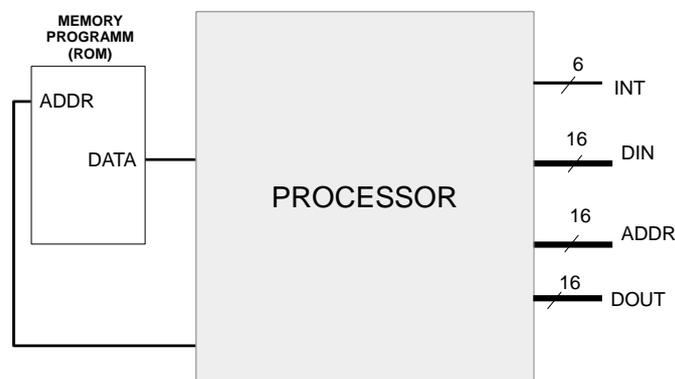


Fig. 1: ROM memory, processor and its connection bus.

Figure 2 illustrates the internal processor blocks. It was divided into two logic areas called “data path”, bordered by a blue dashed line and “control path”, bordered by a pink dashed line. The control path is responsible for the reading of instructions stored in the ROM memory, and to manage the execution of data flow. This management is done by the “Control block” show in Figure 2. Another block that belongs to the control path is the “LIFO memory”, acronym of “Last In, First Out”. When a subroutine is called, or an interrupt occurs, the control block saves the content of the registers (Register block in the data path) before it jumps to the new program memory address.

The data path has six blocks: a block of registers, an arithmetic and logic unit (ALU), a data memory (RAM type) and three single registers. The block of registers implements four registers for general purpose. We have chosen a small number of registers to enforce the students to manage data between the data memory and the block of registers (context saving). The ALU implements two mathematical operations (addition and subtraction), four logical operations (AND, OR, XOR, and NOT), and three jumps: jump if two registers have the same value (JE), jump if a register is zero (JZ), and unconditionally jump (JI). The three single registers are used in the data path to store temporary data for the external bus (output) and from the external bus (input).

The internal data memory (called as RAM) has ten address bits, which allows it to store up to 1K words (16 bits each). The processor can access up to 4K in program memory (called ROM). This quantity of memory is shared by the main program and by the six interrupts allowed by the μ PD processor (INT0 up to INT5), and Table 2 depicts these memory ranges. Each instruction in the program memory has 17 bits, and these instructions will be detailed in the next subsection.

Table.2: Program memory address range.

Area	Begin (hex)	End (hex)
Main programm	000	3FF
INT 0	400	4FF
INT 1	500	5FF
INT 2	600	6FF
INT 3	700	7FF
INT 4	800	8FF
INT 5	900	9FF

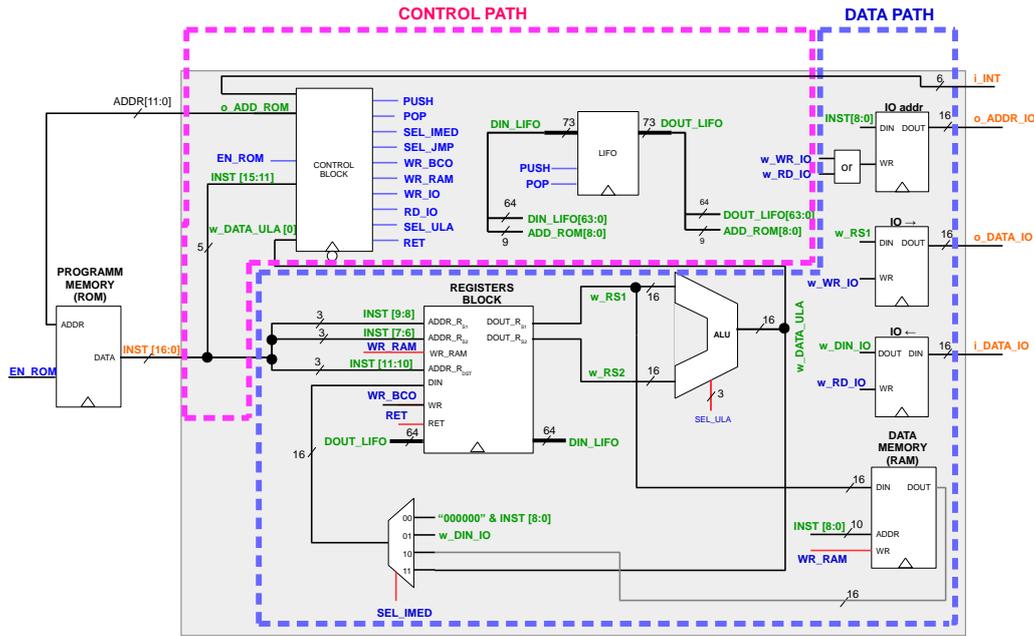


Fig. 2: Internal block of the μ PD processor.

Processor Architecture

The μ PD architecture is based on registers. There are four registers for general purpose, called R0, R1, R2, and R3, all of them inside the Register block (Figure 2). To deal with registers were implemented 21 opcodes in the Instruction Set Architecture (ISA), as shown in Table 3. Int that table, RS1, RS2, and RDST can assume one of the four purpose registers, R0 up to R3.

All instructions stored into the program memory have 17 bits, and they are organized as fields as shown in Figure 3. The most significant five bits are using as opcode of instructions. The fields RS1 and RS2 are called “source registers”, and have two bits each. The ALU will treat the values stored into these registers. On the same way, RDST is the register in which the ALU will store the result of operation done with the register RS1 and RS2.

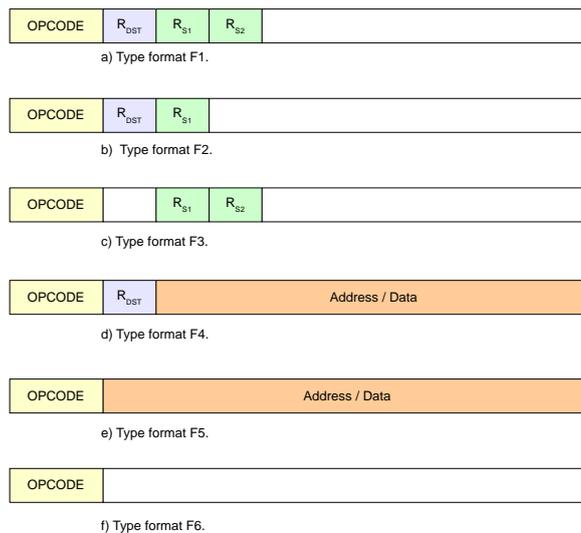


Fig. 3: Instructions format.

As depicted in Figure 3, there are six instructions formats, and we called them as F1 up to F6. These instructions are described in Table 3, and the first column informs which format is related to each opcode.

Table.3: μ PD Instruction Set Architecture.

Type	Mnemonic	Opcode	Description
F1	ADD	00010	Add: $R_{DST} = R_{S1} + R_{S2}$.
	SUB	00011	Sub: $R_{DST} = R_{S1} - R_{S2}$.
F4	IN	00101	External bus Input: R_{S1}
	OUT	00100	External bus output: R_{S1} .
	LD	00111	Load register with data from the memory: R_{S1}
	LDI	00001	Load register with immediate value: R_{S1} .
	STO	01000	Store content of register into the memory: R_{S1} .
	JE	01010	Jump if two register have the same value.
	JZ	01001	Jump if the register is zero.
F5	JI	00110	Jump unconditional.
F3	CMP	10100	Compare value of two registers. If they are equal, set 1.
F1	AND	01011	Logical AND between registers: R_{S1}, R_{S2} .
	OR	01100	Logical OR between registers: R_{S1}, R_{S2} .
	XOR	01101	Logical XOR between registers: R_{S1}, R_{S2} .
F2	NOT	01110	Logical NOT over a register: R_{S1} .
F5	CALL	01111	Call subroutine.
F5	RET	10000	Return from subroutine .
	RETI	10011	Return from an external interrupt treatment.
	STOP	10010	Stops the processor.
	NOP	00000	No operation.
	SETR	10001	Configure which interrupts will be active.

Given the restricted number of general-purpose registers, the students are enforced to do data transfer between these registers and the data memory (RAM), and the same happens to I/O reads and writes. The instruction IN and OUT are related to data input and data output of external I/O devices. Note that in Figure 2 there is a register (called "IO address") with 16 bits. It means that the μ PD processor can access up to 216 external devices, theoretically. The quantity of devices depends on the FPGA size and the devices (components) size, for instance.

Graphic interface

The μ PD was developed focused on interdisciplinary teaching. The students begin with the basic concepts of Organization and Architecture of Computers when they learn about the μ PD and perform basics assembly language programs. On a second course, VLSI circuits design, they build the μ PD processor using VHDL language and can build different devices to connect the external bus of the processor. At this point, the students have tested

components and can do an embedded design based on the soft processor for FPGA.

The μ PD toolset has an Editor, an assembly compiler, a simulator, and a VHDL components builder, and their main features will be introduced in this section. All tools were written using C# language and .NET framework. The first tool is the Code Editor. It has a simplified visual

interface that has a different colour for reserved words. It also has some editor's features, such as line counters, cut, copy, paste, block selection, and block comment. An example of an assembly code written with the integrated Editor is shown in Figure 4.

```
Chamada_e_Intempcoes.asm  Execução por Texto  Execução por Blocos
BEGIN
LDI, R1, 66;
STO, R1, 01;
CMP, R3, R1, R0;
ADD, R2, R1, R0;
AND, R3, R1, R0;
XOR, R0, R2, R3;
OR, R3, R2, R1;
SUB, R3, R0, R2;
NOT, R1, R0;
CALL, FUNC01;
AND, R3, R2, R1;
JI, 0;
END

.INT2
IN, R0, 1;
LDI, R1, 2;
STO, R1, 10;
OUT, R1, 2;
RETI;

.INT4
IN, R1, 2;
STO, R1, 11;
NOT, R2, R1, R0;
RETI;

FUNC01
LDI, R1, 10;
LDI, R2, 11;
ADD, R3, R1, R2;
RET;
```

Fig. 4: Example of an assembly code written with the integrated Editor.

Figure 4 depicts an assembly code written with the integrated Editor. Reserved words, such as LDI and NOT, was written using a blue colour. Other reserved words, such as .INT2 and RETI were written using magenta colour. The begin of the written code (indicated by a red circle with the letter A) is an example of the main program. The code selected by the red circle with the letter B is related to the code written for two interrupts (.INT2 and .INT4). On the bottom of Figure 4, the letter C written inside a red circle indicates a function code (called as FUNC01 in that example) or subroutine.

Once the code was written and assembled by the integrated Assembler tool, it can be executed in two different simulations: the “Text simulation”, and “Block simulation”. The Text simulation is shown in Figure 5.

The red circle with a letter A is pointing to binary code (machine code) and to the assembly program. The line in green colour indicates the step of execution at that moment. In that case, the instruction is LDI R1 20, which means “load register R1 with the number 20”. Note that on the right side the register R1 received the number 20 and it is green at this moment (letter D on the red circle). Letter B is pointing to the data area, also called RAM. Letter C is pointing to a window console. This console is used to display messages to the user related to the simulation under progress. Letter E shows the interrupt buttons that the user can press to simulate as an external interrupt. Letter F is the interface where the user chooses an address for the external device and can read/write data from/to the external device.

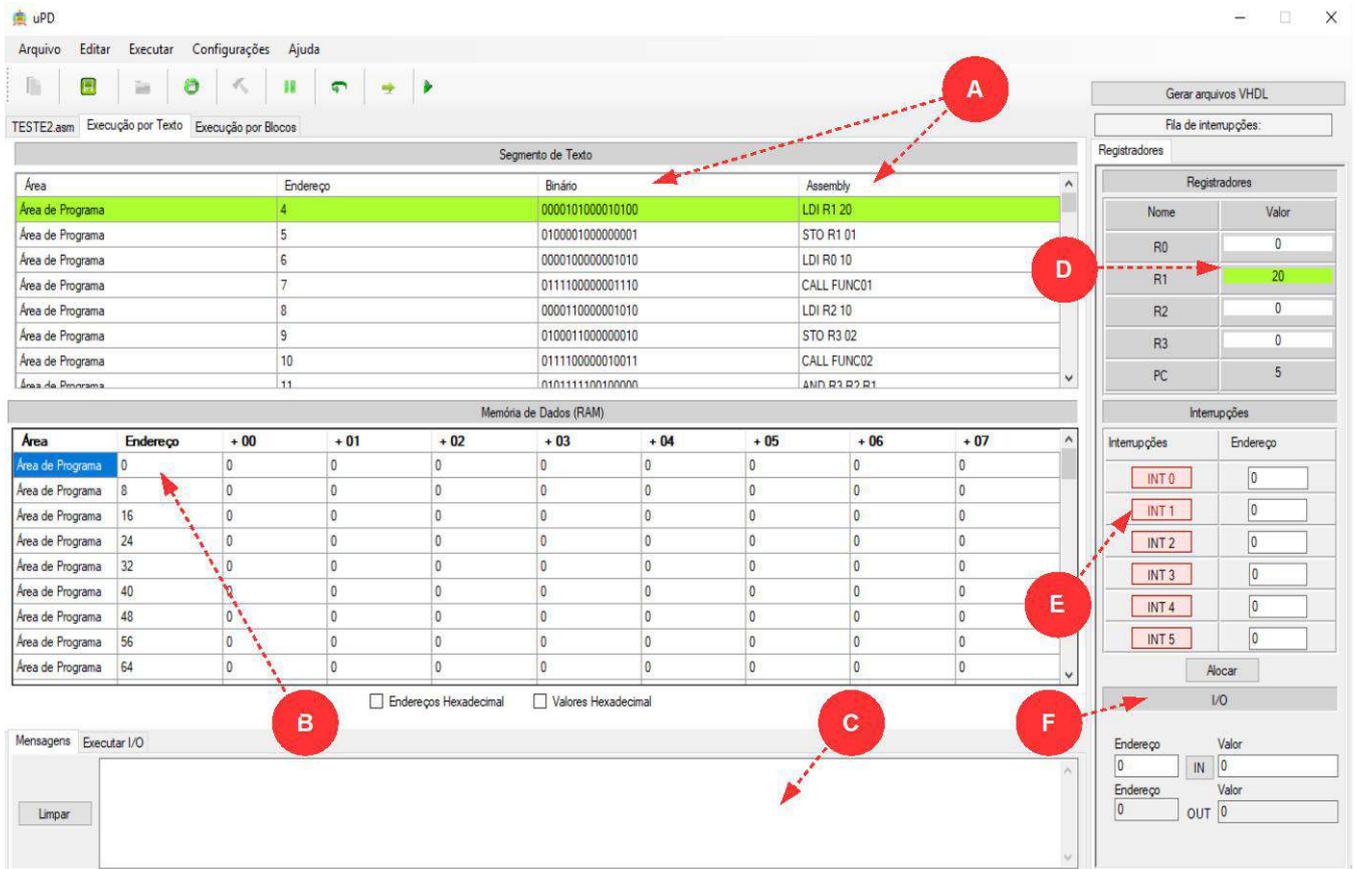


Fig. 5: Example of a text simulation.

Figure 6 shows the Block simulation execution, in which it executes the same program that was done with the Text simulator. The letter A inside the red circle is pointing to the instruction LDI R1 20. Note that some signals at the output of Control block (pointed by the red circles with the letter B and C) were highlighted with colour green. It

means that these signals will be active to ensure that this instruction flow through the data path.

All the simulations (Text and Block) are active as Windows Forms. It means that the user can check the execution step-by-step at Text simulator; meanwhile, he also checks the signal that was activated in the Block simulator.

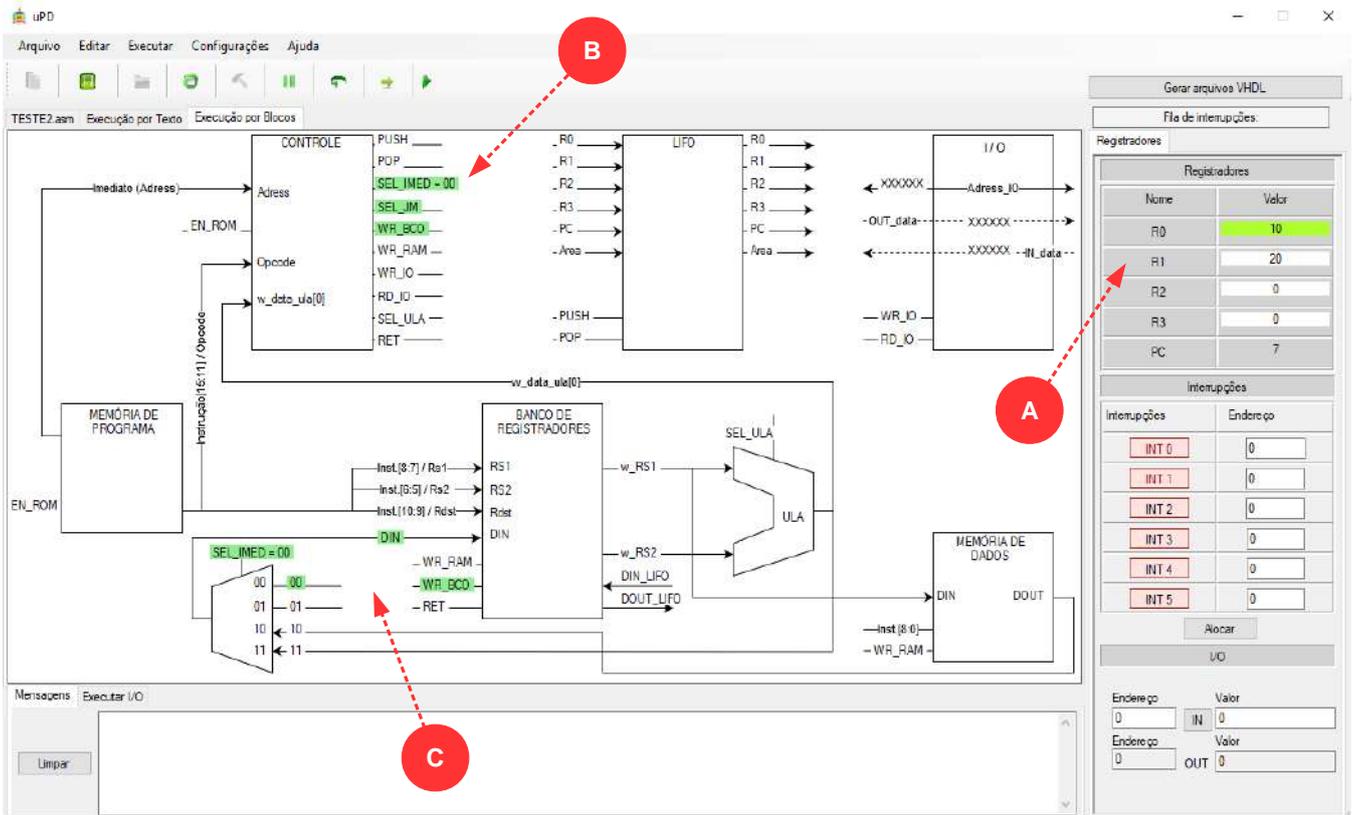


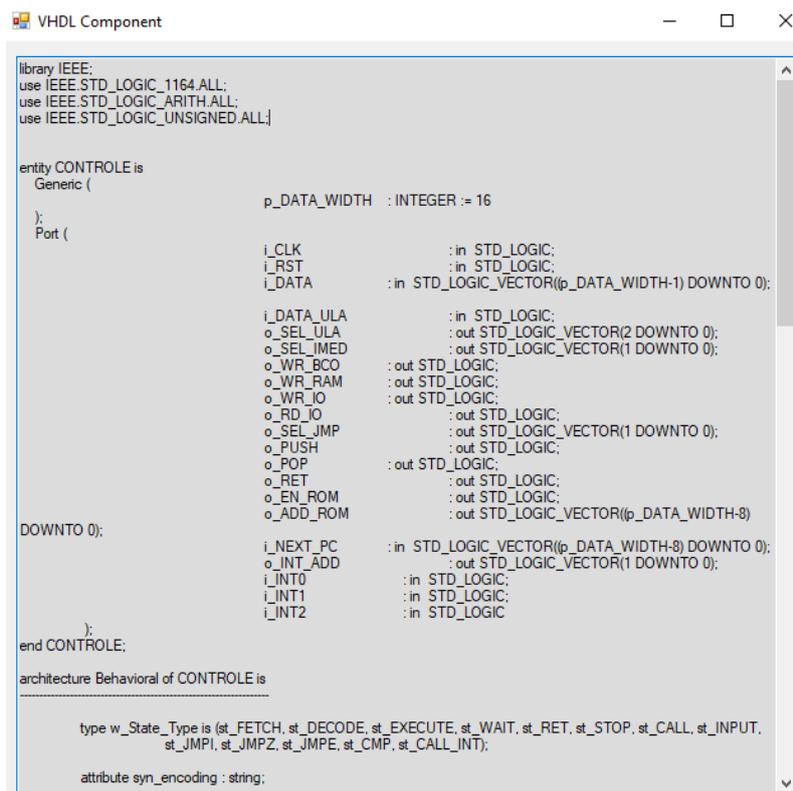
Fig. 6: Example of a block simulation.

VHDL code generation

As mentioned earlier, μ PD was designed to be adopted as an interdisciplinary educational toolset, covering three courses of Computing Engineering: Computer Organization and Architecture, Very Large-Scale Integration (VLSI) Circuit Design, and Embedded Systems Design. That integration is possible due to the VHDL code generator, available in the μ PD toolset. All processor internal blocks can be generated as a component, as shown if Figure 7, in which the control block was generated. These components may be synthesized with an FPGA manufacturers tools, like

Quartus II, from Intel, or Vivado, from Xilinx. The interconnection of these components is part of the learning of the VLSI Circuit Design.

The users may simulate the processor as mentioned in previous subsections but also is possible to simulate only one processor component. It is a useful feature for the learning of students because they can understand the behavioural of each component generated by the tool. The ROM component is filled with the machine code related to the assembly program developed by the students.



```

VHDL Component
library IEEE;
use IEEE STD_LOGIC_1164.ALL;
use IEEE STD_LOGIC_ARITH.ALL;
use IEEE STD_LOGIC_UNSIGNED.ALL;

entity CONTROLE is
  Generic (
    p_DATA_WIDTH : INTEGER := 16
  );
  Port (
    i_CLK           : in STD_LOGIC;
    i_RST           : in STD_LOGIC;
    i_DATA          : in STD_LOGIC_VECTOR(p_DATA_WIDTH-1) DOWNTO 0);

    i_DATA_ULA      : in STD_LOGIC;
    o_SEL_ULA      : out STD_LOGIC_VECTOR(2 DOWNTO 0);
    o_SEL_IMED     : out STD_LOGIC_VECTOR(1 DOWNTO 0);
    o_WR_BCO       : out STD_LOGIC;
    o_WR_RAM       : out STD_LOGIC;
    o_WR_IO        : out STD_LOGIC;
    o_RD_IO        : out STD_LOGIC;
    o_SEL_JMP      : out STD_LOGIC_VECTOR(1 DOWNTO 0);
    o_PUSH         : out STD_LOGIC;
    o_POP          : out STD_LOGIC;
    o_RET          : out STD_LOGIC;
    o_EN_ROM       : out STD_LOGIC;
    o_ADD_ROM      : out STD_LOGIC_VECTOR(p_DATA_WIDTH-8)
DOWNTO 0);
    i_NEXT_PC      : in STD_LOGIC_VECTOR(p_DATA_WIDTH-8) DOWNTO 0);
    o_INT_ADD      : out STD_LOGIC_VECTOR(1 DOWNTO 0);
    i_INT0         : in STD_LOGIC;
    i_INT1         : in STD_LOGIC;
    i_INT2         : in STD_LOGIC
  );
end CONTROLE;

architecture Behavioral of CONTROLE is

  type w_State_Type is (st_FETCH, st_DECODE, st_EXECUTE, st_WAIT, st_RET, st_STOP, st_CALL, st_INPUT,
    st_JMPI, st_JMPZ, st_JMPE, st_CMP, st_CALL_INT);

  attribute syn_encoding : string;

```

Fig. 7: Example of a VHDL block generate by the tool.

IV. PRELIMINARY EVALUATIONS

There are different ways to measure the impact of a pedagogical resource on the students, and they can be a quantitative or qualitative way. The quantitative approach requires more numerical data information. For example, the authors [11] introduced a Simulator as a supporting tool for teaching the standard topics covered by an undergraduate course in computer architecture. They collected the percentage of success across the number of attempts to pass the final examination, over seven years: eight terms without the simulator they proposed, and six terms using their simulator.

On the other hand, a qualitative approach usually is based on the feedback (student's feeling) on the effectiveness of the adopted methodology. One example of this approach is the research done by [12], in which the authors evaluated the using of a simulator for teaching Computer Organization and Architecture. They applied a questionnaire about the proposed simulator, in which there were four options for each question: Agree, Disagree, Strongly Disagree, and Neutral.

We decided for a qualitative approach applying five questions to check if the students understood a common concept for the three courses (Computer Organization and Architecture, Very Large-Scale Integration – VLSI -

Circuit Design, and Embedded Systems Design): “how the data flow” inside a processor, or inside an FPGA design, or in embedded system design using soft-core.

So far, we did evaluations of the tools with students of three mentioned courses (Computer Organization and Architecture, VLSI Circuit Design, and Embedded Systems Design), in two college terms. At the end of the college terms (last classes week), we apply an inquiry form with some questions to the students of three courses. The questions were the following:

1. Did you understand the data flow inside the μ PD processor?
2. Did you understand why the μ PD processor has a LIFO memory?
3. Did you understand the difference between program memory and data memory and how the processor deal with them?
4. Build a VHDL block helps on the understanding of how the processor works?
5. Was it easy to build embedded hardware using the μ PD as soft-processor?

Students of Computer Organization and Architecture answered questions 1, 2, and 3. Students of the other two

courses answered all of them. Each course had 20 students, which means 120 students after two college terms. Figure 8 shows the results of the inquiry form. To be classified as "understood" student must answer the five questions

positively. One of the five questions answered negatively is classified as "confused". Hence, two or more is classified as "do not understand".

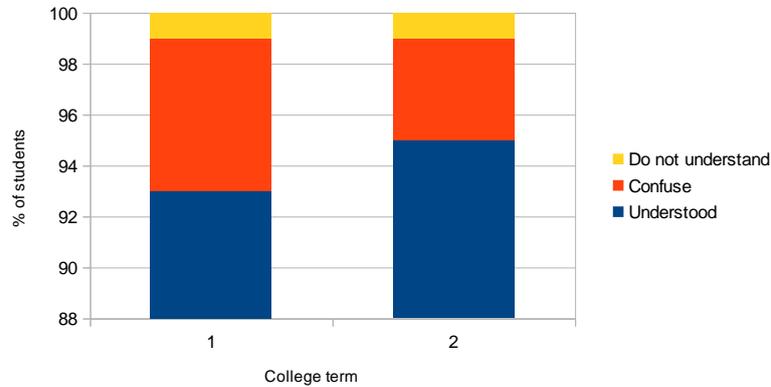


Fig. 8: Students comprehension about μ PD Processor.

We also asked the students to list what they understand as positive in the μ PD toolset, and they could state more than one. The features cited were: "Intuitive", "Generate VHDL code", "Easy to use", "Simple and efficient for learning", "Set of Instructions", and "Few

registers". These features are depicted in Figure 9. Note that the majority of students considered the toolset as "intuitive", and the second most positive feature was "Generate code VHDL".

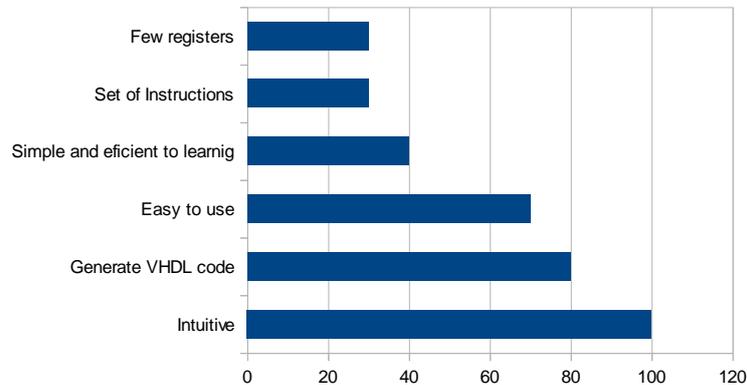


Fig. 9: Positives features ranked by the students.

V. CONCLUSION AND FUTURE WORK

We understand that the toolset we have developed must be improved, on several points. For example, we think that the results related to students understanding depicted in Figure 8 should be 99%, at least. Is important to keep collecting opinions from the new students and use these opinions as feedback to improve the toolset.

Further the feedback, we will develop different components to be connected in the μ PD external bus. These components were requirements asked by the students from the Embedded Systems Design course. According to them, more components will let more time to develop the embedded system that they must do up to the end of the term. They suggested components like a programmable SPI interface, a programmable I2C interface, and a programmable USART. Several sensors

and actuators use one of these interfaces to be controlled by a host processor.

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Functional capacity of diabetic older adults living in a municipality in Northeastern Brazil

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Abstract— *Diabetes Mellitus is a disease that contribute to the loss of functional capacity in older adults. This study aimed to measure diabetic older adults' functional capacity for activities of daily living (ADL) and instrumental activities of daily living (IADL). We carried out a descriptive and analytical cross-sectional study with older adults aged 65+ years at a specialized health care center of Brazil. The medical records of the patients were selected using non-probability sampling. In this study was found, significantly statistical, higher prevalence in ADL among persons aged 75+ years, those with low levels of education and relation between self-rated current health status. For dependence in IADL, it was common among 75+ years old people, those with lower levels of education, with income of up to 2 minimum wages and worse self-rated health. There is a need to work on public policies that contribute to active and successful aging by promoting the autonomy and functional independence of older adults in the household and community.*

Keywords— *Brazil; Diabetes mellitus; Geriatric medicine; Functional capacity.*

I. INTRODUCTION

Healthy aging is defined as including three main components: low probability of disease and functional disability, high cognitive and physical functional capacity and active engagement with life (Rowe & Kahn, 1997). Thus, health aging is much more than just the absence of disease; it includes the preservation of functionality (World Health Organization, 2015)

Increased life expectancy points to the need to ensure that people not only live longer lives, but live healthier, active and independent lives. Therefore, it is necessary to put sustainable health care solutions into practice to tackle the potential increase in chronic diseases, cognitive decline or dependence and its consequences (Gomez et al., 2013).

Population aging has been accompanied by an increase in the incidence of noncommunicable diseases, particularly diabetes mellitus (DM), whose prevalence in the older population has been increasing due to the greater life expectancy of the population and increased survival of patients (Oliveira et al., 2017; Shaw et al., 2010; Wild et al., 2004).

In Brazil, nationwide data show that the incidence of DM increases with age as the rates range from 17.1% among men and 14% among women in people aged 55-64 years to 22.7% among men and 21.7% among women in people aged 65+ (Brasil, 2010).

Diabetes Mellitus is one of the top five non-communicable diseases that most contribute to the loss of functional capacity in instrumental activities of daily living (IADL) (Griffith et al., 2017)

Researchers have reported that people with type 2 diabetes mellitus are at an increased risk of inability to perform activities of daily living as some comorbidities associated with diabetes can impair individual functionality (Araki & Ito, 2009). In addition, hyperglycemia increases dehydration, impairs vision and cognition and increases the risk of infection (Ismail-Beigi et al., 2011), which further contributes to functional decline.

It should be noted that changes in plantar sensitivity caused by diabetes interfere with the balance of older patients, thereby increasing the risk of falls, and decreased visual

acuity can lead to increased dependence on activities of daily living (Berger & Porell, 2008; Corriveau et al., 2004).

Two scales are relevant for clinical practice as they assess the level of dependence in older people. The first one is the Katz scale, which was first developed in 1963 to assess activities of daily living (ADL) in hospitalized patients and then adjusted for use with the general population. This scale was developed based on the premise that functional loss follows a pattern of decline in which the ability to bathe is lost first and followed by the ability to dress, transfer and feed, with rehabilitation occurring in reverse order. The Portuguese version of the Katz Scale underwent cross-cultural adaptation and proved to be equivalent to the original in English, thus facilitating its use in Brazil (S. Katz et al., 1970; Sidney Katz et al., 1963; Lino et al., 2008). The second scale is the Lawton & Brody Scale, which is widely used to assess instrumental activities of daily living (IADL), including more complex activities that allow them to live in the community (M. Lawton & Brody, 1969; R. L. Santos & Júnior, 2008).

Thus, assessing functional capacity in older people with diabetes mellitus, which is the objective of the present study, allows to identify the physical and social needs of this population group and contributes to the elaboration of public policies and the development of health promotion and disease prevention and control strategies focused on functional impairment, which is a common problem in the older population.

II. METHODS

This descriptive and analytical cross-sectional study was carried out with older adults (65+ years old) receiving specialized care from Brazil's Unified Health System in the city of Fortaleza, Northeastern Brazil.

The study was conducted at a Center for Integrated Diabetes and Hypertension Care (*Centro Integrado de Diabetes e Hipertensão – CIDH*). CIDH is a reference center for Diabetes and Hypertension specialized care in the state of Ceará and it provides secondary health care for complications related to these diseases.

The sample size was estimated considering the number of older people (N=242,430) in the city of Fortaleza according to the 2012 DATASUS Report (Saúde, 2012). The formula for a finite population was used and the minimum sample size estimated was 246 older adults. The medical records of the patients were selected using non-probability sampling according to their original reference numbers. We selected one out of every eight records as there were 1978 older people aged 65 years and older who

have had diabetes for at least one year enrolled in the CIDH.

Inclusion criteria were people aged 65 years or older who have had diabetes mellitus for at least one year and who agreed to participate. Older adults with type 1 diabetes were excluded from the study.

Interviewers and data collectors were previously trained to apply the following data collection instruments:

a) Identification form, which collected sociodemographic data (age, gender, marital status, level of education, income and retirement) and general health data (systemic diseases, cognitive problems, foot ulcer, use of medications, smoking, and drinking).

b) The Katz Activities of Daily Living (ADL) scale, which assesses performance in six self-care activities, namely bathing, dressing, toileting, transferring, continence, and feeding. The dependent variable was older adults' functional ability to perform ADL. The older adults were then classified as independent – when they needed assistance in only one activity or in none of them – and dependent – when they needed assistance in two or more activities.

c) The Lawton and Brody Instrumental Activities of Daily Living (IADL) scale, which assesses eight variables related to mobility skills (using a telephone, going to distant places using some mode of transportation, shopping, housekeeping, doing the laundry, cooking, taking medication and handling finances). These skills are related to older adults' effective participation in the community and difficulties in performing them leads to a redistribution of tasks among family members who live with the older person (Lebrão & Laurenti, 2005). There are three response options for each activity on the scale, with a maximum score of 27 points. The score should be interpreted individually and the decline over time reveals deterioration. The lower the score on the scale, the worse the functional ability to perform IADL. The scale has not been validated for the Brazilian population; therefore, in some cases, a person's inability to perform tasks that are not usual (such as cooking) should be taken into consideration as it might impair the analysis of independence (M. Lawton & Brody, 1969; M. P. Lawton, 1971). For data analysis, the results were grouped into three categories: 27 points – independence, 26-18 points – partial dependence, and below 18 points – dependence (Pinto et al., 2016).

The results were organized and consolidated using the Statistical Package for the Social Sciences, Co. Chicago IL USA (SPSS) for Windows (version 23.0). Quantitative variables were described as means and standard deviations

and qualitative variables were described as absolute and relative frequencies. The association between independent variables and functional capacity was assessed using the Chi-squared test or Fisher's exact test. The magnitude of the association was expressed as point and interval estimates of prevalence ratios. All the inferential analyses were performed considering a significance threshold of 5%.

This study was authorized by the CIDH and approved by the Research Ethics Committee of the University of Fortaleza (Approval No. 1.666.717).

III. RESULTS

A total of 248 older adults were analyzed: 140 women (56.5%) and 108 men (43.5%). The mean age of the participants was 73.16 ± 6.4 years.

Most of the participants were married (142; 58.4%), retired (232; 93.5%), and lived in their homes (246; 99.2%). Just over half of them (131; 52.8%) had incomplete primary education, 17 (17; 6.9%) had higher education, and 176 (73.9%) earned up to two minimum wages.

Table 1 shows the risk factors for greater dependence in ADL. People aged 75 years or older had a 2.75-fold higher prevalence of dependence in ADL than their younger peers ($p=0.002$). Older adults with low levels of education had a 6.7-fold higher prevalence of dependence in ADL than those with high levels of education ($PR=6.69$; $p=0.010$). Older adults who earned up to two minimum wages (MW) had a 2.16-fold higher prevalence of dependence in ADL compared with those who earned more than 2 MW.

Table 2 shows statistically significant associations between dependence in ADL and self-rated health at the time of the study ($p=0.002$) and in the past year ($p=0.038$). The older adults who rated their health as poor exhibited a 2.47-fold prevalence of dependence in some ADL when compared with those who rated their health as fair.

With regard to clinical data, dependence in ADL was significantly higher among people with a history of stroke ($PR=2.42$; $p=0.036$), self-reported cognitive problems ($PR=4.15$; $p=0.001$) and underweight measured by the BMI ($PR=2.42$; $p<0.039$).

Table 3 shows the sociodemographic and behavioral characteristics of the older adults according to the level of functional ability to perform IADL. In all, 18.9% ($n=47$) of the participants were dependent and 51.6% ($n=128$) were partially dependent. The participants classified as dependent in IADL were over 75 years of age, had low levels of education and earned up to 2 minimum wages.

A total of 34.9% of the participants aged 75+ and 10.5% of those aged 65-74 years were dependent in some IADL ($p<0.001$). Additionally, dependence in IADL was observed in 25.7% of the illiterate participants and 3.8% of the participants with high levels of education ($p<0.001$). Dependence in IADL was also found in 19.3% of the participants who earned less than 2 MW and in 10.9% of those who earned more than 2 MW ($p=0.011$) (Table 3).

Table 4 shows the distribution of clinical characteristics of the older adults according to the level of functionality in IADL.

With regard to self-rated health in the past year, 26.5% of the participants who rated their health as worse and 16.1% of those who rated their health as better were dependent in IADL ($p=0.019$).

As for clinical aspects, older adults' dependence in IADL was significantly associated with previous history of stroke ($p=0.002$), peripheral neuropathy ($p=0.002$), current foot ulcer ($p=0.022$), heart failure ($p=0.022$) and self-reported cognitive problems ($p<0.001$).

IV. DISCUSSION

The mean age of 73 years ($SD \pm 6.4$) in the present study is in line with the age group most affected by type 2 diabetes as it is a chronic disease that lasts for many years (Santos et al., 2015)

The higher prevalence of diabetes in women (56.5%) agrees with the findings of Bauduceau et al. (2014) and Doucet et al. (2012). However, it cannot be said that diabetes affects more women than men, but rather there is a greater search for health services among women (Diabetes Federation International, 2019). It is known that women seek health services more often than men, which can explain such difference (Levorato et al., 2014).

In the present study, the prevalence of functional dependence was higher among older adults aged 75+ and those who were illiterate and earned up to 2 MW compared with older adults under 75 years of age and those who were highly educated and earned more than 2 MW. Researchers have shown that people with low levels of income and education and with poor access to health services are more likely to develop diabetes mellitus (Schmitz et al., 2009).

In our study, most of the older adults ($n=181$, 72.9%) were dependent in at least one ADL, whereas in the study by Doucet et al. (2012) 73% of the patients were independent in all ADL. This difference may be related to a higher prevalence of diabetes in Brazil and the greater prevention and control of the disease among the French, which is directly related to their functional capacity and autonomy.

As in the study by Alves, Leite and Machado (2008), older adults' self-rated health was also associated with higher prevalence of dependence, that is, the older adults who rated their health as "poor" were more dependent in activities of daily living ($p < 0.042$) compared with their peers who rated their health as fair and/or very good. This finding demonstrates a relationship between a negative self-perception of health and an increase in dependencies, as pointed out in another study (Confortin et al., 2015).

The greater difficulty in carrying out basic activities of daily living can lead to functional disability and consequently affect the quality of life of the elderly. Bearing in mind that the increase in dependence on basic activities surely interferes in social life by preventing the elderly from visiting friends, attending church and, consequently, compromising the way in which the elderly perceive their own health (Huntley et al., 2012; A. P. Ribeiro et al., 2008; J. L. F. Santos et al., 2008).

The absence of a relationship between dyslipidemia and functional capacity to perform ADL in our study is corroborated by Rodrigues et al. (2008) who found that although older adults with dyslipidemia had less functional capacity, such relationship was not significant. Similarly, Ribeiro et al. (2016) found a lower prevalence of physical inactivity in older adults with dyslipidemia.

Despite the high prevalence of systemic arterial hypertension (SAH) among older adults with diabetes, no association between dependence in ADL and SAH was found in the patients analyzed in the present study. However, an important relationship has been reported in another study (Guedes et al., 2013).

In our study, foot ulcer ($n=25$; 10.2%) and amputations ($n=15$; 6.2%) did not significantly interfere with ADL. This finding can be explained by the fact that most older adults in our study had only minor amputations, such as amputations of fingers. The participants did not present with amputations of a whole limb, like legs.

Patients with foot ulcers have less energy and are less willing to carry out their daily activities (Souza et al., 2013). Accordingly, Goodridge, Trepman and Embil (2005) had previously reported that foot ulcers in diabetic patients negatively affect quality of life, especially because they affect mobility and hence decrease their autonomy and ability to come and go as they wish.

As for amputations, the functional capacity to perform activities of daily living is believed to decline according to the time elapsed after amputation (Vogel et al., 2014). However, this parameter was not assessed in our study. Ashraf et al. (2012) found that amputation increases the prevalence of functional disability, especially for

transferring. However, Mac Neill et al. (2008) found that most bilateral amputees who used prostheses on a regular basis remained independent in ADL.

The statistically significant difference ($p=0.002$) between diabetic older adults with cognitive disorders and their peers without cognitive problems in relation to the ability to perform ADL is corroborated by other researchers who found that cognitive problems, particularly immediate verbal communication problems, interfere with the ability to perform ADL (Mograbi et al., 2014). Other problems that may be related to functional disability are memory decline and verbal fluency decline. Yaffe et al. (2013) conducted a prospective analysis of the association between hypoglycemia and dementia in a cohort of older adults with diabetes and found during follow-up that 18.9% of them had developed dementia. The researchers concluded that there is a bidirectional association between hypoglycemia and dementia in older adults with diabetes.

Functional capacity is notoriously critical for individuals to preserve their independence and social relationships throughout life. Large international studies have shown the harms diabetes can cause to older adults, especially in IADL. IADL are more complex and require greater integrity of the most diverse human organ systems for their execution, especially the musculoskeletal and nervous systems (Ramos et al., 2017; Rekeneire & Volpato, 2015).

In the present study, the highest prevalence rates of dependence in IADL were found among diabetic older adults aged 75+ and those with complete secondary education, income below two minimum wages, previous history of stroke, current peripheral neuropathy, heart failure and self-reported cognitive problems. These findings are strongly correlated with data found in Brazilian and international studies (Barbosa et al., 2014; Brigola et al., 2019; Chen & Hu, 2018; Matos et al., 2018; Nurrika et al., 2019).

An epidemiological study carried out in Minas Gerais and Bahia showed a statistically significant association between chronological aging and functional disability. As time passes, the integrity of the organic systems becomes more susceptible to damage caused by several diseases. Such susceptibility is more pronounced in people with chronic diseases as these diseases can have a negative impact on several functions of the body with irreversible consequences. Diabetes, for instance, leads to micro and macrovascular complications over the course of the disease and depending on glycemic control it can lead to unfavorable clinical outcomes that affect older adults' independence (Barbosa et al., 2014; Matos et al., 2018).

Low levels of education are reportedly an important risk factor for functional independence. However, the mechanisms that seek to elucidate the correlation between these variables are not yet well understood by researchers (Brigola et al., 2019; Chen & Hu, 2018; Nurrika et al., 2019). According to Aguiar et al. (2019), education proved to be a means for individuals to become aware of the most diverse risk factors for diseases and unhealthy working conditions, which could lead to less exposure to situations that could predispose people to diseases in the future and which may lead to an imbalance in the various organic systems as they age. Furthermore, education has proved to be a positive factor for strengthening psychosocial and behavioral aspects (Pereira et al., 2017).

A recent cohort study conducted in Brazil found no statistically significant association between income and disability in IADL, but the association between income and disability in ADL was significant. The researchers argued that in IADL people will directly depend on the environment in which they are inserted, that is, their interaction outside the home will depend on what is offered in the environment, such as quality sidewalks, accessibility in public places, green areas and leisure areas, among others (Danielewicz et al., 2019). These findings are similar to those found in other studies (Aguiar et al., 2019; Ramos et al., 2017). On the other hand, a Canadian study found an association between household income and prevalence of older adults with impaired functional capacity, but the pathway by which these variables correlate requires further research (Philibert et al., 2013).

More than a quarter of the diabetic older adults interviewed (26.5%) were dependent in IADL and rated their health as worse compared with the that in the previous year while the participants who presented with preserved functional capacity considered their health was the same as that in the previous year (39.5%). With regard the older adults who self-rated their health as poor, they have done so due to the negative impact the disease has on the subjective assessment of health in terms of quality of life. When older adults lose their independence to interact with the environment, they tend to have a more negative view about their health status (Latham & Peek, 2013; Ramos et al., 2017; Virtuoso Júnior et al., 2016). Furthermore, people tend to experience multimorbidities as they age and hence lose the ability to rate their health as better and are unable to see their health improved over time despite clinical and laboratory control, as it might have been the case of the older adults who rated their health as the same.

As for the variables related to health conditions, functional capacity is strongly associated with cardiovascular events, cerebrovascular disease (Bauduceau et al., 2014) and

peripheral neuropathy (Le Floch et al., 2014). Peripheral neuropathy predisposes diabetic older adults to injuries to the limbs, especially the feet, and the formation of chronic ulcers which tend to have a poor healing process due to vascular damage resulting from metabolic disease. All that will have an impact on people's functionality and quality of life (Almeida et al., 2013; AlSadrah, 2019; Boulton et al., 2018; Souza et al., 2013). This was also found in the present study, in which 40% of older adults with foot ulcers exhibited impairment in IADL, with a significant association between these variables.

In our study, heart failure impaired functional capacity in many participants (34.4%). Heart failure usually leads to the development of cardiopulmonary symptoms that limit the performance of daily activities independently (Barbosa et al., 2014; Butrous & Hummel, 2016; Pirmohamed et al., 2016).

In addition, national and international studies have found high prevalence rates of functional disability in diabetic older adults after a cerebrovascular event (Carmo et al., 2016; Dutra et al., 2017). This relationship is explained by the vascular damage caused by diabetes itself and other lifestyle factors which, when combined, predispose older adults to higher levels of systemic inflammation and damages to the integrity of the various organs, thereby compromising functional capacity (Rekeneire & Volpato, 2015).

A French longitudinal study assessed functional impairment in diabetic older adults using geriatric scales and found that glycated hemoglobin levels were associated with major neurocognitive disorder and diabetes complications and that there were multifactorial pathophysiological mechanisms linking such conditions, such as metabolic dysregulation, inflammation and chronic vascular damage. However, the mechanisms by which such associations occur need further research as psychiatric disorders, such as depressive disorder, can either occur in the early stages of dementia or even mimic it (Bauduceau et al., 2014; Rekeneire & Volpato, 2015; Verny et al., 2015).

The present study has some limitations. One of them is the use of the Lawton & Brody scale, which despite being widely used in the local environment can be influenced by culture and gender and needs to have certain questions adapted to each environment. Another limitation is related to the Katz scale, as it does not assess walking. Although our study was carried out in a large reference center for patients with diabetes, its results cannot be extrapolated to the entire older population. However, our findings may

contribute to the analysis of other populations and the development of further research.

V. TABLES

Table 1. Association of sociodemographic and behavioral variables with functional capacity to perform ADL. Fortaleza, Ceará, Brazil.

Variables	Dependence (n = 32)		Independence (n = 216)		PR (95%CI)	p value
	N	%	N	%		
Age						0.002¹
65-74	13	8.0	149	92.0	1	
75+	19	22.1	67	77.9	2.75 (1.43 - 5.3)	
Gender						0.980 ¹
Men	14	13	94	87	1.01 (0.53 - 1.93)	
Women	18	12.9	122	87.1	1	
Marital Status						0.609 ²
Single	1	7.7	12	92.3	1	
Married	21	14.8	121	85.2	1.92 (0.28 -13.17)	
Divorced/widowed	9	10.2	79	89.8	1.33 (0.18 - 9.65)	
Education						0.010²
Illiterate	9	25.7	26	74.3	6.69 (1.54 -29.11)	
Secondary education	21	13	140	87	3.39 (0.82 -13.98)	
Higher education	2	3.8	50	96.2	1	
Income						0.166 ¹
Up to 2 wages	27	14.1	165	85.9	2.16 (0.68 - 6.8)	
More than 2 wages	3	6.5	43	93.5	1	
Smoking						0.485 ²
Yes	1	5	19	95	0.37 (0.05 - 2.55)	
No	31	13.6	197	86.4	1	
Drinking						0.776 ²
Yes	3	9.7	28	90.3	0.72 (0.23 - 2.24)	
No	29	13.4	188	86.6	1	
Diet						0.825 ¹
Yes	21	12.3	150	87.7	1.09 (0.51 - 2.34)	
No	8	11.3	63	88.7	1	
Use of oral diabetes drugs						0.178 ¹
Yes	23	11.5	177	88.5	0.61 (0.3 - 1.24)	
No	9	18.8	39	81.3	1	
Use of insulin						0.750 ¹
Yes	18	13.5	115	86.5	1.11 (0.58 - 2.13)	

Variables	Dependence (n = 32)		Independence (n = 216)		PR (95%CI)	p value
	N	%	N	%		
No	14	12.2	101	87.8	1	

Note. Source: Own elaboration; ¹ Chi-squared test; ² Fisher's Exact Test

Table 2. Association of clinical characteristics with functional capacity to perform ADL. Fortaleza, Ceará, Brazil.

Variables	Dependence (n = 32)		Independence (n = 216)		PR (95%CI)	p value
	N	%	N	%		
Self-rated health						0.002²
Very good	0	0	25	100	-	
Fair	16	9.9	145	90.1	1	
Poor	15	24.6	46	75.4	2.47 (1.3 - 4.69)	
Current health compared with that in the previous year						0.038¹
Better	10	16.1	52	83.9	3.27 (1.07 - 9.92)	
The same	4	4.9	77	95.1	1	
Worse	17	16.7	85	83.3	3.38 (1.18 - 9.64)	
Dyslipidemia						0.193 ¹
Yes	21	13.2	138	86.8	1.82 (0.72 - 4.64)	
No	5	7.2	64	92.8	1	
Hypertension						0.421 ²
Yes	25	12	184	88	0.72 (0.32 - 1.63)	
No	6	16.7	30	83.3	1	
Stroke						0.036²
Yes	8	25.8	23	74.2	2.42 (1.19 - 4.93)	
No	23	10.6	193	89.4	1	
Hypoglycemia within 6 months prior to the consultation						0.785 ¹
Yes	6	11.5	46	88.5	0.89 (0.39 - 2.06)	
No	25	13	168	87	1	
Infectious episodes within 6 months prior to the consultation						0.228 ¹
Yes	8	18.2	36	81.8	1.58 (0.76 - 3.3)	
No	23	11.5	177	88.5	1	
Peripheral Neuropathy						0.052 ¹
Yes	14	14.9	80	85.1	2.15 (0.97 - 4.76)	
No	9	6.9	121	93.1	1	
Foot ulcer (current)						0.335 ²
Yes	5	20	20	80	1.69 (0.71 - 4.01)	
No	26	11.8	194	88.2	1	

Variables	Dependence (n = 32)		Independence (n = 216)		PR (95%CI)	p value
	N	%	N	%		
Amputation						0.408 ²
Yes	3	20	12	80	1.69 (0.58 - 4.94)	
No	27	11.8	201	88.2	1	
Coronary insufficiency						0.938 ¹
Yes	9	12	66	88	0.97 (0.47 - 2.02)	
No	21	12.4	149	87.6	1	
Heart failure						0.077 ²
Yes	7	21.9	25	78.1	2.11 (0.98 -4.53)	
No	22	10.4	190	89.6	1	
Self-reported cognitive disorders						<0.001 ¹
Yes	14	29.8	33	70.2	4.15 (2.13 - 8.1)	
No	14	7.2	181	92.8	1	
BMI						0.039 ²
Underweight	3	17.6	14	82.4	2.42 (0.75 - 7.84)	
Normal weight	13	17.3	62	82.7	2.38 (1.12 - 5.06)	
Obesity	11	7.3	140	92.7	1	

Note. Source: Own elaboration; ¹ Chi-squared test; ² Fisher's Exact test

Table 3. Association of sociodemographic and behavioral variables with functional capacity to perform IADL. Fortaleza, Ceará, Brazil.

Variables	Dependence (n = 47)		Partial Dependence (n = 128)		Independence (n = 73)		p value
	N	%	N	%	N	%	
Age							<0.001 ¹
65-74	17	10.5	86	53.1	59	36.4	
75+	30	34.9	42	48.8	14	16.3	
Gender							0.177 ¹
Men	15	13.9	61	56.5	32	29.6	
Women	32	22.9	67	47.9	41	29.3	
Marital Status							0.057 ²
Single	1	7.7	6	46.2	6	46.2	
Married	23	16.2	83	58.5	36	25.4	
Divorced/widowed	22	25	36	40.9	30	34.1	
Education							<0.001 ¹
Illiterate	9	25.7	20	57.1	6	17.1	
Secondary education	36	22.4	86	53.4	39	24.2	

Variables	Dependence (n = 47)		Partial Dependence (n = 128)		Independence (n = 73)		p value
	N	%	N	%	N	%	
Higher education	2	3.8	22	42.3	28	53.8	
Income							0.011¹
Upt o 2 wages	37	19.3	106	55.2	49	25.5	
More than 2 wages	5	10.9	19	41.3	22	47.8	
Smoking							0.671 ²
Yes	4	20	12	60	4	20	
No	43	18.9	116	50.9	69	30.3	
Drinking							0.514 ¹
Yes	7	22.6	13	41.9	11	35.5	
No	40	18.4	115	53	62	28.6	
Diet							0.678 ¹
Yes	32	18.7	86	50.3	53	31	
No	11	15.5	40	56.3	20	28.2	
Use of oral diabetes drugs							0.157 ¹
Yes	35	17.5	101	50.5	64	32	
No	12	25	27	56.3	9	18.8	
Use of insulin							0.531 ¹
Yes	23	17.3	73	54.9	37	27.8	
No	24	20.9	55	47.8	36	31.3	

Note. Source: Own elaboration; Chi-squared test¹; Fisher's Exact test²

Table 4. Association of clinical variables with functional capacity to perform IADL in older adults. Fortaleza, Ceará, Brazil.

Variables	Dependence (n = 47)		Partial Dependence (n = 128)		Independence (n = 73)		p value
	N	%	N	%	N	%	
Self-rated health							0,066 ²
Very good	2	8	13	52	10	40	
Fair	27	16,8	82	50,9	52	32,3	
Poor	17	27,9	33	54,1	11	18	
Current health compared with that in the previous year							0,019¹
Better	10	16,1	38	61,3	14	22,6	
The same	9	11,1	40	49,4	32	39,5	
Worse	27	26,5	49	48	26	25,5	
Dyslipidemia							0,976 ¹
Yes	27	17	83	52,2	49	30,8	
No	11	15,9	36	52,2	22	31,9	

Variables	Dependence (n = 47)		Partial Dependence (n = 128)		Independence (n = 73)		p value
	N	%	N	%	N	%	
Hypertension							0.527 ¹
Yes	37	17.7	110	52.6	62	29.7	
No	9	25	16	44.4	11	30.6	
Stroke							0.002¹
Yes	13	41.9	11	35.5	7	22.6	
No	33	15.3	117	54.2	66	30.6	
Hypoglycemia within 6 months prior to the consultation							0.951 ¹
Yes	9	17.3	27	51.9	16	30.8	
No	37	19.2	99	51.3	57	29.5	
Infectious episodes within 6 months prior to the consultation							0.695 ¹
Yes	10	22.7	21	47.7	13	29.5	
No	35	17.5	106	53	59	29.5	
Peripheral Neuropathy							0.002¹
Yes	20	21.3	57	60.6	17	18.1	
No	15	11.5	64	49.2	51	39.2	
Foot ulcer (current)							0.022²
Yes	10	40	9	36	6	24	
No	35	15.9	119	54.1	66	30	
Amputation							0.061 ²
Yes	2	13.3	12	80	1	6.7	
No	42	18.4	116	50.9	70	30.7	
Coronary insufficiency							0.717 ¹
Yes	13	17.3	37	49.3	25	33.3	
No	33	19.4	89	52.4	48	28.2	
Heart failure							0.022¹
Yes	11	34.4	16	50	5	15.6	
No	34	16	110	51.9	68	32.1	
Self-reported cognitive disorders							<0.001¹
Yes	24	51.1	21	44.7	2	4.3	
No	20	10.3	105	53.8	70	35.9	
BMI							0.055 ²
Underweight	7	41.2	7	41.2	3	17.6	
Normal weight	15	20	42	56	18	24	
Obesity	21	13.9	78	51.7	52	34.4	

Note. Source: Own elaboration; Chi-squared test¹; Fisher's Exact test²

VI. CONCLUSION

We conclude that it is important to work on public policies that reduce social inequalities, as this study demonstrated that socioeconomic differences such as income and education are related to the loss of functional capacity in older adults. Autonomy and functional independence in the household and community should be encouraged in order to achieve healthy and active aging.

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Comparative analysis of Klapp and GPR methods in the treatment of idiopathic scoliosis in adults

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Abstract— *Scoliosis is a pathological deviation of the vertebral column in the frontal plane, associated or not to the rotation of the vertebrae in the axial and sagittal plane. It is measured by the Cobb angle, considered the gold standard in the diagnosis. The Global Postural Reeducation (GPR), conceived in the 80s by Philippe Souchard, consists of the muscular work in chains, thus allowing the reorganization and restoration of the muscles maintainers of posture. The klapp method was developed by Rudolf Klapp in the decade of 40, after the observation that only Bipedes had scoliosis, where they were made activities on quadruped position, attenuating the strength of gravity on the spine. Our purpose was to compare the two therapeutic methods in the treatment of idiopathic scoliosis adulthood verifying if there is effectiveness at the end of the proposed protocol. Subjects were selected 6 female, aged between 20 and 30 years, patients with idiopathic scoliosis, who met the inclusion and exclusion criteria established. These were divided into 3 equal groups: control (who did not attend any treatment), klapp and RPG. Nine sessions were carried out with 50 minutes duration for 3 weeks. At the beginning and end of the treatment, the individuals underwent postural evaluation and examination of RX. Both methods reduced the scoliosis present in subjects after the treatment period as compared to the increase seen in the control group (6.7%), with a slight advantage for the klapp method (a reduction of 21%) in relation to the RPG (a reduction of 17.5%). But the results were not significant. Although both methods have reduced the Cobb angle, showing a clinical relevance of results, this reduction was not statistically significant. The reduced sample size certainly influence here, requiring research in larger groups to obtain more reliable results.*

Keywords— *Scoliosis, Physiotherapy, Klapp Method, Global Posture Reeducation.*

I. INTRODUCTION

Scoliosis is a pathological deviation in the spine in the frontal plane with or without rotation of the vertebrae in the axial and sagittal planes. It can be classified as to its curvature: when less than 20 ° it is considered light, moderate between 20 ° and 40 ° and greater than 40 ° severe. As for the types of curvature, there is the shape of C, composed of only one curve; and in S, composed of two curves, the largest curve being considered primary^[1].

The Cobb angle is commonly used for quantitative assessment of the lateral curvature of the spine in the frontal plane in 2 dimensions. Considered the gold standard for the diagnosis and monitoring of patients with scoliosis, this method is also important in the planning of surgical procedures, monitoring and management of spinal

deformities, since it determines the severity of the curvature^[1].

Global Postural Reeducation (GPR), a method developed by the physiotherapist Philippe Souchard, was created in the 1980s. It consists of adjustments in posture to reorganize the segments of the human body, allowing the reorganization and rebalancing of the postural muscles. Identifies and stretches the muscles considered responsible for postural changes^[2].

Rudolf Klapp developed his method in 1940 after an observation about the fact that only bipeds present scoliosis, since the orthostatic position favors the appearance of the phenomenon. Working bipeds in quadruped position, the thoracic spine when horizontal would eliminate the force of gravity, the movements of the

rib cage would have greater amplitude and the spine would suffer maximum relaxation having a greater expansion and mobilization of the rib cage. Despite being a little researched technique, it is widely used in clinical practice in the treatment of scoliosis^[3].

Little is said about the effects of these methods in the treatment of scoliosis, even though they are techniques with evidence of good results when applied. Furthermore, their fundamental rehabilitation principles are consistent with the necessary intervention to reduce scoliotic curvature in patients with it. The objective of this study was to highlight the effects of the Klapp and RPG methods in the treatment of idiopathic scoliosis, comparing them with respect to post-intervention results.

II. METHODOLOGY

2.1 Sample

The sample universe was the University Center of Goiatuba - UNICERRADO, whose community, within the inclusion and exclusion criteria, was recruited. The sample was for convenience, with dissemination on institutional social networks and folders posted at strategic points on the campus, initially formed by 21 subjects and was reduced to 6, distributed equally and randomly in the Klapp, GPR and control groups, the latter only doing the initial and final evaluation.

Nine individuals were excluded from this study because they were not available to participate in the consultations, two after the radiographic examination did not find scoliosis, one in the postural evaluation because they did not present changes consistent with the pathology in question and 3 were excluded by the age criterion.

2.2 Procedures

At the beginning and at the end of the treatment, the individuals were submitted to a postural evaluation using a symmetrograph where the conducts were adopted for greater reliability of the evaluation, such as: distance of 15cm between individual and symmetrograph, the costumes should be bikinis or swimming trunks, in order to better visualize postural changes via bony prominences^[4]. All postural evaluations, at the beginning and end of the experiment, were performed by the same examiner, to avoid evaluation bias. The subjects' images were recorded using the Motorola G5s Plus® Smartphone Digital Camera, using 13 megapixel (MP) resolution.

The second evaluation was performed by radiographic examination (X-ray) of the spine with posteroanterior view to quantify the angulation of scoliosis based on the Cobb angle^[5]. The subjects underwent the X-ray in a hospital in

the municipality of Goiatuba on a previously scheduled date. After the initial evaluations, the subjects in their respective groups performed 9 sessions of 50 minutes each, distributed three times a week.

Both treatment groups received similar passive stretches, which are: paravertebral and gluteus stretches, hamstrings and sural triceps, quadriceps, biceps, brachioradialis, wrist and finger flexors, pectorals and anterior deltoid; neck region, in scalenes, trapezius, platysma and sternocleidomastoid. The stretches were performed up to the physiological limit respecting the individuality of each one and maintained at this threshold for 20 seconds.

The group that received the treatment with the GPR method performed two postures: frog on the ground and frog in the air, both with open arms. The postures were applied in 2 stages, the first being 5 minutes long and the second 10 minutes; with rest interval if necessary^[6]. In the Frog posture on the floor, the individual was instructed to lie supine on the stretcher, hip in semiflexion and rotated externally, knees in flexion, feet in dorsiflexion with heels together. The arms were placed in 90 ° abduction initially with supination of the forearm and finger extension. The Frog posture in the air was performed with the subject in supine on a GPR stretcher, hips at 90 ° of flexion with external rotation, knees semi-inflexed, feet in dorsiflexion and heels together, shoulders at 90 ° of abduction with supination of the forearm and extension of fingers^[7].

The group that received the Klapp method as treatment performed the postures: "lateral crawling" - quadruped position, with the hands directed inwardly, bringing the upper limb forward and the lower limb backwards on the side of the concavity, the head was kept turned to the convexity side; "Large arch" - quadrupedal position, extension of the upper and lower limbs on the concave side on a diagonal. The contralateral knee and elbow were kept close together; "Turning the arm" - position of cats, with upper limb on the concave side in extension and 90° abduction, performing a rotation of the trunk accompanied by the head also towards the side of the concavity; "Big curve" - extension of the upper and lower limbs on the side of the concavity. The postures were maintained for 5 minutes each^[3].

2.3 Inclusion and Exclusion Criteria

Subjects between 20 and 30 years old, of both sexes, with idiopathic scoliosis were admitted to this study. People with rheumatic, cardiac, pulmonary, neurological diseases, smokers, pregnant women, alcoholics and who do not have availability or agreement to participate in the sessions, were excluded from this study because they

presented less resistance to postures and pregnant women due to the fact that the exam is included in the evaluations. radiation that can pose risks to the fetus.

2.4 Data analysis

The parametric data were tabulated and statistically analyzed using the GraphPad Prism 7.0 software, where descriptive statistics were performed (means and standard deviation) and the results before and after the intervention were analyzed by the Anova Multivariate test with Bonferroni's post hoc test of multiple comparisons, considering the samples within the Gauss curve.

2.5 Ethical Issues

All volunteers received the appropriate guidelines for participation in the project, including the risks and benefits of the project, and agreed by signing the informed consent form established in accordance with Res. 466/12 CONEP. The research was authorized by the Human Ethics Research Committee of the Goiânia General Hospital Dr. Alberto Rassi by CAAE 93622618.0.0000.0035.

III. RESULTS AND DISCUSSION

After applying the inclusion and exclusion criteria and evaluation to confirm the presence of scoliosis, 6 subjects participated in the experiment, divided into the Control, Klapp and GPR groups.

The results of intervention are shown in table 1

Table 1: Cobb angle pre / post treatment

Groups	Pre (mean ± SD)	Post (mean ± SD)
Control	15±9.89	16±11.31
Klapp	19±4.24	15±7.07
GPR	26±19.79	21.5±16.26

$p > 0.05$

The results, although showing a reduction in the Cobb angle in both treated groups, showing clinical efficacy, were not statistically significant, and there was also no significant difference in the results between the groups analyzed.

The most relevant radiological images of each group were selected to visualize the scoliotic curve before and after the intervention period.

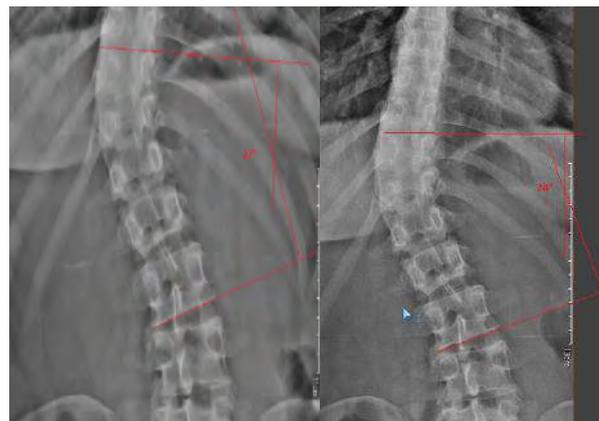


Fig. 1. Control Group A - Before B - After

Source: Authors' data.



Fig. 2. Group GPR A - Before B - After

Source: Authors' data.

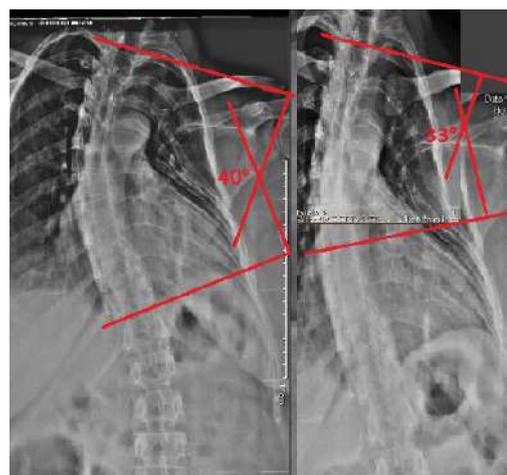


Fig. 3. Klapp Group A - Before B - After

Source: Authors' data.

At the end of vertebral growth, which occurs around 15 years of age, the spine becomes less flexible, thus making

its correction more difficult^[8]. Due to the rotation of the vertebrae, many authors believe to be irreversible and few believe in reducing scoliotic curvature^[9].

Although the Klapp method is little researched, it is present in the daily treatment of scoliosis, due to the fact that it is easy to apply, even in groups. It has as a disadvantage the difficult adherence by patients with older age, because the maintenance of postures is for long periods^[3].

The Klapp method was effective in improving the extensor muscles of the spine and prevented the progression of the angle of gibosity^[10], in addition to attenuation in body asymmetries after application of the method, but none of the authors used the angle as a parameter for scoliosis measurement. Cobb thus making the result of low reliability^[3].

In a study using stretching as a method of treating scoliosis for 40 sessions, a significant reduction in gibosity was detected. Stretching was part of both treatment programs done here, and it is believed that they participated in the subjects' scoliosis reduction process, although the authors cited did not quantify this reduction to serve as a co-collaboration parameter for the final result^[11].

In the study by Segura et al, 16 girls aged 10 to 17 years were selected, divided into 2 groups, one being treated with GPR and the other with Pilates for 20 sessions individually. At the end of treatment, a reduction of 1.87 ° in the Cobb angle of the Pilates group and 3.5 ° in the GPR^[12] group was reported. Here, even with only 9 sessions, a greater reduction in pathological curvature was achieved.

The Klapp method and the GPR are similar in terms of the development of flexibility and muscle tissue, as well as in the stimulation of motor learning in postural muscles. It is suggested to monitor the subjects treated for at least 6 months to 1 year, in order to identify the impact and maintenance of the long-term results of these effects^[11].

The Klapp method was more effective in treating trunk asymmetries when compared to those of the pelvis^[3]. There are reports that the same method was not effective in reducing body asymmetries^[11]. Both studies used computerized photogrammetry as a form of evaluation and 20 consultations were made per subject. Despite the reliability of computerized photogrammetry, studies are lacking on the measurement of the scoliotic curve. Here it was possible to notice a reduction in the curve with less than half of the sessions performed.

The GPR method was effective in reducing scoliosis after 5 sessions, although greater monitoring of patients to

verify the duration of the effects is recommended. This corroborates the result of this research, which with few sessions managed to reduce scoliosis, but it also shows the importance of medium and long-term monitoring to verify the maintenance of gains^[13].

The small sample size, as well as the few sessions made, is placed as biases for the result obtained. It is believed that in larger groups and with more sessions, the results are significantly positive regarding the scoliosis solution.

IV. CONCLUSION

According to the results obtained here, both methods were clinically effective in reducing the Cobb angle when compared to the control group. The results were not statistically significant, and it is believed that the reduced number is the main reason for the occurrence. It can be inferred that the number of sessions is also a factor of influence, although both treatments have reduced the scoliotic curve within the proposed time. There was no significant difference between the Klapp and GPR methods in the findings.

It is also important to emphasize that there is no evidence on the maintenance of post-treatment results, pointing out the importance of long-term monitoring. Further studies are needed on this topic.

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Growth forecast of the covid-19 with the gompertz function, Case study: Italy, Spain, Hubei (China) and South Korea

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Abstract— In this article, carry out an analysis on the growth and expansion models of the new virus outbreak belonging to the Coronavirus family called SARS-CoV-2 and associated with the clinical picture COVID-19. This outbreak of the disease was declared a pandemic by the World Health Organization (WHO) in March 2020, it is now affecting most countries in the world and its accelerated progress is a global concern. A non-linear growth model based on the Gompertz function was designed to characterize the serious pandemic impact in Asian and European countries: Spain, Italy, South Korea, and Hubei (China). The compilation of official data from each area on infected and deceased people until May 11, 2020, to verify the validity of the growth model in the calculated terms. With the obtained values, made a comparison by measuring the forecast errors, using the root indicators of the root mean square error (RMSE), the mean absolute percentage error (MAPE) and the regression coefficient index R^2 , which yielded highly accurate values of the predicted correlation for infected and dead of 0.99 on the dates considered. Verified the validation of the viral growth model of COVID-19 for these four countries and verified how the different measures taken to alleviate the pandemic have affected the final results of infected and dead countries, obtaining different growth coefficients that could be due to some exogenous factors (such as social, political and health factors, among others) that are difficult to measure and require qualitative methods and resources. The simple and well-structured model can be adapted to different propagation dynamics. Due to its direct and rapid implementation, the model could be useful for health managers and politicians for better decision-making in the control and prevention of this pandemic.

Keywords— COVID-19, coronavirus, growth model, Gompertz, pandemic.

I. INTRODUCTION

In December 2019, in the city of Wuhan (China), several pneumonias induced by a new respiratory disease were detected [1]. The causative agent was the new coronavirus that was identified and isolated from a single patient in early January, and subsequently verified in other additional patients [2]. This clinical disease was named as COVID-19 and it was discovered that was a novel betacoronavirus, now named SARS-CoV-2. A very rapid scientific response leads to the publication of its genome which reveals shares 88–96% sequence similarity to bat coronaviruses, in keeping with other pathogenic coronaviruses such as SARS-CoV and MERS-CoV [3–6]. SARS-CoV-2 is a remarkable pathogen which showed a high transmission potential [7,8] and it is responsible for

the international outbreak COVID-19. The fast spreading of the virus can be explained for different reasons, being the human-to-human transmission way the most proven. [9]. Therefore, close contact between individuals can facilitate transmission [10] by scattering drizzle droplets when coughing or sneezing. The swift spread of the disease is explained by the virus survival period of several days [11,12], with active persistence in metal and glass for up to 9 days [13]. Current data seems to suggest that the virus has an incubation period of three to seven days with a mean incubation period of 5.2 days [14], though other authors suggest periods between 2 and 14 days [15,16]. Moreover, asymptomatic, or mildly symptomatic persons can transmit the infection [17], which makes identification

very arduous and the number of infected people higher than the official count.

Given the severity of the outbreak and its swift spread, the WHO declared the new disease on January 30 as a public health emergency of international concern [18]. On March 11, the spread reached 118,000 cases in 114 countries with 4,291 people dead, the WHO's Director-General proclaims COVID-19 as a global pandemic [19]. This declaration forces all countries to take more radical measures to stop the spread of the virus; among those, the confinement of the population and the closure of borders which had already been carried out initially in Hubei on January 23. In Italy, the constrictions began in the northern zone on February 22, going to a total closure on March 9 and the stoppage of all productive activity on March 21. In Spain, the closure of commercial activities begins on 15 March [20]. The measures carried out in South Korea are focused on the initial patients, performing massive tests to all the people [21] who had been in contact with them, isolating only the affected people and areas [22]. With all the measures taken, it is already considered the largest quarantine in history, but the virus continues to spread throughout the world. On May 10, the situation is 3,917,366 confirmed infected, 274,361 dead and 181 affected countries [23].

All this makes the coronavirus is spreading across the globe at an alarming rate and caused more infections and deaths as compared with SARS or MERS [17] which could be due in part to the fact that SARS-CoV-2 is more infectious due its higher R_0 values. The speed of transmission has meant that the preventive and control strategies that states have been taking, such as isolation, detection tests and prophylactic measures, although they have somewhat flattened the epidemic curve, have not been able to prevent the spread of the virus throughout the world. Therefore, there is an urgent need to develop models that allow predicting the behaviour of the pandemic in the different affected areas, in order to be able to take the most appropriate prevention and control measures of the outbreak in each circumstance and with sufficient time in advance. Mathematical modeling of the spread of infectious diseases is essential to understand the evolution of epidemics over time.

Modern mathematical epidemiology can be considered to have started with the studies of Kermack and McKendrick with the classic model of susceptible - infected - recovered (SIR) [24]. Subsequent studies for outbreaks, from SARS [25] and Cholera [26], apply more complex models with multiple variants, with the susceptible - infected - recovered - susceptible pattern (SIRS) [27], where the recovered can be re-infected by not

developing immunity; or the susceptible - exposed - infectious-recovered model (SEIR) [28] where the exposed population is assessed and immunity is evolved. For the description of the growth and development of diseases, the logistic model has been applied; as in the case of bacterial growth [29], the infectious diseases spreading [30], or the Gompertz model that is also used for bacterial sprouting [31]. Currently, the studies that have been carried out on the growth of COVID-19 have focused on specific areas, mainly in China, with the SEIR model by Wu et Leung [32] who predicted the national and international spread of the pandemic, or the study by Yang and Wang [33] who introduces a confinement variable. Also, unreported cases have also been studied and estimated in areas of China [34], and on flights from Japan [35]. Various prediction models have been studied, based on the SEIR model [36] and the logistic model has also been used to successfully predict for 20-day infections [37]. The epidemic evolution model has also been studied following the system of differential equations for the susceptible - infected - recovered - dead (SIRD) variables, analysing the temporal dynamics of the disease on the leap from China to Italy and France [38].

Creating a mathematical model of the spread of infectious diseases is essential to understand the evolution of epidemics over time, the objective of this study is to obtain a model capable of predicting behaviour (number of infections and mortality) to help health systems and politicians in predicting future situations for better decision-making in the control and prevention of this pandemic. Have taken the values of several countries in Europe that are Spain and Italy and two other countries in Asia, which are the Hubei area (China) and South Korea, to apply a growth model based on the Gompertz function and verify its application. . This research is divided into section 2 of the methodology where the workflow followed is explained, in section 3 describe the Gompertz model, in section 4 perform calculations and prognostic models for deaths and infected, ending section 5 with the conclusions of the investigation.

II. METHODOLOGY

The study of the growth prediction of the COVID-19 pandemic using the Gompertz growth model scoped various areas and countries of the world: South Korea, where initially monitoring and control measures were taken that managed to significantly reduce the incidence of the pandemic; Hubei area (China), which was the first area that began with total confinement; and in two European countries, Italy and Spain, where the incidence of infected

and dead is very striking. **Table 1** shows updated population data for each country [39] and COVID-19 infections and deaths as of May 11, 2020. Data on confirmed cases and deaths were obtained from WHO [23], with daily reports presented worldwide from the European Center for Disease Prevention and Control (ECDC) [40], selecting reports on from Italy, Spain and South Korea. Data for Hubei (China) were obtained from the National

Health Commission of the People's Republic of China [41]. It should be noted that on April 16, Hubei's data were updated with values not derived from official statistics, which affected the model and could only be calculated up to that date. In Spain the statistical system was also changed to consider the number of infections, as of April 24, but did not affect considerably the calculations and the results obtained.

Table 1. Summary of country data as of May 11, 2020.

COUNTRY	Population	Life expectancy	Population % aged >65	Infected (2020-05-11)	Dead (2020-05-11)	Fatality rates (CFR)	Infected / 10 ⁶ population	Dead / 10 ⁶ population
Spain	46,400,000	84	20%	227,436	26,744	11.8%	4,902	576
Italy	59,200,000	84	24%	219,814	30,739	14.0%	3,713	519
Hubei (China)	58,160,000	77	12%	68,134	4,512	6.6%	1,171	78
South Korea	51,300,000	83	15%	10,936	258	2.4%	213	5

These initial data show that the most efficient containment system at present is that of South Korea, with an infection rate of 213 people per million inhabitants, and the least effective is that of Spain, with an infection rate of 4,902 per million inhabitants. With regard to deaths, it can be seen that the highest mortality rate is that of Italy, with almost 14% of deaths on those infected, but the one with the highest mortality rate with respect to the population is again Spain with 576 deaths per million inhabitants, and the one with the best data and the lowest mortality rate is again South Korea, with 2,4 % mortality and 5 deaths per million inhabitants.

To carry out the study of propagation and deaths due to COVID-19 using the Gompertz growth model, the following workflow has been followed to obtain the growth forecasts sought, which are shown in **Figure 1**.

1. The collection of data on the spread and deaths of the countries and areas examined until May 11, 2020. The data on the change in the mortality measure in Hubei from April 16, 2020, which changes the curve model obtained.
2. Data preparation and adjusting initial pandemic and death dates by country to make calculations
3. The treatment of assumptions over different rates of spread and maximum number of cases of infection and deaths predicted by country.
4. Estimation of the number of infected and dead in each country using the Gompertz growth function.

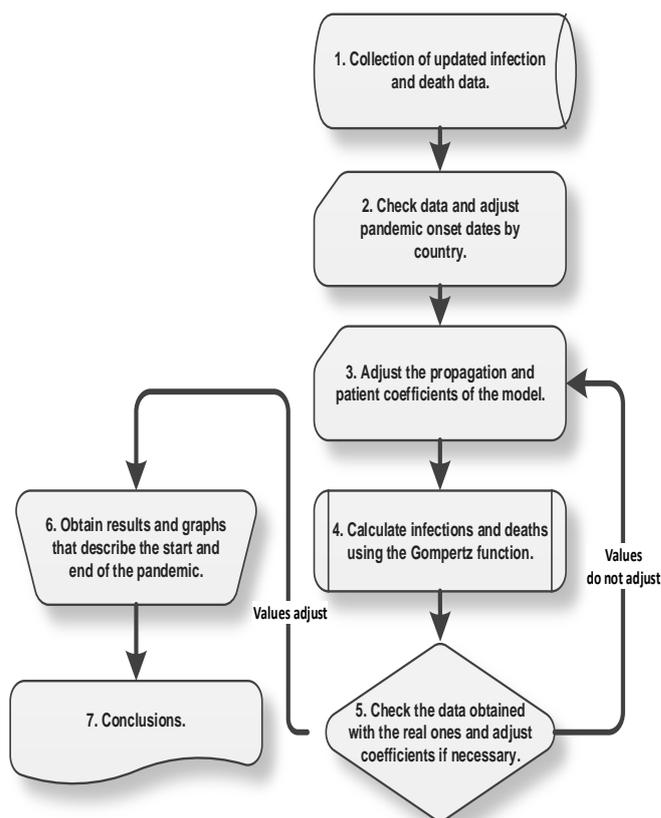


Fig.1: Research flowchart

5. To contrast and verify the results obtained versus actual facts, adjusting the coefficients of growth and prognosis of cases to obtain the values that best fit the current situation, checking their validity by

- calculating the values of R^2 , RMSE and MAPE for each estimate and country.
- With the predicted values that best fit the reality of each country, obtain the sigmoid graph that describes the growth and estimated end of the pandemic for each country, for infected and dead.
 - Conclusions and description of more accurate methods to contain future pandemics.

Table 2. Summary of characteristic and predicted values of COVID-19 infections

Forecast infected characteristic values - GOMPERTZ METHOD						
Country	Constant growth	Infection forecast	RMSE	MAPE	R^2	Forecast infected / 10 ⁶ population
Spain	0.071	253,000	6,903	16.31%	0.9972	5,453
Italy	0.061	243,000	4,279	9.28%	0.9994	4,105

2.1 GOMPERTZ MODEL

The mathematical model of growth used to predict the pandemic is the Gompertz model, which belongs to the family of sigmoid curve modelling [42], initially applied to model human mortality. There are different types of Gompertz curves depending on the parameters involved, but they all have a double exponential as a common characteristic element. With the function defined for human mortality, Charles P. Winsor [43] began to study the growth of biological phenomena, demonstrating its usefulness in biological and bacterial growth curves. Later studies by Laird [44], in some tumours concluded that the exponential model was not totally adequate for the description of growth and that an exponential Gompertz model could explain the observed growth. The Gompertz model was used by many authors in growth studies of all kinds, such as population growth [45], growth of animal fetuses [46], chickens growing [47] and weight growth in fish in Canada [48]. Among multiple options to express the Gompertz's model, since this family of functions comprises a wide variety of curves with double exponential as common feature, this study of growth and development of the COVID-19 addresses the following model.

$$f(t) = k \left(\ln \left(\frac{X_0}{k} \right) \right) e^{-\alpha(t-t_0)}$$

$$t \geq t_0, \quad \alpha > 0, \quad k > X_0 > 0$$

Considering "k" the maximum predicted number of patients infected or dead in the development of the pandemic, "X₀" is the number of initial patients, infected or dead, when the pandemic starts at instant "t₀", and consider "t" the prediction time, and "α" is the growth rate characteristic of the pandemic. For biological growth calculations restrict the values of $t \geq t_0 \geq 0$ and the value of initial patients $X_0 = f(t_0) > 0$.

This sigmoid curve has the characteristic of being monotonous in its growth, being limited in time and presenting a point of inflection where the curve goes from concave to convex reaching approximately 37% of the growth that comes to depend on "X₀" and can be defined for "k > X_{0e}" at the point:

Inflection point dimension: $\left(\frac{\ln \frac{k}{X_0}}{b} + t_0, \frac{k}{e} \right)$ and approximate percentage of growth at that point: $37 \times \left(1 - \frac{X_0}{k - X_0} \right) \%$

III. RESULTS

With the data obtained from infected and dead, carried out the forecast calculations for the Gompertz model using the mathematical modeling software IBM SPSS Statistics [49], to check and calculate multiple mobilizations for the "α" growth rate of deaths and infections, and with multiple values also of the "k" value with the maximum predicted number of deaths and infected per country. With the different values obtained, compared the predicted values with the current actual values, performing a quantitative examination of the fit using error measurement indices commonly used to evaluate prediction models [50]. Using Karl Pearson's R² regression index [51] to justify its greater or lesser correlation [52], also comparing the model accuracy of the different regressions by calculating the RMSE [53] and MAPE [54], which is a forecast indicator that measures the size of the absolute error in percentage terms, giving us a relative measure of the error. The functions used for accuracy calculations are as follows:

$$RMSE = \left[\frac{1}{t} \sum_{i=1}^t (u_p - u_o)^2 \right]^{1/2} \quad MAPE$$

$$= \frac{100}{t} \sum_{i=1}^t \left| \frac{k_r - k_f}{k_r} \right|$$

Where " t " is the number of observations, " u " is the residue of the estimates, the subscript " p " is the predicted residue and " o " the observed residue, " k_r " is the actual number of infected or dead and " k_f " is the estimated number of infected or dead according to the analysed prediction model.

3.1 PREDICTION OF INFECTED

Making the calculations for the number of infected, it is seen as the data from Spain and Italy has a lower growth but the final value is much higher than that obtained in Hubei and South Korea, as it has not yet reached the tipping point of stabilization of cases, but are already reducing the daily cases, while Hubei and South Korea data are stabilized and near the end of the pandemic. The characteristic values obtained in the modeling of the pandemic for the final predicted number of infected people can be seen in **Table 2**, where it can be seen how the values of infected people per million inhabitants are very high in Spain and Italy, with 5,453 and 4,105 infected people per million inhabitants respectively, and in Hubei and South Korea they remain at values very similar to the current 1,172 and 214 infected people per million inhabitants respectively, as these areas are in the upper part of the stability curve and the end of the pandemic.

The dates taken to make the calculations of infected differ from country to country, as they have different dates of the beginning of the virus infections in the countries. Perform the infected forecast calculations by comparing them with the actual values for the dates chosen for each country and check their suitability. The daily infected values have been calculated until the date that the pandemic disappears and the number of infected goes to 0, calculating the end date of the pandemic according to this Gompertz model with the corresponding coefficients of each country used. In Hubei, the end of the infections is forecast for May, in South Korea in June, in Spain in September and the last to emerge from the pandemic would be Italy in October, all of them in 2020. The following **Table 3** shows the dates that have been taken to make the forecasts of infected people by country, as well as the expected end date of the pandemic in each case.

Table.3: Dates used for end of pandemic estimates and forecasts by country

COUNTRY	INFECTED	
	Start date	Forecast end date
Spain	2020-02-24	September 2020
Italy	2020-02-20	October 2020
Hubei (China)	2020-01-22	May 2020
South Korea	2020-01-31	June 2020

The following **Figure 2** shows the real and predicted values calculated for the accumulated number of infected by country, verifying how Hubei and South Korea are at the end of the pandemic with very little increase in those infected over time. **Figure 3** shows the real and calculated values for new infected per day by country, where you can see the approximate time period calculated for the reduction of infected, which is verified with the change in trend of the daily infected curve. As can be seen from the correlation factors R^2 for all countries, there is a very high correlation between the predicted and actual calculated values. Can also see how the spread values are lower in Spain and Italy, but with more cases of contagion, mainly due to the time elapsed for these countries to take measures to stop the pandemic, being the case of the fastest contagion in South Korea. and China but with fewer infected, by taking radical measures of confinement and monitoring of infected to stop the pandemic, with different methods in these countries, which have managed to paralyze the pandemic as soon as possible in these areas. The model that best fit is Hubei's since it is at the end of the pandemic and its fit to the Gompertz model is very good. The models of the rest of the countries have a considerable adjustment, being the one that least adjusts that of South Korea, since they have several sources of infection that were identified late.

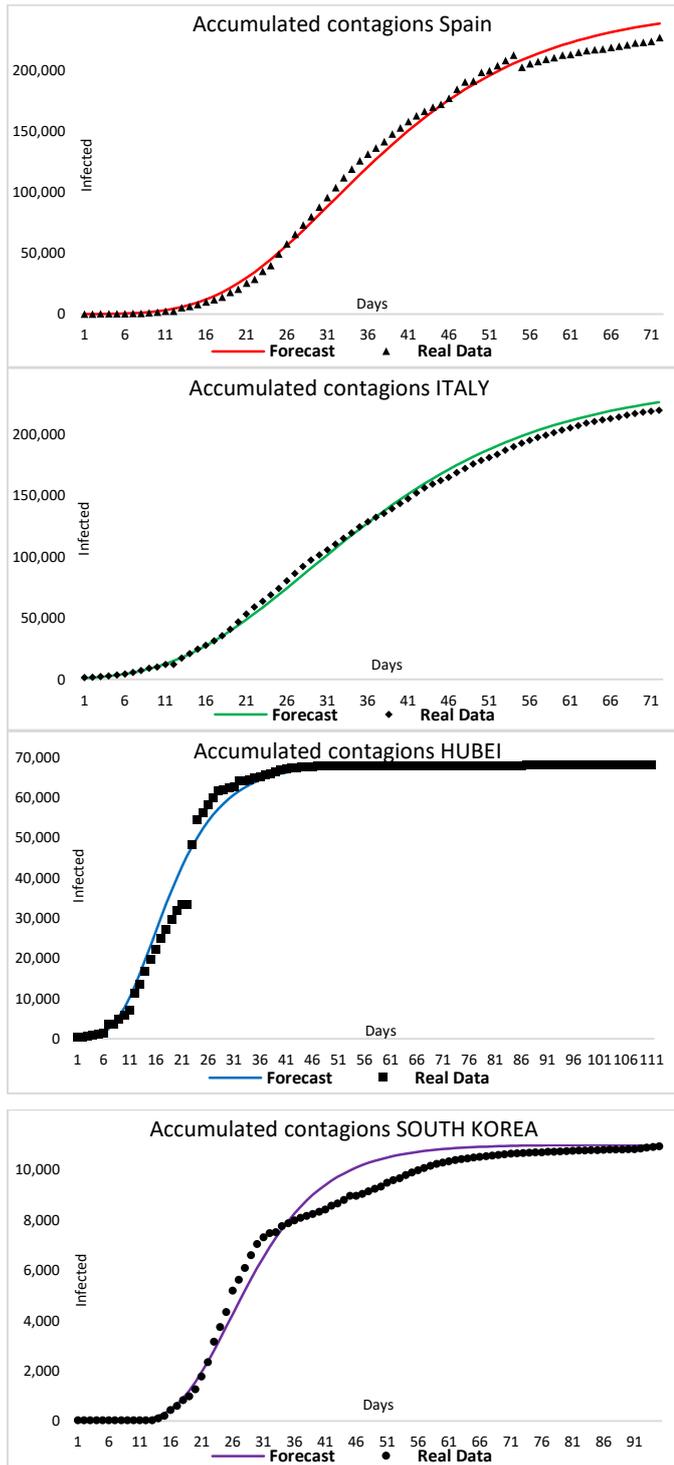


Fig.2: Accumulated contagion forecast until of May 11.

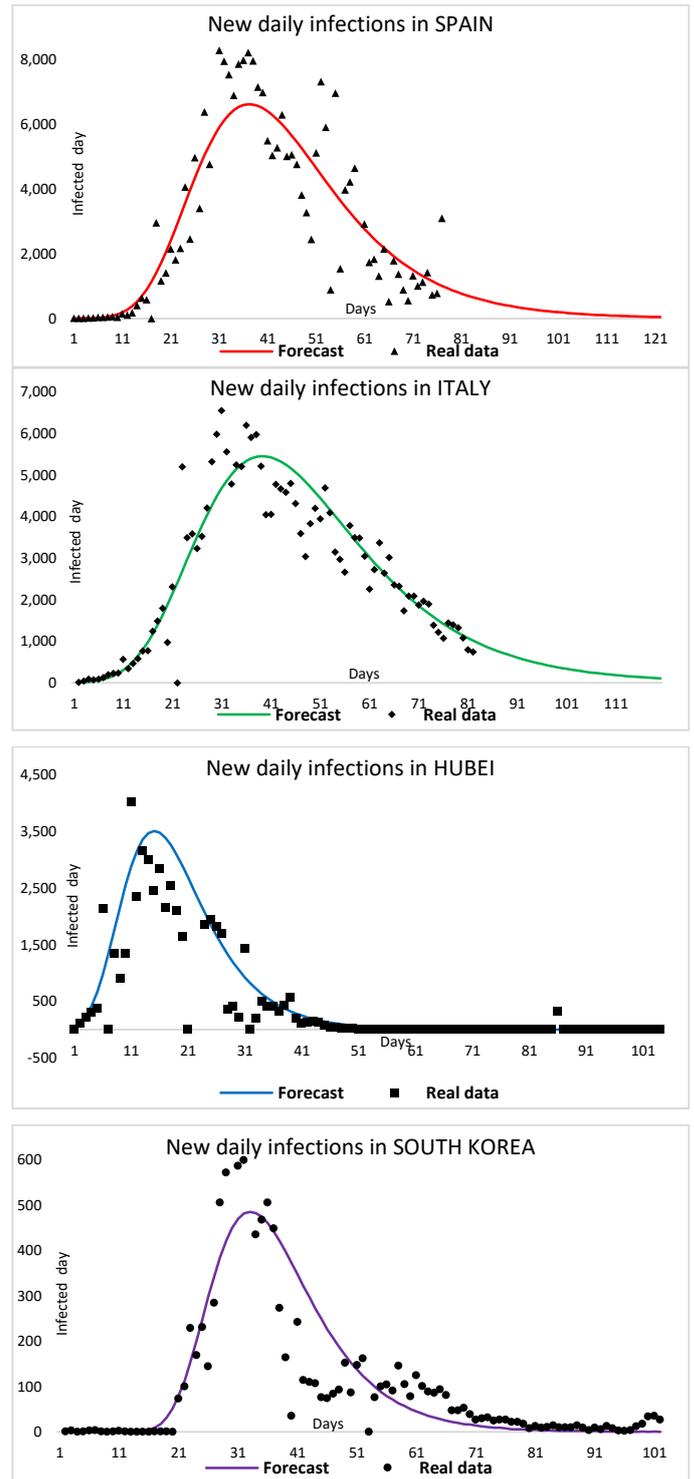


Fig.3: Forecast of new daily infections by country.

3.2 MORTALITY FORECAST

With the same model as Gompertz, began to calculate the growth of the number of deaths from the pandemic. In this case, can see how the growth data is very similar in all the countries studied, with South Korea being the lowest again,

which also has the fewest expected deaths. The values obtained with the Gompertz model also have a very high correlation adjustment coefficient R^2 , with an almost perfect adaptation to the real values. The characteristic values obtained in the pandemic model for the number of deaths can be seen in **Table 4**, where it must be taken into

account that the Hubei data are taken up to the date of April 16, 2020, which were subsequently adjusted data on deaths and the growth curve is no longer applicable as there are no real values throughout the series, therefore the values up to that date and those obtained on May 11, 2020 are used.

Table 4. Summary of characteristic values of deaths from COVID-19

Deaths characteristic values - GOMPERTZ METHOD								
Country	Constant growth	Death forecast	RMSE	MAPE	R^2	Fatality rates (CFR)	Forecast death / 10^6 population	End date of pandemic deaths
Spain	0.073	29,000	542	16.26%	0.9987	11.5%	625	August 2020
Italy	0.06	34,000	375	12.21%	0.9996	14.0%	574	September 2020
Hubei (China) (Until 04-16-20)	0.09	3,225	56	3.43%	0.9990	4.7%	55	May 2020
Hubei (China) (Until 05-11-20)		4,520				6.6%	78	May 2020
South Korea	0.058	280	6	9.86%	0.9988	2.5%	5	June 2020

The highest mortality values are obtained in Italy and Spain with 14% and 11.5% of the infected population respectively, and the lowest, again, in South Korea and Hubei with 2.5% and 4.7% (until 04-14-20) and 6.6% (until 05-11-20) of the infected population respectively, also achieving the lowest number of deaths per million inhabitants, being only 5 and 55 (until 04-14-20) and 78 (until 05-11-20) deaths per million inhabitants respectively, while the highest values are obtained in Spain and Italy with 625 and 574 deaths per million inhabitants respectively. With the forecasts obtained, the forecast of the end date of daily deaths from this pandemic has also been calculated, which in Hubei predicts the end of deaths for May, in South Korea for June, in Spain for August and in Italy for September 2020. The dates chosen for the forecasts are from the beginning of the deaths confirmed by countries, except in Hubei which is from January 22, 2020.

In the following **Figure 4** shows the actual and predicted values calculated for cumulative deaths by country, and in **Figure 5** showing the actual and predicted values of daily deaths by country. In the daily deaths curve, it can be seen how the shape of the curve decreases with time and an approximate date of the end of the deaths from the pandemic can be predicted. Again, the correlation factors R^2 for all countries are very high, from the calculated and predicted values with respect to the real values. It must be taken into account, what how the data from the Hubei

curve can be observed the jump that occurs on April 17 due to the update of data on that date, where 1290 more deaths were added. For Hubei, the curve for the values until April 16 has been estimated. South Korea again having the lowest value of deaths and in the curves can see how South Korea and Hubei are already in the stabilization zone and Spain and Italy are already in the zone of decrease in the number of cases. In the South Korean curve for daily deaths, due to the stochastic noise of such small numbers, it is impossible to adapt the curve of the values obtained to the real one.

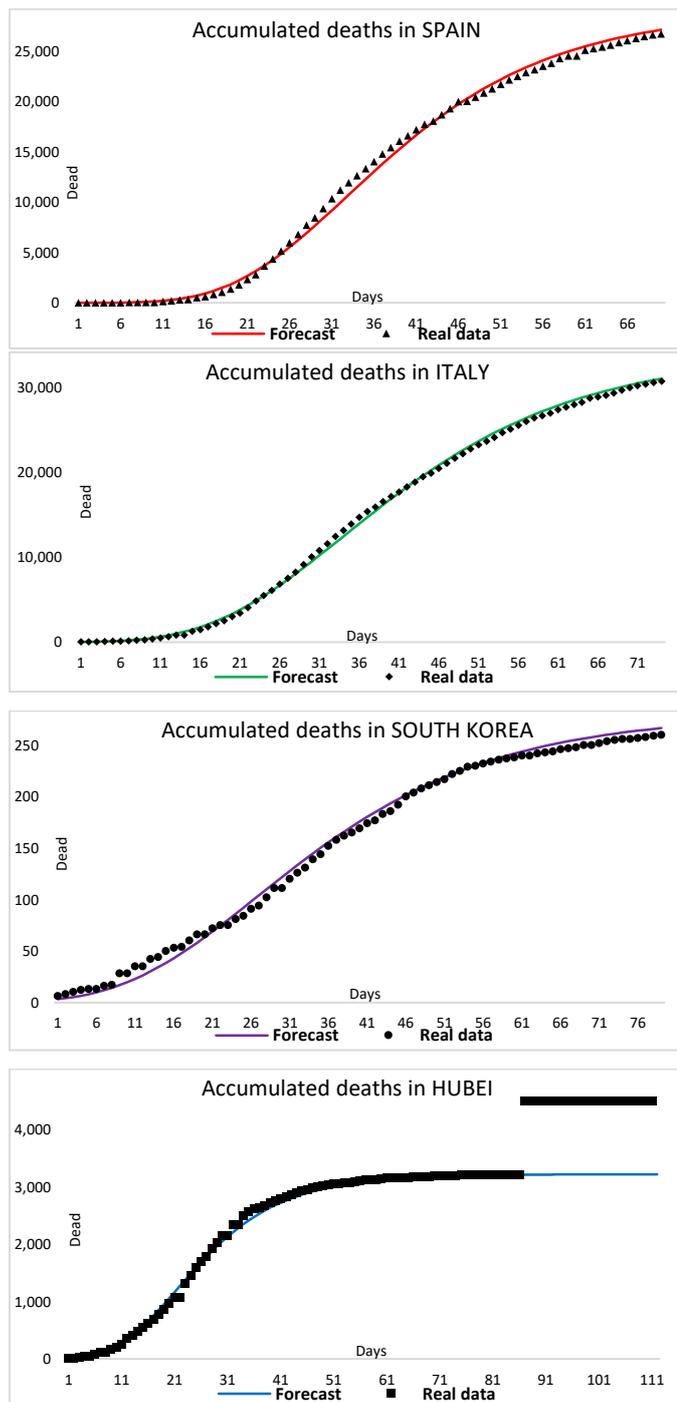


Fig.4: Accumulated death forecast until of May 11.

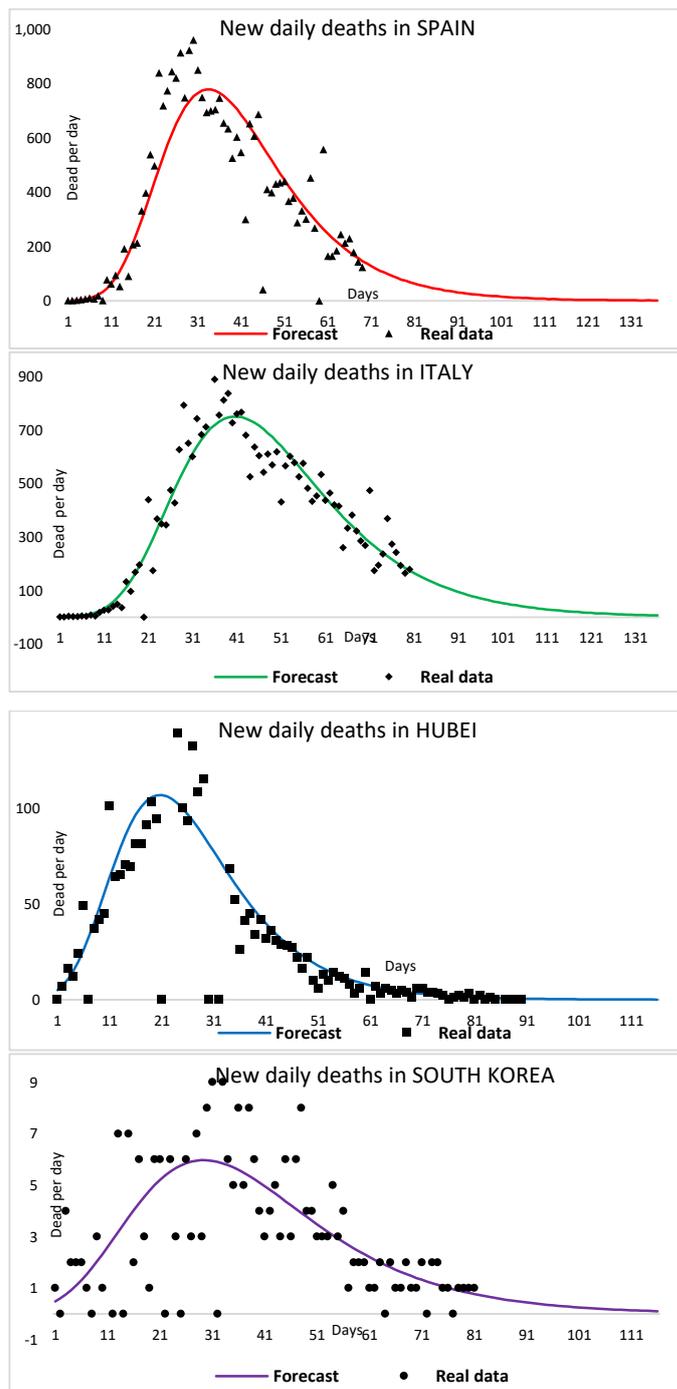


Fig.5: Forecast of new daily deaths by country.

IV. DISCUSSION

This work verifies the use of the mortality growth model to analyze the growth and development of unexpected pandemics, for mortality and new infections of COVID-19. Specifically, show the utility of mathematical modeling of the COVID-19 pandemic when using the Gompertz sigmoid curve growth model. The simulation model presents good results and excellent prognoses, with the correlation index being greater than 0.999 in all cases, both

for mortality and for those infected, giving very low MAPE values for both mortality and those infected. It is verified as in Spain due to the change in the system of confirmation of contagions carried out on April 23[55], the measurement values of infected the MAPE rises to 16% and is the highest of the four calculated cases, giving strange values as of this date .

Have also verified that the short-term estimates are correct for all cases, this study being valid to estimate the mortality and infections of the pandemic with respect to infected individuals, who were detected with symptoms. As such, this study does not apply to asymptomatic patients since they cannot have real data on them. The limitations shown in the study are mainly due to changes in counting the deceased or the infected, which generates problems and erratic data in the statistics of the studied areas. In order to estimate the growth indicators and the peak of infections or deaths, it is necessary to have enough evolution data to be able to make an estimate as accurate as possible, which is why the use of this growth model is limited if you do not have sufficient data on the evolution of the sick or deceased. Another significant limitation of the study are external pandemic containment factors, which are applied by each state. Such factors can cause growth patterns to decrease or increase significantly if the correct measures are taken to contain cases and stop the spread of the virus. Meanwhile, it is worth noting the importance of obtaining reliable data from government health entities to make the correct mathematical predictions.

V. CONCLUSIONS

This study demonstrates the validity of the proposed model, based on Gompertz techniques widely applied to biology, to describe the pandemic growth of COVID-19, both in the number of infections and deaths, emulate dynamic progression and predict the peak of the trend change. Verify how the model is adaptable to different countries with different socio-political circumstances, adjusting the growth coefficients for each case. The result is a theoretical curve that is very close to the real evolution of the pandemic, achieving forecasts with high correlation coefficients with respect to real cases, greater than 0.99 in all cases and countries, both of infections and deaths. Therefore, the Gompertz model could be an appropriate procedure to analyse the growth and development of unexpected pandemics with sudden and general outbreaks, describing epidemiological stability indices based on those obtained in the different countries that have already reached the peak. of no growth.

Taking into account that the countries studied have treated the pandemic in a different way and with different actions, the proposed model can reveal how South Korea's strategy has been more efficient to control this pandemic than those carried out by European countries. , where the number of deaths and infections are extremely high. Have shown that the Asian viral pandemic treatment strategy is much more efficient in these cases than the European one. Our results show that the South Korean procedure based on the systematic control of all those infected, their monitoring, control and isolation is the way to go. Their strategy to combat this exponential invasion of the virus consists of the isolation of groups that have been in contact with the virus, the use of preventive protections for the main contagion through masks, and control through massive population tests. In contrast, the European system with partial confinement and spot testing has been very ineffective in avoiding or mitigating pandemic damage.

The model presented in this document may be extended to other affected countries. The model design will be periodically updated during the global outbreak. The research results could be the basis for future studies related to the evaluation of the impacts of the pandemic on the economy, the ecosystem, and renewable energies, among others. The authors hope that this project will be of some help to health and political authorities during the difficult times of this global outbreak.

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Newtonian Mechanics in the Routine of Civil Construction

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Abstract— *The role played by General Mechanics education on the advancement of scientific and technical knowledge in our society is vitally important. In Brazil, this education is increasingly relevant due to the great boost in civil construction that our society has been attending. Particularly, we would like to highlight that this research aimed to apply the theory and exploration of friction concept, from a constructive criticism in the context of civil construction, for example: surfaces with friction, inclined planes with friction, in wedges and screw or the screw thread. To better understand the concept of friction, we instrumentalized it in a didactic context, respecting the existing knowledge with regard to the study of forces in some problems regarding to analysis of structures with friction, as we mentioned before. We understand that this is the most adaptable to the conception of a textbook in Mechanics, because it allows the exploration of the concepts in a hierarchical manner, as well it enables the deliberate manipulation of this universe to proper a meaningful learning.*

Keywords— *Concept and Applications of Friction, General Mechanics, Meaningful Learning, Types of Friction.*

I. INTRODUCTION

This article is a result of theoretical studies that seek to succinctly introduce the themes of friction in the analysis of mechanical vibration in structures and structural analysis. In the implementation of the research, its phases are organized in a temporal order, being, therefore, differentiated by its main features, being thus explored in parallel.

In daily, it is common to us disregarding the friction presents on surfaces, in other words, the force exerted by a surface on another is the normal to the surface and both surfaces can freely move across each other. This model would be the ideal. Nonetheless, actually, there is no perfectly smooth surface, in other words, frictionless. The friction, for a didactic purpose, can be defined as the resistance between two bodies in contact when they tend to slide or roll one over another. Then, the relative motion of two bodies in contact is always followed by a force opposed to the displacement, generically called friction force or friction.

In the course of the study it is presented a vision of the main properties about the friction. In addition, we speak in

detail on the development that lead to the expansion of friction concept and its types. We develop and represent, according to the mathematical system, the concept of friction presents in some problems in civil construction, like on surfaces, inclined planes, wedges and threaded bolts.

II. DEVELOPMENT

To better understand the concept of friction, we are going to apply it in a didactic way, respecting the previous knowledge regarding to the study of forces into some problems affecting structural analysis, for example: sliding friction, friction on wedges, friction on inclined plane and screw lift.

Friction in sliding situations

Let's consider a block W that is placed on a horizontal surface with friction and that is under action of a horizontal force F. As the weight W has not a horizontal component, the surface reaction does not present a horizontal component, then the reaction is the normal to the surface and is presented by N, as represented in figure 01. For didactical purpose, let's consider that the body slides in a

uniformly movement along a straight line. Thus, the sum of the acting forces and momentums on it are null. [1]

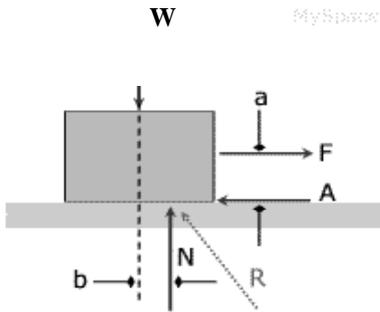


Fig.1: Sliding friction

We can observe through the figure above that if F has a low magnitude, the block will not move, in other words, another horizontal force should exist to balance F. This another force is called static friction force f, that is the net of many forces that acts above all the surface between the block and the plane. However, if the force F gets stronger, the friction force will increase too to a maximum value f_m , in other words, when two bodies in contact are on the verge of sliding one over another. But if F continues to increase, the friction force will not be able to balance it anymore and the block will start to move, reducing this force f_m to a force f_k . So the block will keep its speed, and the force represented by f_k is called kinetic friction force. It is important to highlight that it is proved, through experimental results, that the static friction force f_m as well the kinetic friction force f_k are proportional to the normal component N from the surface reaction. Represented by equations 01 and 02 [1]

$$\vec{f}_m = \mu_s \cdot \vec{N} \tag{01}$$

$$\vec{f}_k = \mu_k \cdot \vec{N} \tag{02}$$

μ_s is a constant so-called coefficient of static friction and μ_k so-called coefficient of kinetic friction. These static friction coefficients are parameters that depend from the nature of surface and other factors as temperature and presence of other elements on the surface such as water, oil. However, to the same material and same conditions, proportionality is valid. It is important to highlight that the friction force that exists when two bodies in contact are on the verge of sliding one over another is usually bigger than the friction force when they are sliding, that is to say, $\mu_s > \mu_k$. [2]

Wedges

Other example very common in constructions are the wedges, that are simple machines used do lift big stone blocks and other heavy loads, for example, the wedges are used to split logs. In other words, the wedge is used to move up or move down a load or to separate two parts of a system. Knowing that, these loads can be moved up by applying a force to the wedge, in general considerably smaller than the weight of the load. Furthermore, due to the friction between the surfaces, a wedge of a proper shape remains in place after been pushed to under the load. In other words, we can use the wedges as we want to make little position adjustments of machines' heavy pieces. A wedge is represented in Figure 02.

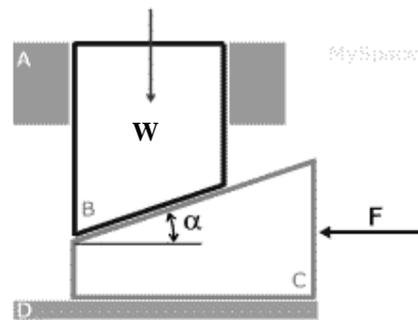


Fig.2: Wedge

In Figure 02, a horizontal force F applied on wedge C tends to lift the column B. Despising the parts' weights and considering the same friction angle ϕ to all the surfaces, it is desired to know the magnitude of force F that lifts a load P above column B at a constant velocity.

As the bodies are in mechanical equilibrium, the sum of parts B and C forces has to be zero, in other words, $\sum F = 0$, and it is represented in Figure 03.

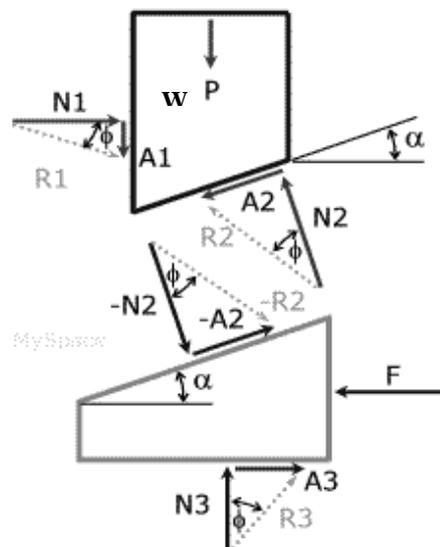


Fig.3: Representation of acting forces on the blocks

In B: $\vec{W} + \vec{R}_2 + \vec{R}_1 = 0$ (03)

In C: $\vec{F} + \vec{R}_3 - \vec{R}_2 = 0$ (04)

The vector diagram can be seen in Figure 04. Considering triangle properties,

$$\vec{F} / \text{sen } c = \vec{R}_2 / \text{sen } b \quad (05)$$

$$\vec{W} / \text{sen } c = \vec{R}_2 / \text{sen } e \quad (06)$$

$$\vec{F} = \vec{R}_2 \text{sen } c / \text{sen } b \quad (07)$$

$$\vec{R}_2 = \vec{W} \text{sen } e / \text{sen } d \quad (08)$$

$$\vec{F} = \vec{W} (\text{sen } c \text{sen } e) / (\text{sen } b \text{sen } d) \quad (09)$$

To the angles:

$$a = 90^\circ - \varphi - \alpha \quad (10)$$

$$b = 90^\circ - \varphi \quad (11)$$

Therefore,

$$\text{sen } b = \cos \varphi \quad c = \alpha + 2\varphi \quad (12)$$

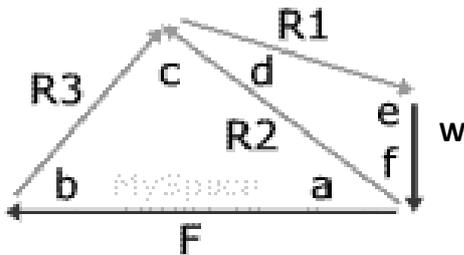


Fig.4: Representation of vector diagram

$$d = 90^\circ - 2\varphi - \alpha \quad (13)$$

Therefore,

$$\text{sen } d = \cos (2\varphi + \alpha) \quad (14)$$

$$e = 90^\circ + \varphi \quad (15)$$

Therefore,

$$\text{Sen } e = \cos \varphi \quad (16)$$

$$f = \varphi + \alpha \quad (17)$$

Replacing, $\vec{F} = \vec{W} \text{sen } (\alpha + 2\varphi) \cos \varphi / (\cos \varphi \cos (2\varphi + \alpha))$.

The simplification of this equation results in:

$$\vec{F} = \vec{W} \tan (2\varphi + \alpha) \quad (18)$$

Jack screw

It is a screw with a rectangular threaded (Figure 06) and it is used to raise certain load. They are usually used for jacks, presses and other engines. In other words, the screw thread behaves like an inclined plane rolled up to form a screw. To better understand this concept, let's observe the Figure 05 that represents a block on an inclined plane that makes an angle α with the horizontal and is under action of its own weight, according to Figure 05, and has a friction angle φ with the surface.

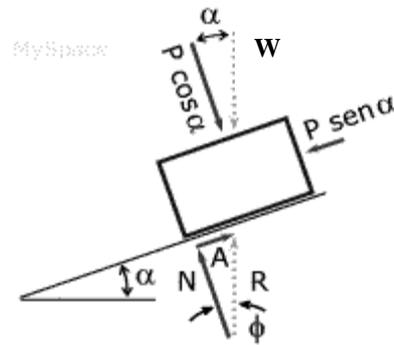


Fig.5: Inclined plane

Thereby, we are able to conclude that the body remains at rest if,

$$\alpha \leq \varphi. \quad (19)$$

For this purpose, we can find the momentum M of Figure 06, for which it will be necessary to apply in function of this load, the thread's internal (Di) and external diameter (De), the thread's angle α and the friction angle φ .

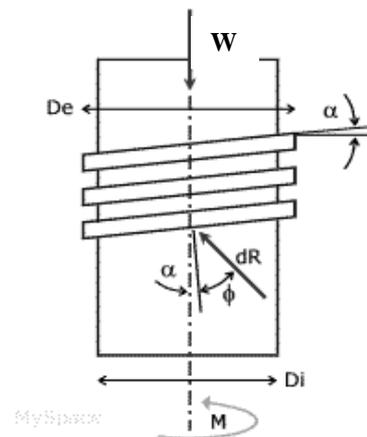


Fig.6: Rectangular thread screw

Considering that each thread screw supports the load W uniformly distributed along an average radius r , given by $(D_e + D_i)/4$. So, in each infinitesimal portion of r it will occur a reaction dR that makes an angle $(\alpha + \phi)$ with the vertical. In other words, in equilibrium condition:

$$\sum \vec{F}_y = 0 = \vec{W} - \int dR \cos(\alpha + \phi) \quad (20)$$

or

$$\vec{W} = \cos(\alpha + \phi) \int dR \quad (21)$$

As we have

$$\sum \vec{M} = 0 = \vec{M} - ((D_e + D_i)/4) \int dR \sin(\alpha + \phi) \quad (22)$$

Thus,

$$\vec{M} = \vec{W} \tan(\alpha + \phi) (D_e + D_i)/4 \quad (23)$$

III. FIGURES AND EQUATIONS

The following is the representation of the figures used in this article, present in the development of this paper.

a) Sliding friction

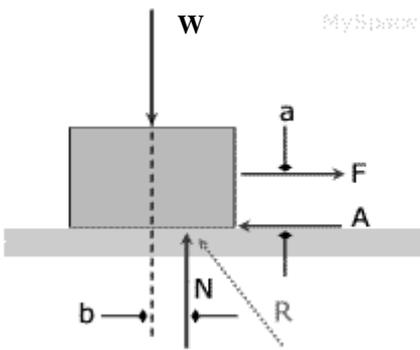


Fig.7: Sliding friction
 Image source: Google images

b) Wedge

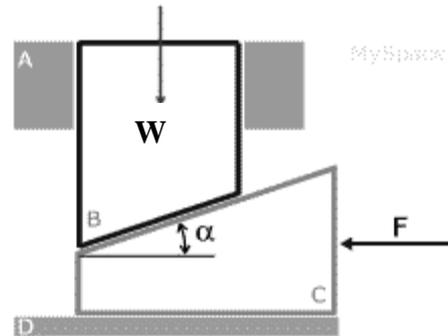


Fig.8: Wedge
 Image source: Google Images

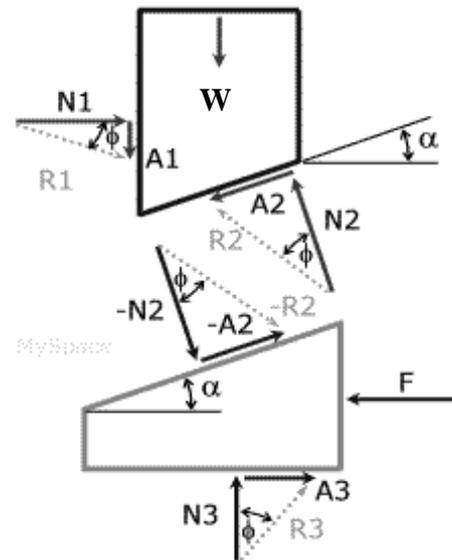


Fig.9: Representation of forces acting on the blocks

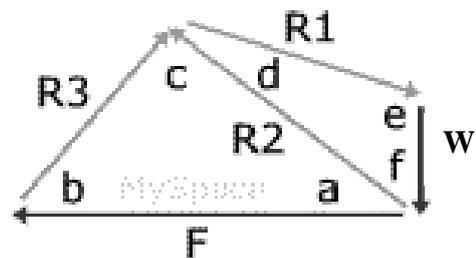


Fig.10: Representation of vector diagram
 Image source: Google images

c) Jack screw

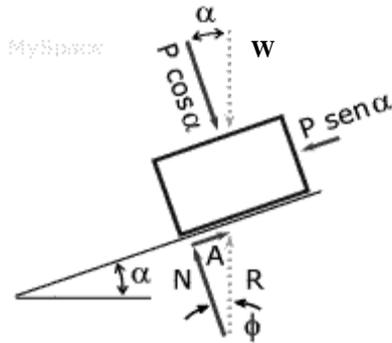


Fig.11: Inclined plane

Image source: Google images

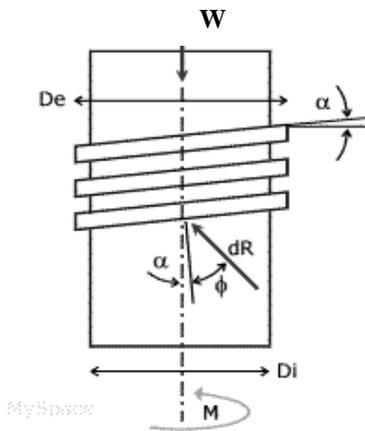


Fig.12: Rectangular thread screw

Image source: Google images

The vector components are represented below in bold and are named as: [3]

- 1) \vec{W} → Weight force
- 2) \vec{R} → Net force
- 3) c, b, d, e → Angles relative to Figure 04.
- 4) φ, α → Angles of triangle.
- 5) \vec{f} → Friction force

$$\vec{W} + \vec{R}_2 + \vec{R}_1 = 0 \tag{03}$$

$$\vec{F} + \vec{R}_3 - \vec{R}_2 = 0 \tag{04}$$

$$\vec{F} / \text{sen } c = \vec{R}_2 / \text{sen } b \tag{05}$$

$$\vec{W} / \text{sen } c = \vec{R}_2 / \text{sen } e \tag{06}$$

$$\vec{F} = \vec{R}_2 \text{sen } c / \text{sen } b \tag{07}$$

$$\vec{R}_2 = \vec{W} \text{sen } e / \text{sen } d \tag{08}$$

$$\vec{F} = \vec{W} (\text{sen } c \text{sen } e) / (\text{sen } b \text{sen } d) \tag{09}$$

$$a = 90^\circ - \varphi - \alpha \tag{10}$$

$$b = 90^\circ - \varphi \tag{11}$$

$$\text{sen } b = \cos \varphi \quad c = \alpha + 2\varphi \tag{12}$$

$$d = 90^\circ - 2\varphi - \alpha \tag{13}$$

$$\text{sen } d = \cos (2\varphi + \alpha) \tag{14}$$

$$e = 90^\circ + \varphi \tag{15}$$

$$\text{Sen } e = \cos \varphi \tag{16}$$

$$f = \varphi + \alpha \tag{17}$$

$$\vec{F} = \vec{W} \tan (2\varphi + \alpha) \tag{18}$$

Equations

a) Sliding friction

- 1) \vec{f}_m → Static frictional force
- 2) \vec{f}_k → Kinetic frictional force
- 3) μ_s → Coefficient of static friction
- 4) μ_k → Coefficient of kinetic friction

$$\vec{f}_m = \mu_s \cdot \vec{N} \tag{01}$$

$$\vec{f}_k = \mu_k \cdot \vec{N} \tag{02}$$

b) Wedges

c) Jack screw

- 1) \vec{M} → Momentum of a force
- 2) \vec{R} → Net force
- 3) c, b, d, e → Angles relative to Figure 04.
- 4) φ, α → Angles of triangle
- 5) φ → Angles of friction

$$\alpha \leq \varphi. \quad (19)$$

$$\sum \vec{F}_y = 0 = \vec{W} - \int dR \cos(\alpha + \varphi) \quad (20)$$

$$\vec{W} = \cos(\alpha + \varphi) \int dR \quad (21)$$

$$\sum \vec{M} = 0 = \vec{M} - ((D_e + D_i) / 4) \int dR \sin(\alpha + \varphi) \quad (22)$$

$$\vec{M} = \vec{W} \tan(\alpha + \varphi) (D_e + D_i) / 4 \quad (23)$$

IV. CONCLUSION

This work aimed to develop a didactic material in the field of Newtonian Mechanics, geared for the meaningful learning of generators concepts attributed to the study of problems involving the friction force applied to sliding bodies, on wedges, on inclined planes and on screw or screw thread.

From this analysis, we intended to demonstrate and represent the friction force present in several structures associated with civil construction. In other words, it results in the expansion of friction concept, which conception and application in the practical context reflects the physical concepts' representational ability in various situations. Furthermore, its wide range of actions allows the gradual deepening exploitation of this physics concept, being unnecessary a systematic introduction of mathematical formalism.

ACKNOWLEDGEMENTS

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Algorithm development based on artificial intelligence for function manipulation and comparison with numerical techniques used in engineering teaching

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Abstract— This paper aims to develop and verify the efficiency of algorithm applications and compare them with the numerical techniques used in engineering areas, stem from structures of neural network for function approximation. For that, function modeling were used, based on complex formulas, making approximation mandatory. The statement investigated is that neural networks are capable to solve with great accuracy problems of this kind. As a test model, a measurement approximation of thermodynamics tables (saturated water) was carried and it was compared with the results of traditional methods (linear and quadratic functions), confirming the efficiency and possibility of its use.

Keywords— neural networks, artificial intelligence, engineering education.

I. INTRODUCTION

Artificial Intelligence (AI) consists in withdraw information from the embbed ambient and utilize them to solve determinated problems, like a study. This way, it becomes adaptive for use in a variety of areas of knowledge, as engineering [1]. According to Heckmann [2], Artificial Intelligence is a Science to make a computer do tasks that, until now, only people could do it and very capacited people could do well.

The engineering is visible everywhere, their working fields are extremely embracing, making possible to preside in small domestic tubulation system and even in great petrolific industry. With the technology evolution, the engineer obtained more efficient and faster ways to mathematically calculate using the computer. It can reach even higher levels solving math problems. Therefore, it is necessary to have engineers capable to use the resources of computer Science, since the integration of these fields can be very effective in problem solving.

The AI show itself as an efficient alternative to be studied. Among its capacities are problems involving proximity and function modeling, which can be applied areas such as thermodynamic and function optimizer

problem solving with lots of variables and common restriction in project area [2]. According to Russel and Norvig [3], learn how to approximate function is considered inductive task, the Artificial Neural Networks (ANN) learns to represent function effectively and usefully.

In this research, it will be compared the function approximate method obtained by artificial neural network and by numerical analysis method, such as interpolation and spline functions, that can be defined by polinomes [4]. As an object, the thermodynamics tables will be used to find a function that approximate the non-registered results to solve specific problems.

At the same time, the constants involved in the estimates of the approximation error for neural networks often depend exponentially or polynomially on the dimensionality of the data [5,6]. Thus, by using lower dimensional data following the mapping of the original data into the lower dimensional space, it can be expected that the error of the approximation will be reduced [7].

This paper aims to develop algorithm that can test Artificial Intelligence techniques (neural network) and compare its practical efficiency with numerical techniques

(interpolations), to verify a possibility of its use in solving common problems on Mechanical Engineering. Simple experiments will be made using algorithms, which will be possible to calculate its efficiency regarding other methods.

II. LITERATURE REVIEW

Function approximation is a core task in many engineering, economic, and computational problems [8]. There are many approaches to the function approximation including relatively simple methods such as least squares linear approximation and many more complex methods such as approximation with splines or neural networks [9].

Functional neural models can also be created by translating well understood principles from classical algorithms from the fields of machine learning [10]. Such techniques work as a data-driven brain models and the hardware and can be used for creating entire cognitive architectures with the potential of helping to decipher neural principles [11].

2.1 Linear Interpolation

Linear Interpolation is the simpler case and also the most used. Given two distinct points in a function, a degree 1 polynomial must be created $P_1(x) = a_0 + a_1x$, which has to satisfy the equation system, where geometrically $P_1(x)$ is an equation of a line that pass through two points, x_0 and x_1 [12].

The interpolation function always pass by known points of the original function and, from them, are estimated the unknown values. Being $f(x)$ the original function and $g(x)$ the approximation, it can be realized that the distance between them rises when they are more distant of the points used on interpolation. This distance is that defines the error [13].

In practical aspects, functions with more than six points are rarely used, because the error overly rises, so, surpassing to splines in the other cases. The splines are used to get a reduction of the approximate function. The utilized method for his approximation consists in adjusts the polynomial of lower degree than the data subset. These polynomial links are called spline functions [13].

Higher degree polynomials tend to not to perceive abrupt changes in the function behavior. Polinômios com ordem alta tendem a não captar mudanças bruscas no comportamento da função. Thus, the splines obtain better approximation in functions with this kind of characteristic [14].

2.2 Neural Networks: learning and implementation

As Braga et al. [15] stated, the neural network training can be supervised or unsupervised. While the unsupervised training doesn't require a desired output (the network makes an auto organized considering only the input data), the supervised training considers the network learning from input data and the respective desired outputs.

While, for a satisfactory performance of a RNA is necessary to properly choose the network attributes. There are lots of learning algorithms developed for RNA training, and also needed to define the number of network layers, the neurons of hidden layers, the activation function of hidden layers and output and the specifics parameters that compose each algorithm [16].

The main characteristic of neural network is its adaptation and generation capacity. This feature is acquired changing its synaptical weights in such a way that minimizes the network output error, until an optimum solution is reached. To achieve such solution, some specific training algorithms from each neural network architecture are used.

The Backpropagation algorithm was developed by Werbos [17] and by Parker [18]. Since its creation, the backpropagation algorithms has been largely used as a learning algorithm for RNA with multiple layers' topology [19-21]. For this paper, Multilayer Perceptron Perceptron (MLP) network was used, which is based in this algorithms (or variations) for its training [2].

2.3 Thermodynamic Tables

The comprehension of these tables are very important for academical develop of a mechanical engineer, because they are indispensable when working with steam or thermodynamic cycles. Temperature and pressure can be expressed in three occasions: compressed liquid, superheated steam and saturated steam [22].

The tables have rich content of details, low error tax from real of compounds and lots of temperature versus pressure are already listed, besides they are constantly used with linear interpolation by engineer students. With these characteristics, the tables are a good option to be used in the approximation method, because, besides showing practical values, also shows simplicity in its use [22].

III. METHODOLOGY

Through testing of the studied methods of this paper, we developed algorithms wrote in C language, and Matlab was used for graph generation, with that it is possible to obtain better view and results analysis.

Every code used in this research is owned by the authors and are available on the link “<https://github.com/Eliasrgjunior1/CITI2017-1/blob/master/README.md>”, any adaptation or parts from others authors were used. Its development was based on techniques described during the literature review, highlighting the AI fundamentals.

About function approximation case, thermodynamics table (saturated steam water), which calculations using interpolation (linear, quadratic and spline function) were made and neural networks were used as object of study. A routine was generated, using the Matlab, so the graphs for every function using each method can be plotted. To model the functions, 46 samples were selected from the table randomly for Neural Network training and interpolation. The efficiency calculation for each technique was done using the thirty-three unused samples. Comparing the values obtained with the real ones, it was possible to estimate the error in both methods, showing the most efficient one in this context.

For each case with neural network were used, its structure was made in Multilayer Perceptron's (MLP) architecture and its training was the Levenberg Maquardt (LM), so the used topologies can be varied to obtain results more similar with the real ones.

Through these methods, this research aims to obtain desired solutions about the possibilities of application of neural network on engineering, its efficiency and the facility of the projects.

3.1 Data preparation

In order to the data be suitable to test realization, the following steps were made:

- Creation of a file containing the values to be used from thermodynamic tables of saturated water, focusing on values of pressure and enthalpy;

- Development of the routine for the Matlab plot graphs extracted from the developed algorithms. These ones will be plotted in two dimensions with pressure to temperature;

- Tabled point plotting to visualize the table clearly.

3.2 Algorithm Programming

In this phase, the following actions were done:

- Development of an artificial neural algorithm (ANA) through MatLab®, with a hidden layer, and LM training. The algorithm will be capable to alter the number of neurons of the hidden layer, to do the tests with many topologies;

- Development of an algorithm to linear interpolation using splines;

- Development of an algorithm for interpolation, using quadratic spline functions, that must receive the number of points and the needed table points to approximate the function.

3.3 Tests

The tests followed the process defined by the flowchart (Fig. 1):

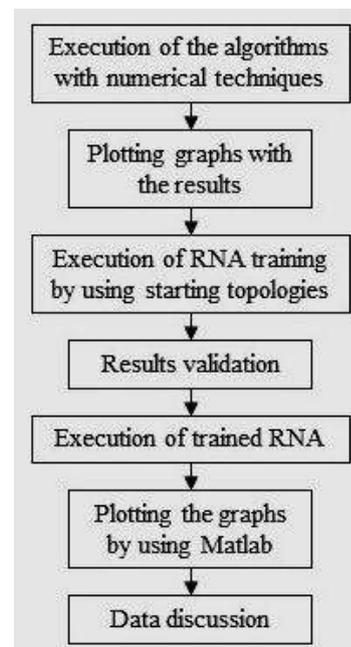


Fig. 1: Process flowchart.

IV. RESULTS AND DISCUSSION

4.1 Saturated Water Thermodynamic Table

The graphs of thermodynamic tables obey a determined pattern, which has to be learnt by the Neural Networks (NN). For validation, the points of the table were placed in order, generating the graph presented in Fig. 2).

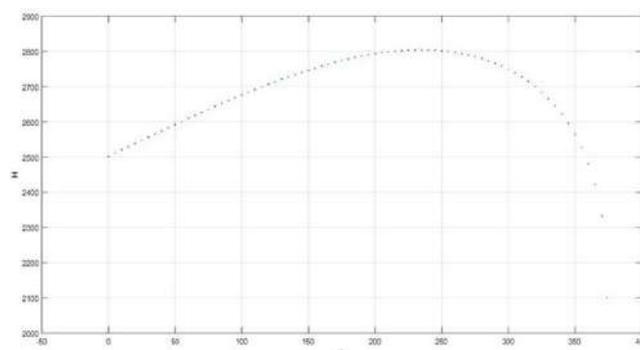


Fig. 2: Temperature (°C) x enthalpy (kJ/kg) graph.

4.2 Dispersion Calculation

The algorithm used for interpolation worked like as expected, modeling the function with low error rate. From trained neural network and interpolation, desired values approximations were obtained. As result, the variance and standard deviation were calculated (Table 1).

Table.1: Results of the calculation of standard deviation and variance – temperature x enthalpy.

Tests	Standard Deviation	Variance
Linear Interpolation	0,35438	0,125585
Quadratic Interpolation	0,017839	0,000318
NN1	0,829772	0,688521
NN2	0,004884	0,000238
NN3	0,001444	0,002085
NN4	2,231818	4,98101
NN5	1,2319894	1,520028
NN6	4,299726	18,487644

4.3 Approximation graph analysis

The algorithms used in interpolation worked as expected, modeling the function with low error rate. From trained neural networks and interpolations, the approximations for desired values were obtained.

Graphs comparisons between the NN of 1 or 2 layers and interpolations were made and better efficiency obtained can be noticed. Fig. 3 and Fig. 4 shows the graphs of combined NNs and points of interest. Fig. 5 demonstrates the values obtained by polynomial interpolations. To ensure a high-quality product, diagrams and lettering must be either computer-drafted or drawn using India ink.

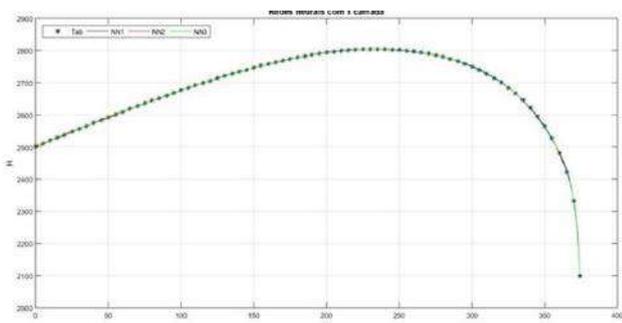


Fig. 3: Temperature (°C) x enthalpy (kJ/kg) graph. - NN of 1 hidden layer approximation.

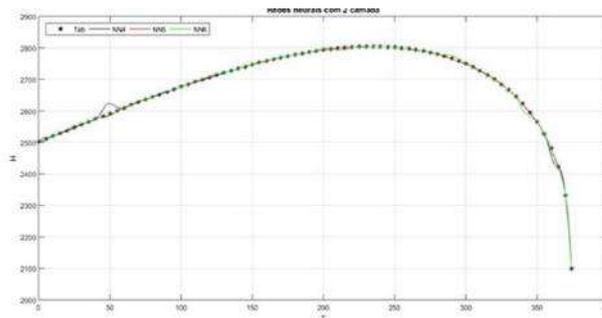


Fig. 4: Temperatura (°C) x enthalpy (kJ/kg) - NN of 2 hidden layers approximation.

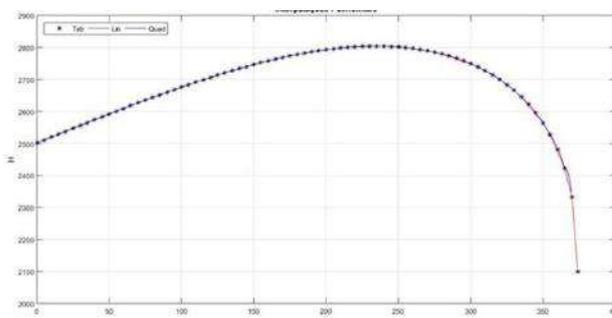


Fig. 5: Temperature (°C) x enthalpy (kJ/kg) - approximation with polynomial interpolation.

At last, for comparative effects, a combined graph of the neural network and polynomial interpolation values were plotted as presented in Fig. 6.

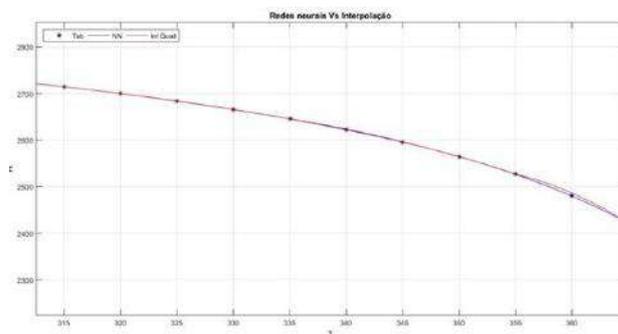


Fig. 6: Temperature (°C) x enthalpy (kJ/kg) comparing the obtained values by the approximation techniques used in this study.

The graphs show the approximation results, using all of the points. The neural networks didn't behave in an exact way, it may contain errors, including the points that were used for training. It is important to state that this behavior doesn't occur in interpolation, because with a proper training can eliminate this kind of error. Also, there is a homogeneous behavior in the whole function, where the

error is not increased, comparing with the interpolation, they have more efficient approximation in these points.

It's possible to notice, by the graphs obtained by the used table, that it generates a continuous function with insignificant randomness. This is the best scenario for linear and quadratic interpolation to be applied. In situations that high precision is not necessary, the linear interpolation would be ideal, since it's simpler, but, when the application requires high precision, the methods must be compared.

In every test, the neural network configuration number 2 could stand out from the others, so this will be the patten for comparison purposes.

It also can be noticed that the linear interpolation falls short when the curves with higher inclination, making the error, in some cases, rise considerably. The obtained curve by quadratic interpolation wasn't symmetrically arranged, which deviates the function from satisfactory results.

The NN must have its training meticulously made to have an efficient result. Some configurations show an error rate higher than the others, but the final result obtained was more precise than quadratic interpolation. The NN's dispersions were lower or equal in all situations, as displayed in the tables.

From the training, it can be observed that the needed error rate for this kind of function is from $10e-2$ order, lower errors rate configures about the training, which is the two-layered neural network's case. Besides, it is possible to realize that, with less complex functions, simpler NN, with a layer and few neurons, are more efficient for this objective. The training with few samples (relatively to NN) was possible and the neural network adapted themselves without great effort.

V. CONCLUSION

Based on the superior performance met by neural network on interpolations, even in standard functions with low randomness, it's assured that they can be used to complete the measurement table (like thermodynamic ones), adapt the control answer description function, vectorial drawing in specialized software, like Matlab and help in physics phenomenon's study. Besides thermodynamical for function description, and even help to solve and develop specifics engineer.

The most efficient NN's topologies – NN2 and NN3 – can be used by starting point to similar projects, the described training can be utilized in other problems. The Neural Network can also be used in cases that have function mathematical solution, like this one, and presents

similar results or more efficient ones, since the adequate training routine is followed.

Based on the results reported, some other comparison of numerical analysis can be explored, like extrapolation and some function modeling that can be difficult to calculate, also be able to compare between the others variables provided on thermodynamical tables.

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Contribution of academic monitoring to the teaching-learning process: Experience report of monitors in the discipline Nursing Care in Emergency and Trauma

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Abstract— *Objective: To report the experience of monitors of the discipline Nursing Care in Emergency and Trauma in the performance of their academic activities, from August to December 2019. Method: Experience report presenting the experiences of the monitors of the Nursing course at UNAMA (University of the Amazon), Belém, State of Pará, Brazil, on the dynamics developed in the teaching-learning process in the discipline Nursing Care in Emergency and Trauma, taught in the 7th semester of the undergraduate nursing course, in the period referring to the second semester of 2019. Result: During the monitoring experience, activities were carried out in the realistic simulation laboratory, as well as in the classroom, with the purpose of reinforcing the contents of the curricular component, as well as clarifying possible doubts from students about the health care process addressed in classroom by the professor. It is considered that the relevance of academic monitoring in higher education goes beyond the acquisition of a curricular title; because in addition to fostering an*

intellectual gain in the teaching-learning process, it contributes substantially to the knowledge of the monitored students and, especially, in the relationship between the tutor and the monitor student, significantly favoring the exchange of knowledge. Conclusion: The monitoring contributed to promote the capacity of the monitors in terms of concentration, argumentation and mastery over the group. We emphasize the importance of preparing studies and research carried out and exchanging knowledge that contribute to the intellectual, emotional and social empowerment of student monitors, thus revealing new professional perspectives, with security, competence and skills for a qualitative action in the health teaching process.

Keywords— Mentors. Learning. Education, Nursing.

I. INTRODUCTION

Academic monitoring, governed by Federal Law no. 5.540 / 1968, allows students to act as moderators in the teaching-learning process and to participate in the organization and planning of pedagogical strategies together with teachers. This experience provides an introduction to the teaching context and, in addition, allows the monitor stimuli to improve technical skills and competences, interpersonal and intrapersonal relationships and leadership skills⁽¹⁾.

The academic monitoring program was introduced with the aim of adding values and learning to all academic practices since November 28, 1968, which provides the stimulus for performance and proactivity in the discipline sought, allowing some benefits for the academic, such as: scholarship, tuition discounts if it is linked to a private Higher Education Institution (HEI), among other benefits⁽²⁾. Furthermore, monitoring provides remarkable learning and significant professional training to the health demands that emerge from the population, as well as allowing students to enter the context of educational and leadership practices in favor of their preparation for professional practice⁽³⁾.

The educational practices introduced in the monitoring program of the Nursing Course provide knowledge and health promotion for the entire community, as they are extension practices of a university character that provide feedback, both for other academics and for the teacher responsible for discipline⁽⁴⁾.

Although this teaching-learning strategy is relevantly common in universities, there are still few studies that address the theme.

In the meantime, the guiding teachers conceive of monitoring as a modality that needs systematic coordination in person or at a distance (via e-mail) and supervision, to better prepare the monitors in the administration and promote assistance to other students, representing a strategy of investment in dynamic and co-participative learning⁽⁵⁾.

Monitoring allows the student to live experiences and awaken to being a teacher, as it helps in the teaching-learning process and helps to strengthen the academic trajectory of colleagues in the acquisition of skills, solidification of theoretical and practical knowledge and incentive to search for new knowledge scientific⁽⁶⁾.

In research on the role of monitoring in the development of academic training, it was shown that 88.6% of students improved their performance with group work, 74.14% developed new teaching methods, 40% developed the habit of reading and 68% declared improvements in posture in seminar presentations⁽⁷⁾.

In this understanding, the student, in the role of monitor in collaboration with the teacher, performs a fundamental activity, in addition to performing his duties in the classroom and laboratories, other related activities, which include teaching, research and extension, corroborating for meaningful learning and strengthening the academic community⁽⁸⁾.

The discipline Nursing Care in Emergency and Trauma has an extensive course, requiring the monitor and teacher to adopt active teaching methodologies aimed at critical formation, creative and reflective, carried out through practical classes, in which one can simulate situations of real care, allowing familiarity with the necessary materials and equipment, techniques and the correct sequence of care, through simulations, dramatizations and repetitions of procedures⁽⁹⁾.

In this conception, the study proposes to expose the contributions of academic monitoring of the discipline of Nursing Care in Emergency and Trauma, for the teaching-learning process in the training of professional nurses. The experience report is understood as an experience, which goes beyond a mere summary description about some activity, because when reading it, it is possible to know more accurately the experience described. It also makes it possible, from a theoretical point of view, to compare it with other similar experiences, allowing for greater reflection on the theme addressed.

Thus, the realization of this study is justified by enabling greater discussion and expansion of new studies on the subject, in addition to providing subsidies for the development of future research that focuses on the theme. Thus, the objective of this study was to report the experience of monitors of the discipline Nursing Care in Emergency and Trauma in the performance of their academic activities, from August to December 2019.

II. METHOD

Experience report about the experiences of the monitors of the Bachelor of UNAMA (University of the Amazon), Belém, State of Pará, Brazil, about the dynamics developed in the teaching-learning process in the discipline Nursing Care in Emergency and Trauma, from August to December 2019.

The descriptive method was used. Therefore, a critical analysis of the activities developed during the period subscribed with the monitors of the discipline and the reports developed at the end of the academic semester was carried out.

The discipline of Emergency Nursing Care and Trauma is a mandatory curricular component of the undergraduate nursing course, being taken in the seventh academic period of this HEI Theoretical-practical, with a total workload of 80 hours.

The monitoring activities were developed by students who had already taken the course. In addition, students were approved in an internal selection process instituted in the first semester, with entry in the second semester of 2019, through the request of the professor in charge of the discipline, of the academic board of UNAMA in agreement with the coordination of the Nursing Course.

The selection process consisted of a written test, an interview with the judging committee, chaired by the professor responsible for the discipline and an analysis of the candidates' academic performance. In this process, three monitors were selected, one with a scholarship and two volunteers, who were subsequently distributed in the three shifts.

The monitoring activities were developed both in the classroom and in the realistic simulation laboratory, where there was an opportunity to develop competencies and skills in the preparation of the activity plan, when exercising with students, clarifying doubts about the subjects taught or remembering the practical maneuvers developed in the previous semesters, aligned with the curriculum design, always under the supervision of the teacher responsible for the discipline.

The monitors fulfilled a mandatory workload of 20 hours per week in accordance with the selection notice, 12 hours of which are intended for attending the student in the monitoring room or in the realistic simulation laboratory, 4 hours for the study of the discipline and 4 hours for academic production. The times were distributed to the 3 monitors throughout the week, in the morning, afternoon and night shifts.

III. RESULTS AND DISCUSSION

The activities carried out by the monitors, range from class follow-up, activities, guidance, clarification of students doubts, and because it is a discipline that includes practical workload with curricular internships at the hospital level, there was also a need to carry practical laboratory classes, so that students have the opportunity to carry out and review the procedures related to the discipline.

The proposal to combine the activities inherent to teaching, participation in the removal of doubts after classes and active participation during theoretical and practical classes simulated in the laboratory, emerged from several moments of debate between the teachers responsible for the discipline, aiming to combine items fundamental for the training of the future nurse.

From the survey of the needs of the class, the monitor scheduled a meeting with the teacher responsible for the discipline, aiming to define the dynamics of the class, as well as deciding exactly how the monitor's collaboration would be in the teaching-learning process. At the time, the monitors were guided by the teacher as to the aspects inherent to the didactic behavior and the theoretical-practical contents to be taught.

In this perspective, the monitoring contributed to the academic scope self-sufficiency with regard to decision-making, related to the act of giving discipline reviews, indication of materials for reading and carrying out simulated activity in the laboratory, in favor of active and qualitative learning, both in the classroom, and for professional and personal life, allowing better interpersonal relationships between students and monitors, teachers and the university, solidifying learning⁽¹⁰⁾, because even though certain disciplines present a certain degree of difficulty, the monitor collaborates with building knowledge, expanding training, cooperating to incorporate attitudes that facilitate the learning of skills, attitudes and competences⁽¹¹⁾.

In the meantime, monitoring is recognized as a pedagogical strategy of great scope and relevance, which enables the intellectual improvement of the monitors with

regard to the acquisition of skills related to teaching, raising reflections and strengthening the training of health professionals from an understanding teaching that values the construction of knowledge from the perspective of more critical and reflective thoughts⁽¹²⁾.

The monitoring program is an essential component of the teaching process. Such activity contributes to the training of health professionals in line with the sociopolitical assumptions of the current health system, in Brazil the Unified Health System (SUS), and enters the scenario of discussion about the education of the student, in addition to being a space that favors the construction of knowledge for the monitor, students and teachers; it allows immersion in teaching to the monitor, an intervention to improve the quality of teaching at graduation and a support plan in which the most advanced students help their colleagues in the search for knowledge⁽¹³⁾.

In this context, the monitoring activities started loaded with anxiety, as such activity is permeated with uncertainties, especially with regard to emotional and behavioral skills, from how to react to doubts to the posture and vocabulary accessible to students.

The monitoring project is a pedagogical support service made available to students with an interest in deepening the knowledge related to a given discipline, as well as enriching the academic curriculum, envisioning better results in terms of competitiveness in selections in the graduate, Lato or Stricto Sensu processes, among other academic processes.

The higher education nursing course is one of the courses in the world that most benefit from monitoring activities, with the objective of making it possible for students to get closer to their future work environment⁽¹⁴⁾.

For this activity to achieve its purposes, this resource must be idealized through effective communication and exchange, where both the teacher and the student learn from each other in the course of the teaching process, breaking with traditional models of unilateral and verticalized teaching, conceiving such space and activity as a fundamental strategy, propelling and consolidating teaching⁽¹⁵⁾.

Despite the recognized importance attributed to the academic monitoring program, research carried out in a private institution in Fortaleza-CE, Brazil, showed low interest from students in participating in the monitoring program, justified by the lack of incentive of some HEIs to attract and encourage students for activities of this kind, as well as an unsatisfactory financial contribution offered by the programs⁽¹⁶⁾. Another factor that contributes to lack of interest is the lack of time in the curricular component so

that the monitors can incorporate academic activities and diversify the monitoring work plan⁽¹²⁾.

Academic monitoring is characterized as an important teaching-learning method, as it stimulates attitudinal skills in the student monitor, subsidizing the improvement of teaching, through the improvement of nursing care practices, based in motivating and dynamic teaching strategies with the potential to consolidate the qualitative curricular practices essential for working with the teacher⁽¹⁷⁾.

In this context, moving to the practical field, it was possible to perceive that the hours available for laboratory practices favor student learning, as they have the opportunity to simulate the performance of procedures that are routinely part of their professional life and, previously develop their manual skills before direct contact with patients in the internship fields.

It should be noted that in this process, the act of preparing classes to teach students is of great relevance and importance, because through this experience it is possible to contribute to the empowerment of the monitor, taking into account that the monitoring activities go beyond the acquisition of a curricular title, having positive impacts on the personal aspect of the monitor, contributing substantially to the students' knowledge, a trusting relationship between the tutor and the monitor student, thus favoring the exchange of knowledge and consolidation of the teaching-learning process.

The monitoring contributes positively due to the contextualization of the subjects compiled in clinical cases and directed studies, put into practice through simulated practical classes in the laboratory, thus allowing to broaden the horizons regarding the actions inherent in making nurses in the labor Market. The teacher had a fundamental role in this process, guiding and solving doubts, so that the class taught would occur satisfactorily.

One of the benefits obtained from this experience was the improvement of theoretical and practical knowledge, from an expanded view of the teaching-learning process. In addition, the monitoring provides subsidies for the academic to develop a practice with greater security, within the best practices in care and scientific evidence.

The importance of the monitoring program in academic training was evidenced, since guiding other academics encourages to seek more knowledge, in addition to improving skills and allowing greater interaction with academics and teachers in the process of teaching-learning-teaching.

IV. CONCLUSION

From the results, it was demonstrated that the monitoring is a scenario of active construction of knowledge and development of skills, attitudes and competences, which are relevant to the personal and professional growth of the student. In addition, the activities developed are essential in the teaching-learning process, with significant benefits for both students and the teacher, as they provide significant exchange of knowledge between the actors involved.

In view of the objectives of the monitoring program, it is concluded that these were achieved, as there was an improvement in academic training and in the learning of the student monitor, as well as providing interaction between these actors and the others involved.

It is considered that a well-trained monitor contributes to the insertion of excellent professionals in the job market, since decision making and autonomy are instigated, and a commitment to other students from previous semesters is reinforced in the scope of monitoring activities, ratifying responsibility in the social role as a professional future.

It is understood that the study brings important contributions to the reflection regarding the effectiveness of academic monitoring in the teaching-learning process and its relevance in the context of higher health education. The study can also contribute to advances in research on the subject and, potentially, to the improvement of undergraduate nursing, impacting on the training of professionals much better prepared to meet the health needs that emerge from their reality in different human groups and health cycles life.

Monitoring contributes to the construction and reframing of knowledge inherent to the profession, in the perspective that knowledge is dynamic, is constantly changing and, therefore, the search cannot be stagnant. The process contributes to identify and share with the health and nursing teams knowledge that supports qualified care action, corroborating the role of nurse educator still in their training.

From the results of this study, the need for further study on the topic by the academic community is reiterated, considering its relevance.

Despite the lack of studies at national and international levels, dedicated to investigating the teaching-learning process and the relationships that permeate the implementation and evaluation of monitoring programs, especially in the training of nurses, with its implications for professional performance, further studies are suggested.

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Analysis of the Colebrook-White Equation and further approaches to solve Fluid Loss Coefficient Definition Problems

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Abstract— With the advancement of fluid mechanics in engineering, the need to estimate the pressure drop coefficient, becomes necessary for flow loss calculations in order to be able to measure pipe diameter or stipulate flow regimes that are required for a given situation. This coefficient appears in the Darcy-Weisbach formula in equality with the Poiseuille equation and is now measured by the Colebrook-White equation. However, because this equation presents a different characteristic, where the coefficient appears on both sides of the same equation, scholars of the area over time modeled approximations derived from this previous knowledge. In this work we will approach the Colebrook-White principles and their subsequent approaches. The aim of this paper is to analyze the correlations cited, as well as their authors, also analyzing the relative errors between the approximations and the Colebrook-White equation at specific intervals for the relative roughness and the Reynolds number and, from this, to determine which ones have the lowest relative error.

Keywords—fluid mechanics, pressure loss coefficient, Colebrook-White equation and mathematical approximation.

I. INTRODUCTION

Engineering regarding fluid mechanics has several focuses of study. One of these focuses is on the flow of fluids and their particularities. The focus of this work is on the flow and its concepts, with respect to the flow resistance factor for pressure loss calculations in fluids.

It is discovered through studies that when a fluid gets closer and closer to the “wall” of the pipe, its flow velocity tends to zero, that is, there is a resistance to flow (viscosity of the inner surface of the pipe).

According to Sá Marques and Sousa (1996), the Colebrook-White equation is commonly mentioned in the

literature on fluid mechanics and has wide applicability by the technicians involved in this specialty, being considered the closest to the physical reality of flows.

To Coban (2012), the Colebrook-White equation is an implicit formula that generates the best result for the pressure loss coefficient in turbulent regime, however, to obtain these results there is a need to perform iterative processes. Such equation has as parameters the relative roughness (ε/D) and the Reynolds number (Re).

Therefore, there are several studies of explicit equations to measure this resistance precisely, replacing the Colebrook-White equation, as closely as possible to the result of the implicit equation.

The calculation of the head loss is the main issue of this work, however there is a problem, since the Colebrook-White equation that is used for this purpose has a characteristic of being implicit, since it presents the coefficient on both sides of the equality.

Due to this characteristic, calculating using this equation becomes complex, as there is a need to perform iterative processes to obtain a result.

With this problem, we seek to gather information, data and authors that otherwise express this modeling, in a less complex way, aiming at an explicit equation and with the results as close as possible to the formula made by Colebrook-White.

For flow in industrial pipelines, knowing how to accurately measure the head loss is essential, as there are several unknowns to be seen, be it the material, the roughness to be worked, the dimensioning, the necessary performance for each case, etc.

According to Resende (2007), the head loss is highlighted, for example, in a hydroelectric power plant, because as the head loss is increased, the generation capacity is decreased. For this, a formula is needed that accurately models this coefficient.

According to Zidan (2015), a suggestion by C.M. White for transition formula which similar to those obtained experimentally for commercial pipes, was simply add together the lower limits of integration y , which satisfy the rough and smooth pipe laws, providing the general formula.

This article has as general objectives to analyze the explicit equations and verify which ones have the lowest and highest average relative error and analyze the relative errors and organize them from the lowest to the highest percentage, since the lowest percentage will have results of coefficient closest to those of Colebrook-White and, by

definition, the ideal approximation will be considered. The highest percentage will demonstrate the opposite.

II. THE COLEBROOK-WHITE EQUATION AND ITS APPROXIMATIONS

Below are briefly presented the equations used for study, followed by the calculations to make comparisons.

Colebrook-White equation

To Baqer (2015), the Colebrook equation is an implicit equation that combines experimental results from studies of turbulent flow in rough tubes. The equation is used to iteratively solve the Darcy-Weisbach friction factor " λ ".

According to Soares (2012), we present equation 2.1.

$$\frac{1}{\sqrt{\lambda}} = -2 \log \left(\frac{\varepsilon}{3.7D} + \frac{2.51}{Re\sqrt{\lambda}} \right) \quad (2.1)$$

Moody approach

Pimenta (2017) explains Moody's equation (1947) as presented in 2.2.

$$\lambda = 0.0055 \left[1 + \left(2 * 10^4 \frac{\varepsilon}{D} + \frac{10^6}{Re} \right)^{\frac{1}{3}} \right] \quad (2.2)$$

Wood approach

Asker, Turgut and Coban (2014), Wood (1966) made correlations validating region extensions for $Re > 10^4$ and $10^{-5} < (\varepsilon/D) < 4 \times 10^{-2}$. Equation 2.3 demonstrates such an approximation.

$$\lambda = a + b * Re^{-c} \quad (2.3)$$

Where:

$$a = 0.53 * (\varepsilon/D) + 0.094 * (\varepsilon/D)^{0.225} \quad (2.4)$$

$$b = 88 * (\varepsilon/D)^{0.44} \quad (2.5)$$

$$c = 1.62 * (\varepsilon/D)^{0.134} \quad (2.6)$$

Churchill approach

According to Brkić (2011), Churchill's approach (1973) is demonstrated in equation 2.7.

$$\frac{1}{\sqrt{\lambda}} = -2 \log \left(\frac{\varepsilon}{3.71D} + \left(\frac{7}{Re} \right)^{0.9} \right) \quad (2.7)$$

Eck approach

According to Asker, Turgut and Coban (2014), Eck (1973) performs an approximation expressed in equation 2.8.

$$\frac{1}{\sqrt{\lambda}} = -2 \log \left(\frac{\varepsilon}{3.71D} + \frac{15}{Re} \right) \quad (2.8)$$

Haaland approach

Fox, McDonald and Pritchard (2014), Haaland (1984) contributed to the approximation of Colebrook-White's implicit equation to "λ" (Darcy-Weisbach friction factor) and can be expressed in equation 2.9.

$$\frac{1}{\sqrt{\lambda}} = -1.8 \log \left[\left(\frac{\epsilon}{3.7D} \right)^{1.11} + \frac{6.9}{Re} \right] \quad (2.9)$$

Tsal approach

According to Pimenta (2017), Tsal's approximation (1989) is expressed in equation 2.10.

$$A = 0.11 \left(\frac{68}{Re} + \frac{\epsilon}{D} \right)^{0.25} \quad (2.10)$$

Where:

$$A \geq 0.018; \lambda = A$$

$$A < 0.018; \lambda = 0.0028 + 0.85A$$

Buzzelli approach

According to Asker, Turgut and Coban (2014), Buzzelli (2008) developed the relationship present in equation 2.11.

$$\frac{1}{\sqrt{\lambda}} = A - \left[\frac{A + 2 \log(B/Re)}{1 + (2.18/B)} \right] \quad (2.11)$$

Where "A" and "B" are expressed in the equations 2.12 and 2.13, respectively below.

$$A = \frac{(0.744 \ln(Re) - 1.41)}{(1 + 1.32 \sqrt{\epsilon/D})} \quad (2.12)$$

$$B = \frac{\epsilon}{3.7D} Re + 2.51A \quad (2.13)$$

Relative error

To Asker et al (2014), the calculation that will be the basis for the analysis of the approximations in relation to the Colebrook-White equation will be that of the relative error. The relative error can demonstrate how close the result of the coefficient of the explicit equation will be when compared to the coefficient of the equation. Such an equation of relative error can be expressed in equation 2.14.

$$RE = \left(\frac{|\lambda_{CW} - \lambda_{approach}|}{\lambda_{CW}} \right) 100 \quad (2.14)$$

Where:

RE = Relative error (%)

λ_{CW} = Friction factor of the Colebrook-White equation (dimensionless)

λ_{approach} = Friction factor of the approach (explicit equation) in question (dimensionless)

The following Table 1 illustrates the error percentages and their respective classifications.

Table 1 –Relative error (%) and their classifications

MeanRelativeError (%)	Classification
≤ 0.55	Perfect
0.56 – 1.00	Good
1.10 – 2.00	Regular
2.10 – 3.00	Weak
> 3.00	Terrible

Source: Pimenta (2017)

III. RESULTS AND DISCUSSION

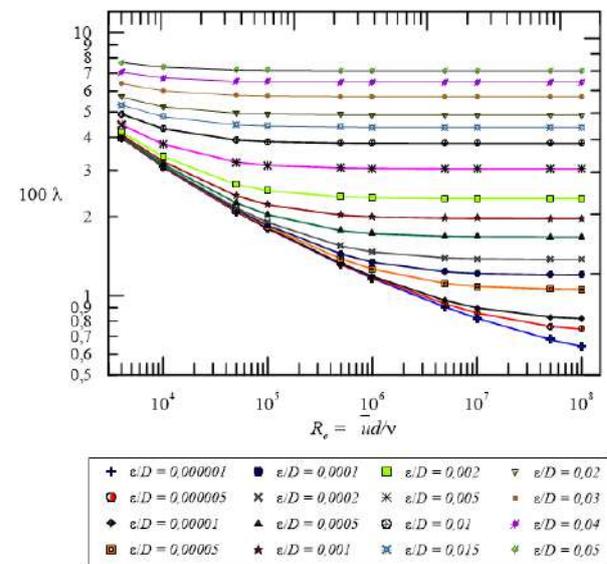
The present work obtained friction factor data considering that the turbulent flow, with Reynolds number greater than four thousand. To obtain the data, sixteen values of relative roughness were used, which correspond from the smooth surface to a rougher surface.

After that, there will be a discussion of relative errors between Colebrook-White and their approximations, to observe the best explicit equations regarding relative errors.

Colebrook-White

The Colebrook-White equation will be used as a reference for comparison with the other explicit equations. For the friction factor calculations, the following parameters were used: $4 \times 10^3 \leq Re \leq 10^8$ and $10^{-6} \leq \epsilon/D \leq 5 \times 10^{-2}$. The graph 1 shows the calculated values of the friction factor for Colebrook - White equation.

Graph 1 –Friction factor with Colebrook-White equation



Graph 1 shows the values for the friction coefficient in the vertical part (y-axis) and the values of the Reynolds number in the horizontal (x-axis). The respective values of the relative roughness are shown in the lines to which the legend explains their respective colors and values.

It can be seen from Graph 1 that the greater the Reynolds number, the lower the value of the coefficient “λ” for the relative roughness intervals. It is also noticed that there is a tendency for values of “λ” very close to the Reynolds intervals, especially in the periods of $5 \times 10^4 \leq Re \leq 10^8$, where the results approach the equality as the value of the relative roughness grows.

This can be explained by the fact that Equation (2.1), together with the explicit equations, presents a sum of the relative roughness (ϵ/D) with the Reynoldsnumber ($1/Re$), since the rest will be just a relation of mathematical operations with constants. This sum, as the relative roughness increases and goes through the Reynolds number intervals, it tends to have a common result. For example, for a relative roughness = 5×10^{-2} , in the Reynolds number range between $5 \times 10^4 \leq Re \leq 10^8$, the sum will tend to 5×10^{-2} , as the term “ $1 / Re$ ” will tend to zero.

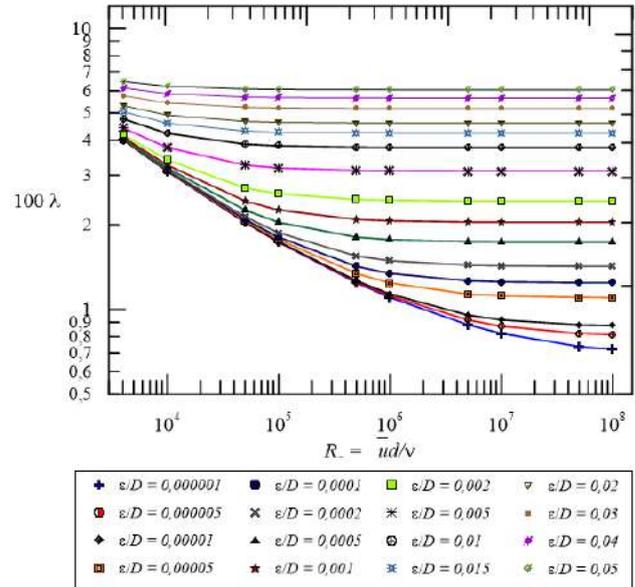
Bandeira (2015) reports that the viscous sublayer presents a thickness which is capable of covering the rough elements, it will not have a significant loss, in this condition it can be said that the flow is in a hydraulically smooth regime. However, the thickness of the viscous sublayer is influenced by the Reynolds number, as the Reynolds number increases, the thickness of the viscous sublayer decreases and for a given high Reynolds number some rough elements emerge significantly, at that moment the friction becomes a function of Reynolds number and roughness as well. For even higher Reynolds values, all the rough elements emerge through the viscous sublayer and the loss of pressure depends on the size of the rough elements, in this condition the flow is in a rough regime.

According to Schlichting (1979), the friction factor varies up to a certain Reynolds number, this is due to the ratio between the protrusions of the surfaces and the height of the boundary layer, however, after a certain point the friction factor stops varying, that is, the friction factor no longer depends on the Reynolds number, this is because the flow has reached a completely rough regime, being possible to visualize in the graph 1 the friction factor remains constant for each line that represents each relative roughness.

Moody

Calculations will be performed at the intervals above for Equation 2.2. Graph 2 shows the values of λ according to the relative roughness and Reynolds number.

Graph 2 - Friction factor for the Moody equation



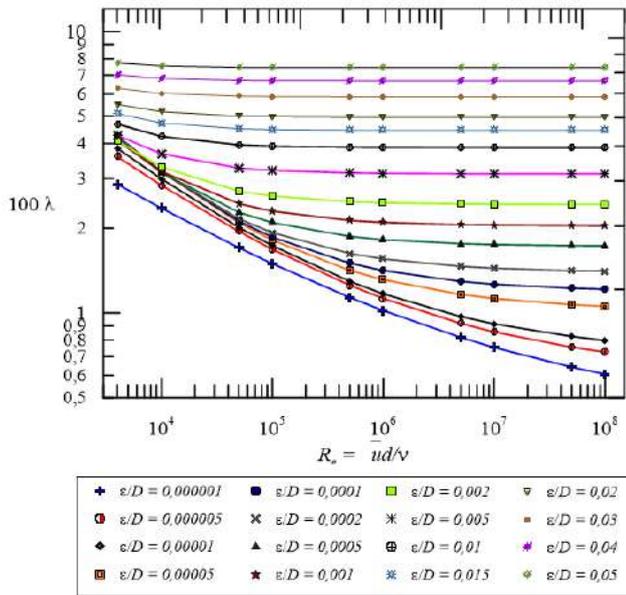
It can be seen from Graph 2 that there is a difference with Graph 1 in values for “λ”, such discrepancies will be addressed in the error percentage, using Equation 2.14. The behavior and explanation for it are similar to Graph 1, but there are differences in values due to the approximation of the model equations.

Wood

The wood approximation, equation (2.3) was used to obtain data that are shown in Graph 3.

Graph 3 shows the data in which the Wood equation was used, with the behavior of the lines slightly different from the previous graphs, it being possible to observe that for low values of the Reynolds number the results are more different than the Colebrook - white data.

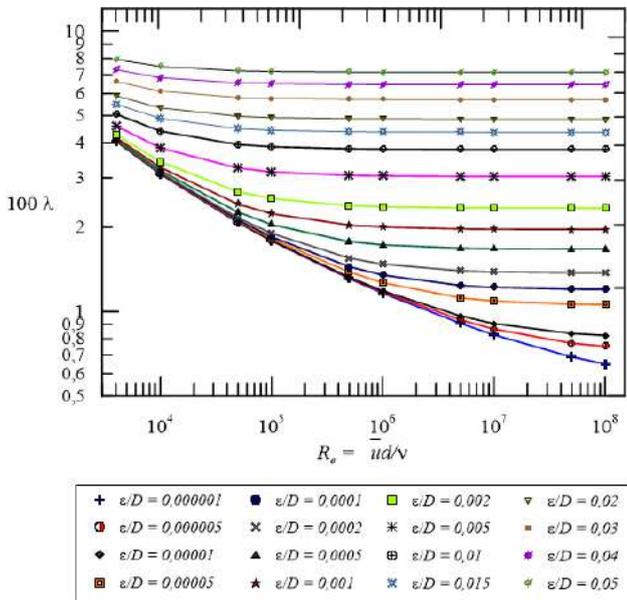
Graph 3 - Friction factor with Wood's equation



Churchill

According to equation (2.7), Graph 4 illustrates the friction factor values in the Churchill equation for each interval as shown.

Graph 4 - Friction factor with Churchill's equation



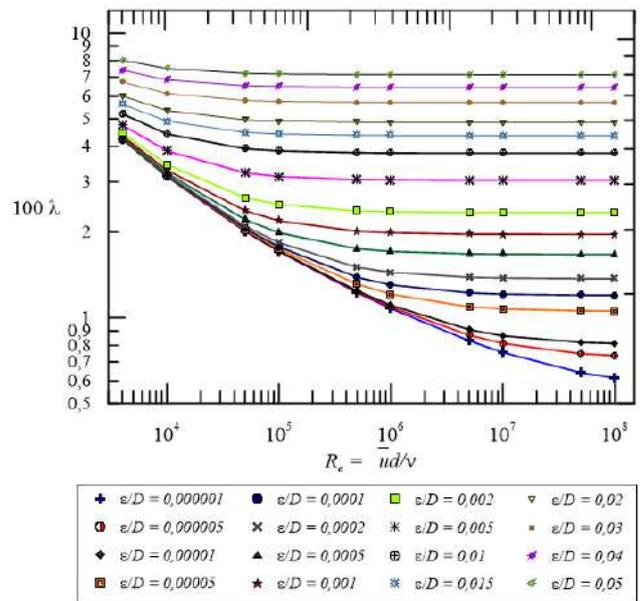
Graph 4 shows the behavior of the lines and margins of values remarkably similar for the coefficient when compared with the Colebrook - White data.

Eck

The Eck model was also simulated with the same conditions as the simulation of the other models.

The Graph 5 contemplates the results of the “λ” coefficient for equation (2.8), for the “Re” intervals and the relative roughness.

Graph 5–Friction factor with Eck equation



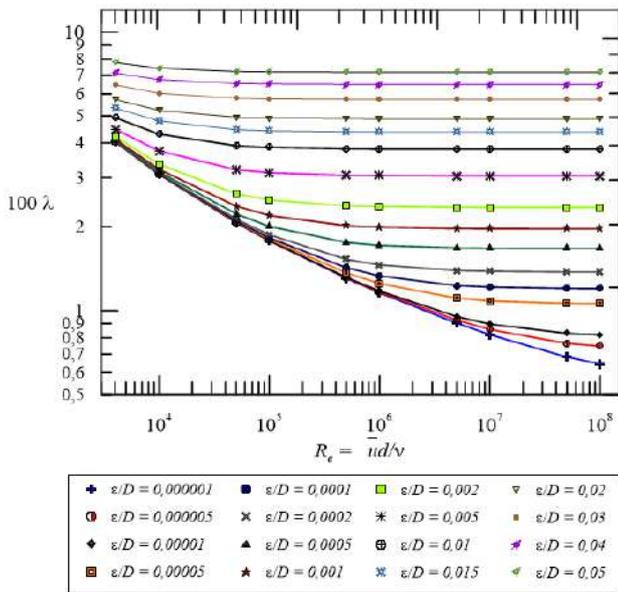
It can be seen from Graph 5 that there is the same behavioral similarity of the graphs of coefficient values previously mentioned, and with values of “λ” awfully close to the results of Colebrook-White.

Haaland

For equation 2.9, the following graph 6 is made to demonstrate the values of the friction factor. Graph 6 shows the results of “λ” for the pre-determined “Re” and “ε/D” intervals.

It can be seen from Graph 6 that there is the same behavioral similarity and with coefficient values tending to equality when compared to Graph 1.

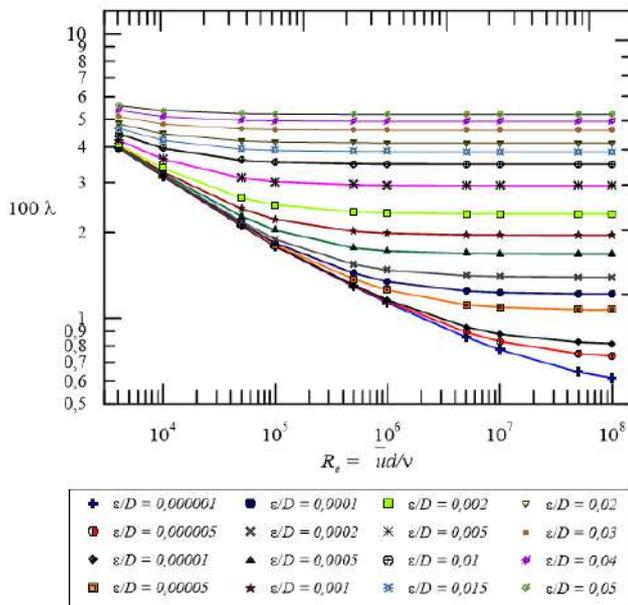
Graph 6–Friction factor with Haaland equation



Tsal

For the equation Tsal(2.10), was used for show the data in the graph 7.

Graph 7–Friction factor with Tsal equation



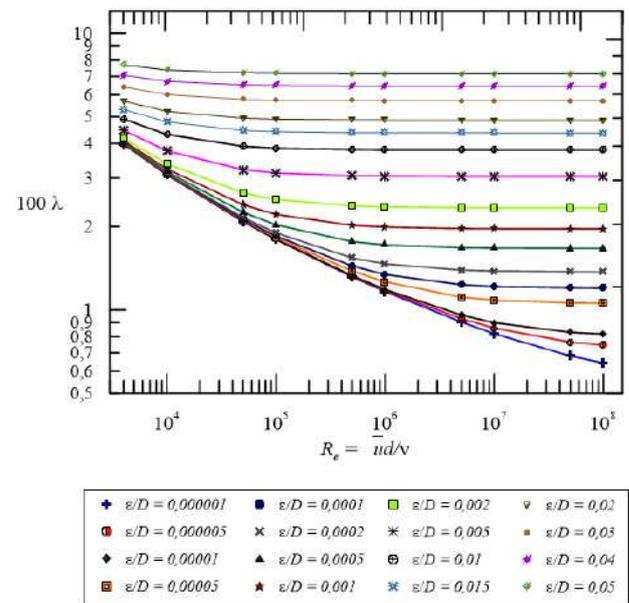
According to the above data, there is a similarity in behavior but there is a considerable discrepancy, it is possible to verify that for low Reynolds numbers the relative roughness present nearest friction factor values than the other methods, it becomes clearer when it is held a comparison with other graphics.

Buzelli

Buzelli propose the equation (2.11) for determination friction factor. The graph 8 shown the coefficient values for the “Re” and “ε/D”.

It can be seen in Graph 8 that it is most similar to Graph 1 in the values of “λ”, with low discrepancies will be addressed in the percentage of error, using Equation 2.14. And the low discrepancy makes this approximation method has good results compared to Colebrook - White.

Graph 8–Friction factor withBuzelli equation



Relative Error

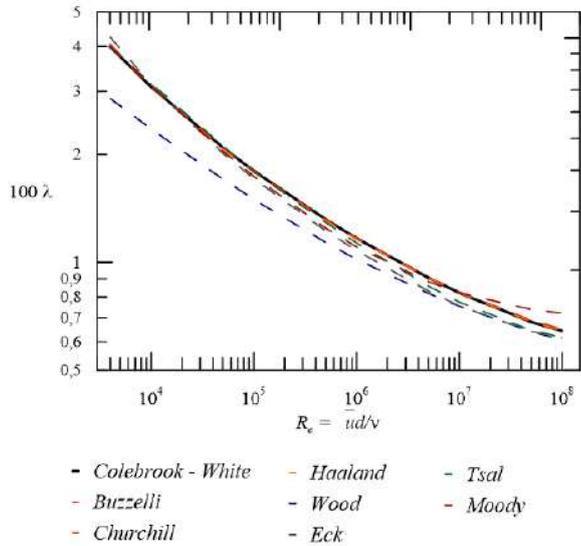
Considering that all the models presented above are an approximation of the Colebrook - White equation, the relative error will occur when comparing the results of each model with Colebrook-White.

The comparison made in the present work lists the results of all models for each relative roughness.

Error for relative roughness of 0.000001

The graph 9 shows the result of all models, including Colebrook - White, for the relative roughness of 0.000001.

Graph 9–Comparison of the friction factor models for relative roughness of 0.000001



The data shown in graph 9, it is possible to observe that for the relative roughness of 0.000001, Wood's method presented a more discrepant result when compared to the Colebrook-White data. Table 2 shows percentage values of the relative error between all the models.

Table 2 - Values (in %) of the relative errors for the relative roughness de 0,000001

Relative Error (values in %)for $\epsilon/D = 0,000001$							
Re	Moody	Wood	Churchill	Eck	Haaland	Tsal	Buzze lli
4×10^3	0,603	28,23		6,443			
10^3	2	35	1,7526	8	1,2910	7	0,0395
1×10^4	0,472	23,72	0,4078	1,513	0,0076	2,281	0,0280
5×10^4	2,205	18,38	0,5276	3,573	0,8608	1,114	0,0201
1×10^5	3,544	16,77	0,6138	4,951	0,9308	0,505	0,0187
5×10^5	5,466	13,79	0,4256	7,064	0,7398	1,951	0,0171
1×10^6	5,414	12,59	0,2387	7,629	0,5739	2,969	0,0165
5×10^6	2,537	9,579	0,3294	8,195	0,1499	5,196	0,0139
1×10^7	0,004	8,209	0,6003	8,003	0,0032	5,746	0,0114
5×10^7	8,291	5,852	1,1037	5,934	0,1845	5,151	0,0028
1×10^8	12,07	5,816	1,1534	4,436	0,1956	4,140	0,0004

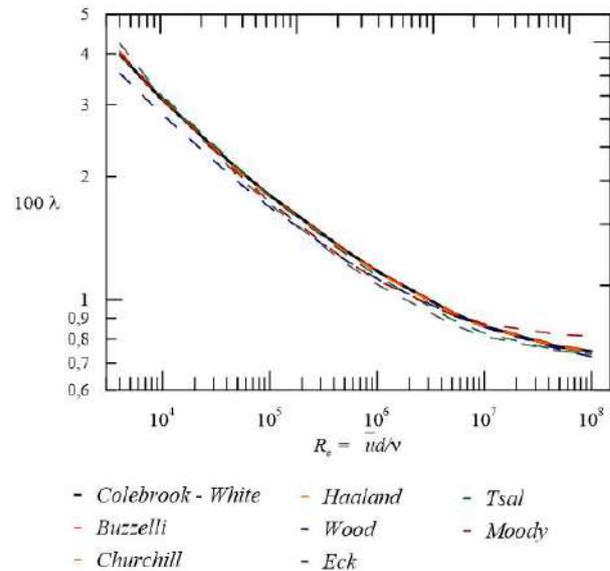
When comparing the results contained in table 1 with table 2, it is possible to conclude, that for the relative roughness condition of 0.000001, the approximation models could be classified as: Moody ($0.0042 \leq RE \leq 12.0702$) Good for low Reynolds numbers and terrible for high Reynolds numbers; Wood ($5.8164 \leq RE \leq 28.2335$) Terrible; Churchill ($0.2387 \leq RE \leq 1.7526$) between perfect and regular; Eck ($1.5131 \leq RE \leq 8.1955$) between regular and terrible; Haaland ($0.0032 \leq RE \leq 1.2910$) between perfect and regular; Tsal ($0.4707 \leq RE \leq 5.7462$) between perfect and terrible; Buzzelli ($0.0004 \leq RE \leq 0.0395$) perfect result.

From the analysis of the graph 9 and the table2, it is possible to verify that the Wood, Moody and Eck models generate results with greater errors in relation to the Colebrook - White equation, while the Haaland and Buzzelli models present good approximations.

Error for relative roughness of 0.000005

The graph 10 shows the result of all models, including Colebrook - White, for the relative roughness of 0.000005.

Graph 10–Comparison of the friction factor models for relative roughness of 0.000005



The data shown in graph 10, it is possible to observe that for the relative roughness of 0.000005, in general method all have a tendency to next Colebrook-White data.

Table 3 shows percentage values of the relative error between all the models.

Table 3 - Values (in %) of the relative errors for the relative roughness de 0.000005

Relative Error (values in %)for $\epsilon/D = 0.000005$							
Re	Moody	Wood	Churchill	Eck	Haaland	Tsal	Buzzelli
4×10^3	0,6022	10,0637	1,7539	6,4438	1,2853	0,475	0,0419
1×10^4	0,4744	8,0763	0,4105	1,5131	0,0024	2,2756	0,0298
5×10^4	2,1781	6,7929	0,5177	3,5734	0,8884	1,1186	0,0212
1×10^5	3,4861	6,503	0,5972	4,9514	0,9738	0,5022	0,0194
5×10^5	5,1982	5,2293	0,375	7,0641	0,8548	1,8314	0,0159
1×10^6	4,9456	4,2378	0,1624	7,6295	0,743	2,6919	0,0137
5×10^6	1,322	1,3542	0,4588	8,1955	0,4815	3,9182	0,0052
1×10^7	1,3556	0,4532	0,6939	8,0038	0,3712	3,7189	0,0016
5×10^7	7,3162	1,2884	0,7813	5,9347	0,0763	2,0579	0,0005
1×10^8	8,8914	2,8841	0,6258	4,4363	0,0313	1,4248	0,0008

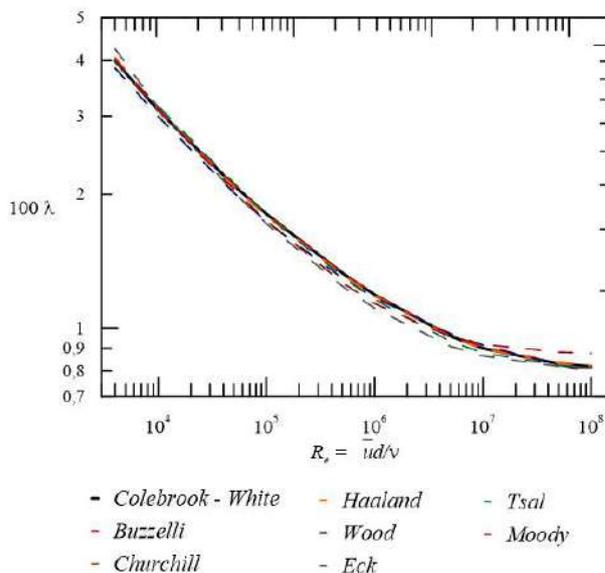
To compare the results contained in table 1 with table 3, it is possible to conclude, that for the relative roughness condition of 0.000005, the approximation models could be classified as: Moody ($0.4744 \leq RE \leq 8.8914$) Perfect for low Reynolds numbers and terrible for high Reynolds numbers; Wood ($0.4532 \leq RE \leq 10.0637$) between perfect and terrible; Churchill ($0.1624 \leq RE \leq 1.7539$) between perfect and regular; Eck ($1.5131 \leq RE \leq 8.1955$) between regular and terrible; Halland ($0.0024 \leq RE \leq 1.2853$) between perfect and regular; Tsal ($0.4750 \leq RE \leq 3.9182$) between perfect and terrible; Buzzelli ($0.0008 \leq RE \leq 0.0419$) perfect result.

From the analysis of the graph 10 and the table 3, it is possible to verify that the Wood, Moody and Eck models generate results with greater errors in relation to the Colebrook - White equation, while the Buzzelli models present good approximations.

Error for relative roughness of 0.00001

The graph 11 shows the result of all models, including Colebrook - White, for the relative roughness of 0.00001.

Graph 11-Comparison of the friction factor models for relative roughness of 0.00001



The data shown in graph 11, it is possible to observe that for the relative roughness of 0.00001, in general method all have a tendency to next Colebrook-White data.

Table 4 shows percentage values of the relative error between the models.

Table 4 - Values (in %) of the relative errors for the relative roughness de 0.00001

Relative Error (values in %)for $\epsilon/D = 0.00001$							
Re	Moody	Wood	Churchill	Eck	Haaland	Tsal	Buzzelli
4×10^3	0,6010	3,6684	1,7555	6,4440	1,2790	0,4803	0,0437
1×10^4	0,4768	3,1838	0,4140	1,5152	0,0133	2,2688	0,0312
5×10^4	2,1443	3,7351	0,5055	3,5550	0,9171	1,1236	0,0218
1×10^5	3,4136	3,8349	0,5768	4,9112	1,0165	0,4984	0,0196
5×10^5	4,8824	2,6404	0,3158	6,8481	0,9507	1,6910	0,0140
1×10^6	4,4224	1,4885	0,0782	7,2056	0,8651	2,3813	0,0104
5×10^6	0,3719	1,2789	0,5476	6,5418	0,5901	2,8287	0,0012
1×10^7	2,0695	1,6458	0,7100	5,4704	0,4194	2,3309	0,0000
5×10^7	6,245	0,61	0,5767	2,32	0,0275	0,88	0,001

0^7	4	28		39		61	1
$1x1$	7,103	2,34	0,4120	1,36	0,0732	0,51	0,000
0^8	4	56		46		88	8

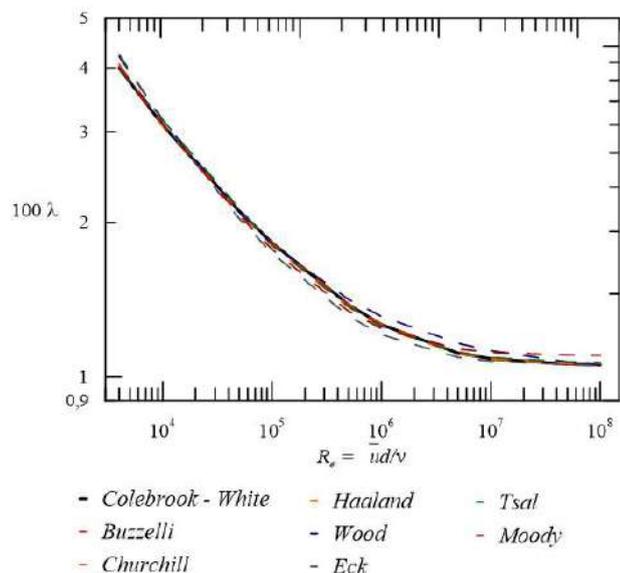
To compare the results contained in table 1 with table 4, it is possible to conclude, that for the relative roughness condition of 0.00001, the approximation models could be classified as: Moody ($0.4768 \leq RE \leq 7.1034$) between perfect and terrible; Wood ($0.6128 \leq RE \leq 3.8349$) between good and terrible; Churchill ($0.0782 \leq RE \leq 1.7555$) between perfect and regular; Eck ($1.3646 \leq RE \leq 7.2056$) between regular and terrible; Halland ($0.0133 \leq RE \leq 1.2790$) between perfect and regular; Tsal ($0.4803 \leq RE \leq 2.8287$) between perfect and weak; Buzzelli ($0.0000 \leq RE \leq 0.0437$) perfect result.

From the analysis of the graph 11 and the table 4, it is possible to verify that the Moody and Eck models generate results with greater errors in relation to the Colebrook - White equation, while the Buzzelli models present good approximations.

Error for relative roughness of 0.00005

The graph 12 shows the result of all models, including Colebrook - White, for the relative roughness of 0.00005.

Graph 12–Comparison of the friction factor models for relative roughness of 0.00005



The data shown in graph 12, it is possible to observe that for the relative roughness of 0.00005, in general method all have a tendency to next Colebrook-White data.

Table 5 shows percentage values of the relative error between the models.

Table 5 - Values (in %) of the relative errors for the relative roughness de 0.00005

Relative Error (values in %)for $\epsilon/D = 0.00005$							
Re	Moody	Wood	Churchill	Eck	Haaland	Tsal	Buzzelli
$4x1$	0,591	5,31		6,44		0,52	0,051
0^3	2	21	1,7682	41	1,2365	30	3
$1x1$	0,495	2,35		1,51		2,21	0,036
0^4	3	21	0,4411	78	0,0829	42	3
$5x1$	1,884	0,63		3,53		1,15	0,022
0^4	6	82	0,4116	22	1,0725	99	3
$1x1$	2,872	0,53		4,86		0,95	0,017
0^5	1	49	0,4249	17	1,2216	96	1
$5x1$	2,934	2,33		6,59		0,86	0,003
0^5	5	26	0,0352	40	1,1960	20	9
$1x1$	1,733	3,79		6,73		0,82	0,000
0^6	8	10	0,3175	31	1,0199	12	5
$5x1$	1,879	4,55		5,20		0,12	0,001
0^6	1	21	0,5905	10	0,3647	95	7
$1x1$	2,926	3,66		3,88		0,52	0,001
0^7	4	98	0,4986	57	0,1349	78	7
$5x1$	4,006	0,89		1,29		0,98	0,000
0^7	5	03	0,1969	62	0,1217	03	4
$1x1$	4,161	0,14		0,72		1,04	0,000
0^8	4	26	0,1077	30	0,1601	84	2

To compare the results contained in table 1 with table 5, it is possible to conclude, that for the relative roughness condition of 0.00005, the approximation models could be classified as: Moody ($0.4953 \leq RE \leq 4.1614$) between perfect and terrible; Wood ($0.1426 \leq RE \leq 5.3121$) between perfect and terrible; Churchill ($0.0352 \leq RE \leq 1.7682$) between perfect and regular; Eck ($0.7230 \leq RE \leq 6.4441$) between good and terrible; Halland ($0.0829 \leq RE \leq 1.2365$) between perfect and regular; Tsal ($0.1295 \leq RE \leq 2.2142$) between perfect and weak; Buzzelli ($0.0002 \leq RE \leq 0.0513$) perfect result.

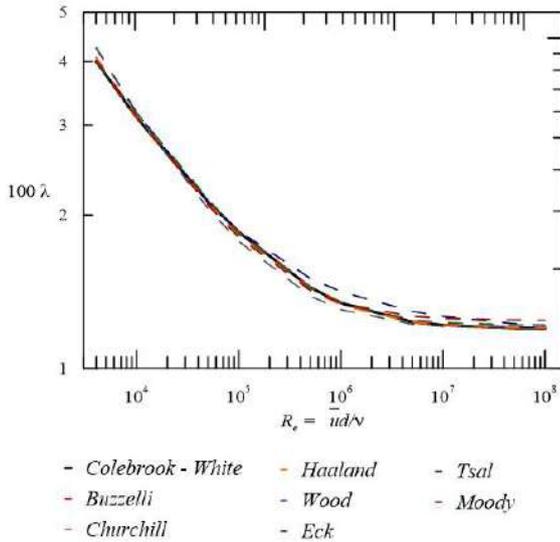
From the analysis of the graph 12 and the table 5, it is possible to verify that the Moody, Wood and Eck models generate results with greater errors in relation to the Colebrook - White equation, while the Buzzelli models present good approximations.

Error for relative roughness of 0.0001

The graph 13 shows the result of all models, including Colebrook - White, for the relative roughness of 0.0001.

The data shown in graph 13, it is possible to observe that for the relative roughness of 0.0001, in general method all have a tendency to next Colebrook-White data.

Graph 13–Comparison of the friction factor models for relative roughness of 0.0001.



1x1 0⁷	3,099	3,99	0,3505	1,09	0,0011	1,14	0,001
	6	42		85		23	3
5x1 0⁷	3,614	1,88	0,1021	0,28	0,1567	1,36	0,000
	8	84		77		02	2
1x1 0⁸	3,684	1,21	0,0430	0,17	0,1782	1,39	0,000
	0	83		00		01	1

To compare the results contained in table 1 with table 6, it is possible to conclude, that for the relative roughness condition of 0.0001, the approximation models could be classified as: Moody ($0.0674 \leq RE \leq 3.6840$) between perfect and terrible; Wood ($0.2603 \leq RE \leq 6.2406$) between perfect and terrible; Churchill ($0.0430 \leq RE \leq 1.7839$) between perfect and regular; Eck ($0.1700 \leq RE \leq 6.4453$) between perfect and terrible; Halland ($0.0011 \leq RE \leq 1.3439$) between perfect and regular; Tsal ($0.0253 \leq RE \leq 2.1462$) between perfect and weak; Buzzelli ($0.0001 \leq RE \leq 0.0566$) perfect result.

From the analysis of the graph 13 and the table 6, it is possible to verify that the Wood and Eck models generate results with greater errors in relation to the Colebrook - White equation, while the Churchill and Buzzelli models present good approximations.

Table 6 shows percentage values of the relative error between the models.

Table 6 - Values (in %) of the relative errors for the relative roughness de 0.0001

Relative Error (values in %) for $\epsilon/D = 0.0001$							
Re	Moody	Wood	Churchill	Eck	Haaland	Tsal	Buzzelli
4x1 0³	0,578	6,24	1,7839	6,44	1,1921	0,57	0,056
	7	06		53		62	6
1x1 0⁴	0,517	2,33	0,4744	1,53	0,1510	2,14	0,039
	4	94		84		62	3
5x1 0⁴	1,584	0,26	0,3032	3,35	1,1910	1,19	0,020
	5	03		63		64	5
1x1 0⁵	2,279	0,45	0,2609	4,49	1,3439	0,70	0,012
	4	51		12		69	9
5x1 0⁵	1,382	4,14	0,2851	5,04	1,1556	0,28	0,000
	4	94		18		66	3
1x1 0⁶	0,067	5,29	0,4993	4,34	0,8576	0,02	0,000
	4	33		14		53	4
5x1 0⁶	2,539	4,92	0,4833	1,86	0,1668	0,91	0,002
	4	64		76		55	1

Error for relative roughness of 0.0002

The graph 14 shows the result of all models, including Colebrook - White, for the relative roughness of 0.0002.

Graph 14–Comparison of the friction factor models for relative roughness of 0.0002.

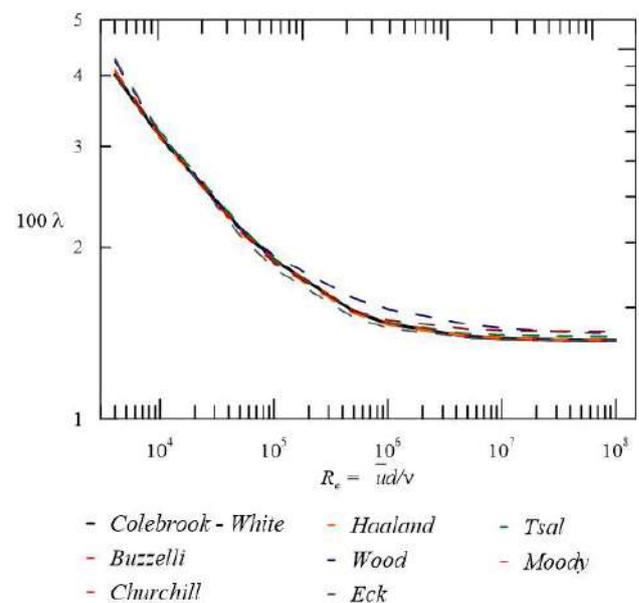


Table 7 shows percentage values of the relative error between the models.

Table 7 - Values (in %) of the relative errors for the relative roughness de 0.0002

Relative Error (values in %)for $\epsilon/D = 0.0002$							
Re	Moody	Wood	Churchill	Eck	Haaland	Tsal	Buzzelli
4×10^3	0,5536	5,5207	1,8148	6,4468	1,1169	0,6824	0,0634
1×10^4	0,5586	1,3325	0,5387	1,5637	0,2578	2,0107	0,0421
5×10^4	1,0551	0,1287	0,1127	3,1519	1,3197	1,2441	0,0159
1×10^5	1,3136	1,5749	0,0003	4,0853	1,4205	0,3137	0,0067
5×10^5	0,3931	5,4281	0,5106	3,8343	0,9325	0,1647	0,0007
1×10^6	1,5094	6,0242	0,5801	2,9274	0,5699	0,5442	0,0023
5×10^6	3,0849	5,0383	0,3470	0,9918	0,0122	1,1458	0,0015
1×10^7	3,3556	4,2927	0,2205	0,5606	0,0889	1,2568	0,0007
5×10^7	3,5886	2,9150	0,0391	0,1604	0,1771	1,3541	0,0001
1×10^8	3,6189	2,5250	0,0014	0,1063	0,1887	1,3668	0,0000

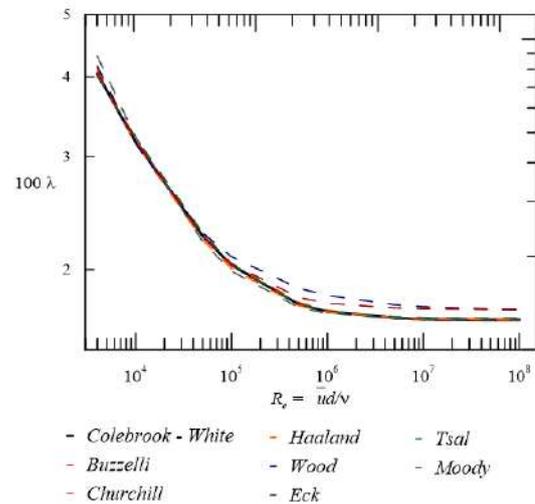
To compare the results contained in table 1 with table 7, it is possible to conclude, that for the relative roughness condition of 0.0002, the approximation models could be classified as: Moody ($0.3931 \leq RE \leq 3.6189$) between perfect and terrible; Wood ($0.1287 \leq RE \leq 6.0242$) between perfect and terrible; Churchill ($0.0003 \leq RE \leq 1.8148$) between perfect and regular; Eck ($0.1063 \leq RE \leq 6.4468$) between perfect and terrible; Haaland ($0.0122 \leq RE \leq 1.4205$) between perfect and regular; Tsal ($0.1647 \leq RE \leq 2.0107$) between perfect and weak; Buzzelli ($0.0000 \leq RE \leq 0.0634$) perfect result.

From the analysis of the graph 14 and the table 7, it is possible to verify that the Wood and Eck models generate results with greater errors in relation to the Colebrook - White equation, while the Churchill and Buzzelli models present good approximations.

Error for relative roughness of 0.0005

The graph 15 shows the result of all models, including Colebrook - White, for the relative roughness of 0.0005.

Graph 15-Comparison of the friction factor models for relative roughness of 0.0005.



The data shown in graph 15, it is possible to observe that for the relative roughness of 0.0005, in general method all have a tendency to next Colebrook-White data.

Table 8 shows percentage values of the relative error between the models.

Table 8 - Values (in %) of the relative errors for the relative roughness de 0.0005

Relative Error (values in %)for $\epsilon/D = 0.0005$							
Re	Moody	Wood	Churchill	Eck	Haaland	Tsal	Buzzelli
4×10^3	0,4754	2,7265	1,9038	6,4561	0,9450	0,9977	0,0738
1×10^4	0,6591	0,6114	0,7158	1,7452	0,4651	1,6082	0,0428
5×10^4	0,1100	1,0257	0,3036	1,9659	1,3819	1,2363	0,0060
1×10^5	0,5033	3,0735	0,4591	2,1613	1,2810	0,2975	0,0003
5×10^5	2,4292	5,8815	0,6182	1,1036	0,4824	0,0822	0,0032
1×10^6	3,0521	5,9005	0,5045	0,6710	0,1984	0,1608	0,0029
5×10^6	3,7038	4,9482	0,1862	0,2009	0,1086	0,4178	0,0006
1×10^7	3,7977	4,5351	0,0957	0,1321	0,1536	0,4552	0,0003

$5x10^7$	3,875	3,892	0,0123	0,075	0,1908	0,486	0,0000
	1	5		1		2	
$1x10^8$	3,884	3,731	0,0323	0,067	0,1955	0,490	0,0000
	9	8		8		1	

To compare the results contained in table 1 with table 8, it is possible to conclude, that for the relative roughness condition of 0.0005, the approximation models could be classified as: Moody ($0.1100 \leq RE \leq 3.8849$) between perfect and terrible; Wood ($0.6114 \leq RE \leq 5.9005$) between good and terrible; Churchill ($0.0123 \leq RE \leq 1.9038$) between perfect and regular; Eck ($0.0678 \leq RE \leq 6.4561$) between perfect and terrible; Halland ($0.1086 \leq RE \leq 1.3819$) between perfect and regular; Tsal ($0.0822 \leq RE \leq 1.6082$) between perfect and regular; Buzzelli ($0.0000 \leq RE \leq 0.0738$) perfect result.

From the analysis of the graph 15 and the table 8, it is possible to verify that the Wood models generate results with greater errors in relation to the Colebrook - White equation, while the Churchill, Haaland and Buzzelli models present good approximations.

Error for relative roughness of 0.001

The graph 16 shows the result of all models, including Colebrook - White, for the relative roughness of 0.001.

The data shown in graph 16, it is possible to observe that for the relative roughness of 0.001, in general method all have a tendency to next Colebrook-White data.

Graph 16–Comparison of the friction factor models for relative roughness of 0.001.

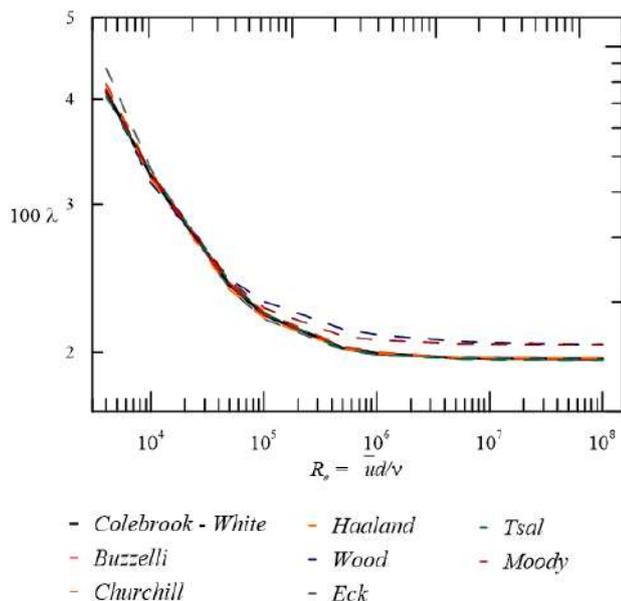


Table 9 shows percentage values of the relative error between the models.

Table 9 - Values (in %) of the relative errors for the relative roughness de 0.001

Relative Error (values in %)for $\epsilon/D = 0.001$							
Re	Moody	Wood	Churchill	Eck	Haaland	Tsal	Buzzelli
$4x10^3$	0,336	0,002	2,0406	6,462	0,7474	1,513	0,0797
	8	9		5		4	
$1x10^4$	0,761	1,831	0,9652	1,929	0,6390	0,952	0,0369
	3	2		1		1	
$5x10^4$	1,202	1,790	0,6925	1,130	1,2126	0,933	0,0005
	9	1		1		1	
$1x10^5$	1,872	3,698	0,7555	1,152	0,9395	0,430	0,0010
	6	9		5		5	
$5x10^5$	3,339	5,366	0,5453	0,489	0,1889	0,201	0,0032
	4	1		8		5	
$1x10^6$	3,663	5,243	0,3761	0,299	0,0113	0,290	0,0019
	4	8		4		9	
$5x10^6$	3,961	4,615	0,0964	0,116	0,1548	0,361	0,0003
	9	5		4		5	
$1x10^7$	4,002	4,397	0,0331	0,091	0,1774	0,370	0,0001
	0	5		3		2	
$5x10^7$	4,034	4,088	0,0367	0,070	0,1957	0,377	0,0000
	6	6		8		1	
$1x10^8$	4,038	4,017	0,0490	0,068	0,1980	0,378	0,0000
	7	5		3		0	

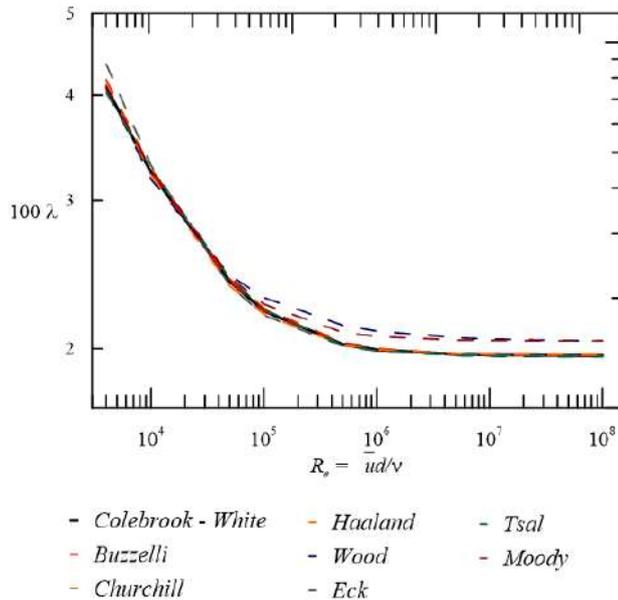
To compare the results contained in table 1 with table 9, it is possible to conclude, that for the relative roughness condition of 0.001, the approximation models could be classified as: Moody ($0.3368 \leq RE \leq 4.0387$) between perfect and terrible; Wood ($0.0029 \leq RE \leq 5.3661$) between perfect and terrible; Churchill ($0.0331 \leq RE \leq 2.0406$) between perfect and regular; Eck ($0.0683 \leq RE \leq 6.4625$) between perfect and terrible; Halland ($0.0113 \leq RE \leq 1.2126$) between perfect and regular; Tsal ($0.2015 \leq RE \leq 1.5134$) between perfect and regular; Buzzelli ($0.0000 \leq RE \leq 0.0797$) perfect result.

From the analysis of the graph 16 and the table 9, it is possible to verify that the Wood and Moody models generate results with greater errors in relation to the Colebrook - White equation, while the Buzzelli models present good approximations.

Error for relative roughness of 0.002

The graph 17 shows the result of all models, including Colebrook - White, for the relative roughness of 0.002.

Graph 17–Comparison of the friction factor models for relative roughness of 0.002.



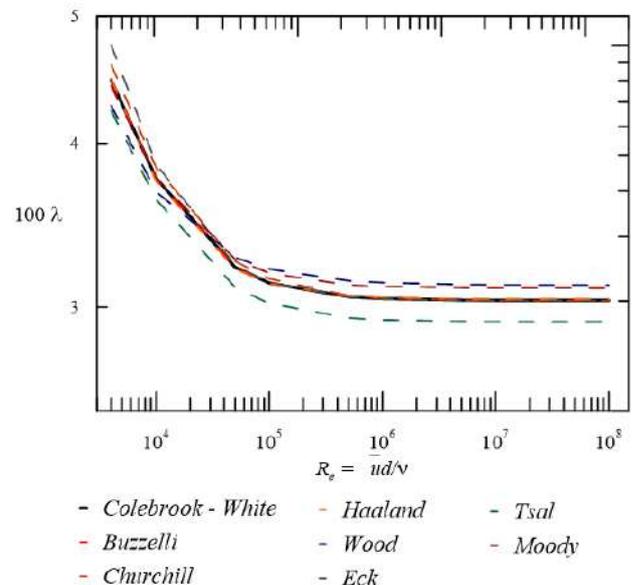
To compare the results contained in table 1 with table 10, it is possible to conclude, that for the relative roughness condition of 0.002, the approximation models could be classified as: Moody ($0.0338 \leq RE \leq 3.7952$) between perfect and terrible; Wood ($2.1561 \leq RE \leq 4.3863$) between weak and terrible; Churchill ($0.0102 \leq RE \leq 2.2766$) between perfect and weak; Eck ($0.0724 \leq RE \leq 6.4610$) between perfect and terrible; Haaland ($0.0037 \leq RE \leq 0.8390$) between perfect and good; Tsal ($0.0829 \leq RE \leq 2.5097$) between perfect and weak; Buzzelli ($0.0000 \leq RE \leq 0.0774$) perfect result.

From the analysis of the graph 17 and the table 10 it is possible to verify that the Wood and Moody models generate results with greater errors in relation to the Colebrook - White equation, while the Haaland and Buzzelli models present good approximations.

Error for relative roughness of 0.005

The graph 18 shows the result of all models, including Colebrook - White, for the relative roughness of 0.005.

Graph 18–Comparison of the friction factor models for relative roughness of 0.005.



The data shown in graph 18, it is possible to observe that for the relative roughness of 0.005, Moody's, Wood's and Tsal's method presented a more discrepant result when compared to the Colebrook-White data.

Table 11 shows percentage values of the relative error between the models.

Table 10 shows percentage values of the relative error between the models.

Table 10 - Values (in %) of the relative errors for the relative roughness de 0.002

Relative Error (values in %)for $\epsilon/D = 0.002$							
Re	Moody	Wood	Churchill	Eck	Haaland	Tsal	Buzzelli
4×10^3	0,0338	2,4737	2,2766	6,4610	0,5105	2,5097	0,0774
1×10^4	0,7841	2,4322	1,3352	2,1920	0,7339	0,3041	0,0235
5×10^4	1,9852	2,1561	0,9970	0,3276	0,8390	0,0829	0,0008
1×10^5	2,6110	3,5440	0,8721	0,3902	0,5182	0,3132	0,0034
5×10^5	3,4861	4,3863	0,4097	0,1876	0,0037	0,5924	0,0020
1×10^6	3,6354	4,2864	0,2460	0,1341	0,0976	0,6336	0,0009
5×10^6	3,7635	3,9678	0,0320	0,0849	0,1790	0,6674	0,0001
1×10^7	3,7801	3,8715	0,0102	0,0784	0,1896	0,6717	0,0000
5×10^7	3,7935	3,7445	0,0544	0,0731	0,1982	0,6752	0,0000
1×10^8	3,7952	3,7174	0,0619	0,0724	0,1992	0,6756	0,0000

Table 11 - Values (in %) of the relative errors for the relative roughness $\epsilon/D = 0.005$

Relative Error (values in %)for $\epsilon/D = 0.005$							
Re	Moody	Wood	Churchill	Eck	Haaland	Tsal	Buzzelli
4×10^3	1,0089	4,3897	2,7640	6,3793	0,2773	5,2495	0,0517
1×10^4	0,0912	2,3136	1,8829	2,5321	0,5484	3,6547	0,0045
5×10^4	1,4101	1,7347	1,0699	0,3142	0,2846	3,4520	0,0035
1×10^5	1,7454	2,4604	0,7508	0,0925	0,0879	3,5401	0,0034
5×10^5	2,0814	2,8519	0,2295	0,0519	0,1335	3,6456	0,0007
1×10^6	2,1288	2,8342	0,1091	0,0672	0,1663	3,6614	0,0003
5×10^6	2,1677	2,7598	0,0253	0,0788	0,1934	3,6745	0,0000
1×10^7	2,1726	2,7378	0,0491	0,0802	0,1968	3,6761	0,0000
5×10^7	2,1765	2,7102	0,0729	0,0814	0,1996	3,6775	0,0000
1×10^8	2,1770	2,7047	0,0767	0,0815	0,2000	3,6776	0,0000

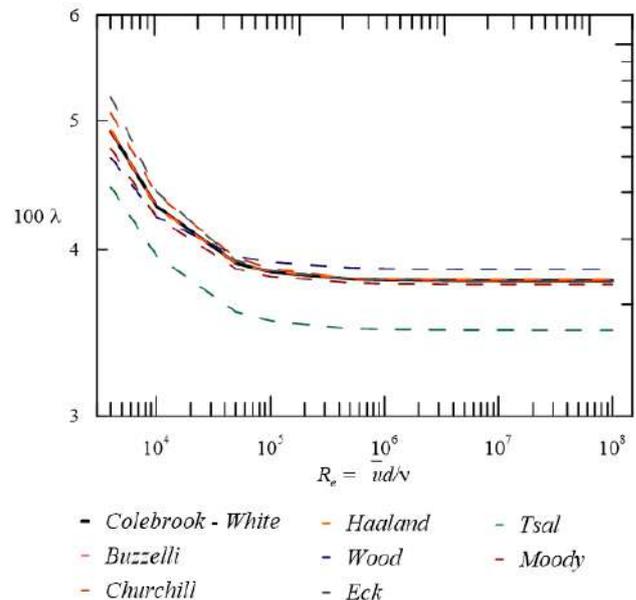
To compare the results contained in table 1 with table 11, it is possible to conclude, that for the relative roughness condition of 0.005, the approximation models could be classified as: Moody ($0.0912 \leq RE \leq 2.1770$) between perfect and weak; Wood ($1.7347 \leq RE \leq 4.3897$) between regular and terrible; Churchill ($0.0253 \leq RE \leq 2.7640$) between perfect and weak; Eck ($0.0519 \leq RE \leq 6.3793$) between perfect and terrible; Haaland ($0.0879 \leq RE \leq 0.5484$) perfect result; Tsal ($3.4520 \leq RE \leq 5.2495$) terrible result; Buzzelli ($0.0000 \leq RE \leq 0.0517$) perfect result.

From the analysis of the graph 18 and the table 11, it is possible to verify that the Tsal and Wood models generate results with greater errors in relation to the Colebrook - White equation, while the Haaland and Buzzellimodels present good approximations.

Error for relative roughness of 0.01

The graph 19 shows the result of all models, including Colebrook - White, for the relative roughness of 0.01.

Graph 19-Comparison of the friction factor models for relative roughness of 0.01.



The data shown in graph 19, it is possible to observe that for the relative roughness of 0.01, Wood's and Tsal's method presented a more discrepant result when compared to the Colebrook-White data.

Table 12 shows percentage values of the relative error between the models.

Table 12 - Values (in %) of the relative errors for the relative roughness $\epsilon/D = 0.01$

Relative Error (values in %)for $\epsilon/D = 0.01$							
Re	Moody	Wood	Churchill	Eck	Haaland	Tsal	Buzzelli
4×10^3	2,9242	4,4488	3,1583	6,1280	0,3127	9,1533	0,0223
1×10^4	1,8730	1,7900	2,1068	2,5781	0,1894	8,1720	0,0000
5×10^4	0,9702	1,2223	0,9096	0,4491	0,0047	8,1108	0,0032
1×10^5	0,8102	1,6719	0,5639	0,1780	0,0908	8,1594	0,0020
5×10^5	0,6692	1,9675	0,1213	0,0376	0,1763	8,2124	0,0003
1×10^6	0,6507	1,9857	0,0346	0,0644	0,1882	8,2200	0,0001
5×10^6	0,6357	1,9852	0,0560	0,0859	0,1979	8,2263	0,0000
1×10^7	0,6338	1,9823	0,0712	0,0885	0,1991	8,2270	0,0000
5×10^7	0,6320	1,9777	0,0859	0,0900	0,2001	8,2270	0,0000

θ^7	3	8		7		7	
$1x1$	0,632	1,976		0,091		8,227	
θ^8	1	9	0,0883	0	0,2002	8	0,0000

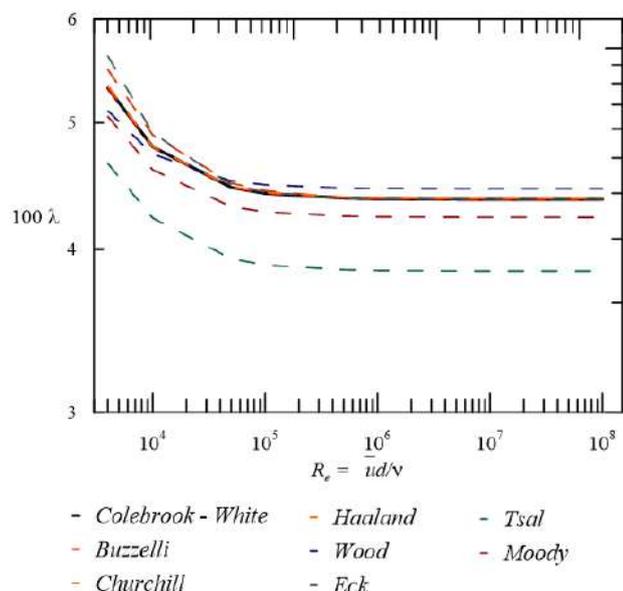
To compare the results contained in table 1 with table 12, it is possible to conclude, that for the relative roughness condition of 0.01, the approximation models could be classified as: Moody ($0.6321 \leq RE \leq 2.9242$) between good and weak; Wood ($1.2223 \leq RE \leq 4.4488$) between regular and terrible; Churchill ($0.0346 \leq RE \leq 3.1583$) between perfect and terrible; Eck ($0.0376 \leq RE \leq 6.1280$) between perfect and terrible; Halland ($0.0047 \leq RE \leq 0.3127$) perfect result; Tsal ($8.1108 \leq RE \leq 9.1533$) terrible result; Buzzelli ($0.0000 \leq RE \leq 0.0223$) perfect result.

From the analysis of the graph 19 and the table 12, it is possible to verify that the Tsal models generate results with greater errors in relation to the Colebrook - White equation, while the Haaland and Buzzelli models present good approximations.

Error for relative roughness of 0.015

The graph 20 shows the result of all models, including Colebrook - White, for the relative roughness of 0.015.

Graph 20-Comparison of the friction factor models for relative roughness of 0.015.



The data shown in graph 20, it is possible to observe that for the relative roughness of 0.015, Moody's and Tsal's method presented a more discrepant result when compared to the Colebrook-White data.

Table 13 shows percentage values of the relative error between the models.

Table 13 - Values (in %) of the relative errors for the relative roughness de 0.015

Relative Error (values in %)for $\epsilon/D = 0.015$							
Re	Moody	Wood	Churchill	Eck	Haaland	Tsal	Buzzelli
$4x1$	4,848	3,904		5,843		12,44	
θ^3	5	8	3,3067	8	0,4302	81	0,0093
$1x1$	3,967	1,281		2,470		11,80	
θ^4	2	6	2,0955	6	0,0311	60	0,0006
$5x1$	3,336	1,165		0,438		11,80	
θ^4	1	8	0,7778	1	0,1103	79	0,0024
$1x1$	3,239	1,521		0,171		11,84	
θ^5	7	1	0,4521	4	0,1504	23	0,0013
$5x1$	3,158	1,784		0,043		11,87	
θ^5	4	6	0,0703	9	0,1895	75	0,0002
$1x1$	3,148	1,811		0,070		11,88	
θ^6	0	1	0,0001	9	0,1948	24	0,0001
$5x1$	3,139	1,827		0,092		11,88	
θ^6	6	2	0,0711	5	0,1992	64	0,0000
$1x1$	3,138	1,828		0,095		11,88	
θ^7	5	3	0,0828	2	0,1997	69	0,0000
$5x1$	3,137	1,828		0,097		11,88	
θ^7	7	6	0,0940	4	0,2002	73	0,0000
$1x1$	3,137	1,828		0,097		11,88	
θ^8	5	5	0,0957	7	0,2002	74	0,0000

To compare the results contained in table 1 with table 13, it is possible to conclude, that for the relative roughness condition of 0.015, the approximation models could be classified as: Moody ($3.1375 \leq RE \leq 4.8485$) terrible result; Wood ($1.1658 \leq RE \leq 3.9048$) between regular and terrible; Churchill ($0.0001 \leq RE \leq 3.3067$) between perfect and terrible; Eck ($0.0439 \leq RE \leq 5.8438$) between perfect and terrible; Halland ($0.0311 \leq RE \leq 0.4302$) perfect result; Tsal ($11.8060 \leq RE \leq 12.4481$) terrible result; Buzzelli ($0.0000 \leq RE \leq 0.0093$) perfect result.

From the analysis of the graph 20 and the table 13 it is possible to verify that the Moody and Tsal models generate results with greater errors in relation to the Colebrook - White equation, while the Haaland and Buzzelli models present good approximations.

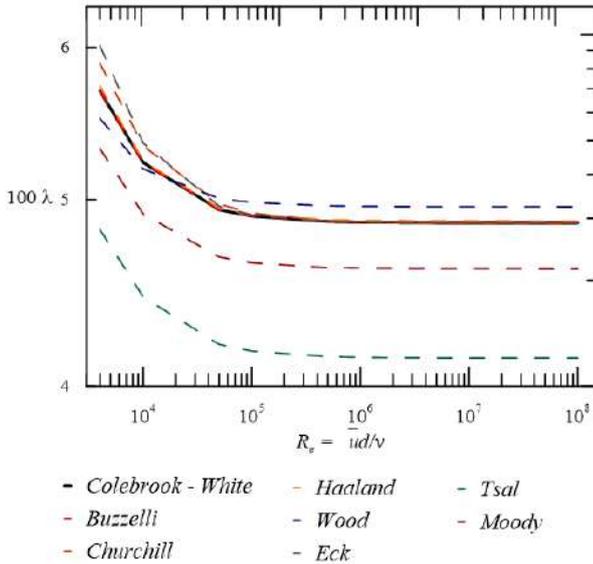
Error for relative roughness of 0.02

The graph 21 shows the result of all models, including Colebrook - White, for the relative roughness of 0.02.

The data shown in graph 21, it is possible to observe that for the relative roughness of 0.02, Moody's, Wood's and

Tsal’s method presented a more discrepant result when compared to the Colebrook-White data.

Graph 21–Comparison of the friction factor models for relative roughness of 0.02.



To compare the results contained in table 1 with table 14, it is possible to conclude, that for the relative roughness condition of 0.02, the approximation models could be classified as: Moody ($5.3728 \leq RE \leq 6.6985$) terrible result; Wood ($0.7635 \leq RE \leq 3.2524$) between good and terrible; Churchill ($0.0213 \leq RE \leq 3.3443$) between perfect and terrible; Eck ($0.0517 \leq RE \leq 5.5701$) between perfect and terrible; Haaland ($0.1621 \leq RE \leq 0.5380$) perfect result; Tsal ($14.8601 \leq RE \leq 15.2998$) terrible result; Buzzelli ($0.0000 \leq RE \leq 0.0038$) perfect result.

From the analysis of the graph 21 and the table 14 it is possible to verify that the Moody and Tsal models generate results with greater errors in relation to the Colebrook - White equation, while the Haaland and Buzzelli models present good approximations.

Error for relative roughness of 0.03

The graph 22 shows the result of all models, including Colebrook - White, for the relative roughness of 0.03.

Graph 22–Comparison of the friction factor models for relative roughness of 0.03.

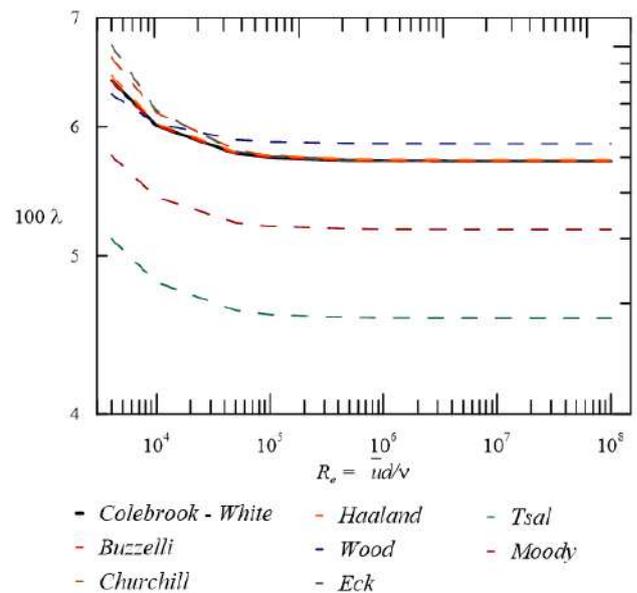


Table 14 shows percentage values of the relative error between the models.

Table 14 - Values (in %) of the relative errors for the relative roughness de 0.02

Relative Error (values in %)for $\epsilon/D = 0.02$							
Re	Moody	Wood	Churchill	Eck	Haaland	Tsal	Buzzelli
4×10^3	6,698	3,252	3,3443	5,570	0,5380	15,29	0,0038
	5	4		1		98	
1×10^4	5,971	0,763	2,0254	2,339	0,1671	14,86	0,0013
	1	5		8		01	
5×10^4	5,506	1,340	0,6806	0,407	0,1621	14,88	0,0018
	0	7		7		92	
1×10^5	5,440	1,646	0,3776	0,153	0,1787	14,91	0,0009
	5	3		7		58	
5×10^5	5,386	1,887	0,0388	0,051	0,1955	14,94	0,0001
	4	7		7		19	
1×10^6	5,379	1,915	0,0213	0,077	0,1979	14,94	0,0000
	6	9		5		54	
5×10^6	5,374	1,936	0,0812	0,098	0,1998	14,94	0,0000
	1	8		2		83	
1×10^7	5,373	1,939	0,0909	0,100	0,2001	14,94	0,0000
	4	1		7		87	
5×10^7	5,372	1,940	0,1001	0,102	0,2003	14,94	0,0000
	8	8		8		90	
1×10^8	5,372	1,941	0,1016	0,103	0,2003	14,94	0,0000
	8	0		1		90	

Table 15 shows percentage values of the relative error between the models.

Table 15 - Values (in %) of the relative errors for the relative roughness de 0.03

Relative Error (values in %)for $\epsilon/D = 0.03$							
Re	Moody	Wood	Churchill	Eck	Haaland	Tsal	Buzzelli
4×10^3	10,10	1,93	3,2856	5,09	0,692	20,06	0,000
	94	09		13	1	98	4
1×10^4	9,602	0,28	1,8592	2,10	0,315	19,84	0,001

0^4	0	88		05	8	40	9
$5xI$	9,317	1,99	0,5476	0,34	0,210	19,88	0,001
0^4	9	12		75	4	97	2
$1xI$	9,281	2,24	0,2820	0,11	0,204	19,90	0,000
0^5	2	06		89	4	77	5
$5xI$	9,251	2,44	0,0002	0,06	0,201	19,92	0,000
0^5	5	88		57	0	46	1
$1xI$	9,247	2,47	0,0482	0,08	0,200	19,92	0,000
0^6	8	57		88	6	68	0
$5xI$	9,244	2,49	0,0951	0,10	0,200	19,92	0,000
0^6	8	75		74	4	87	0
$1xI$	9,244	2,50	0,1026	0,10	0,200	19,92	0,000
0^7	4	03		97	3	89	0
$5xI$	9,244	2,50	0,1096	0,11	0,200	19,92	0,000
0^7	1	26		16	3	91	0
$1xI$	9,244	2,50	0,1107	0,11	0,200	19,92	0,000
0^8	1	29		18	3	91	0

Graph 23–Comparison of the friction factor models for relative roughness of 0.04.

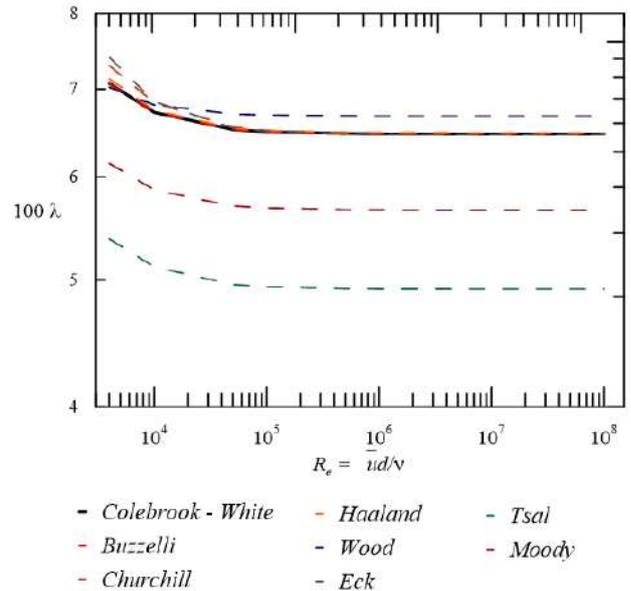


Table 16 shows percentage values of the relative error between the models.

Table 16 - Values (in %) of the relative errors for the relative roughness de 0.04

Relative Error (values in %)for $\epsilon/D = 0.04$							
Re	Mood y	Woo d	Church ill	Eck	Haala nd	Tsal	Buzze lli
$4xI$	13,15	0,689		4,701		23,98	
0^3	65	9	3,1681	9	0,7851	18	0,0000
$1xI$	12,78	1,316		1,908		23,85	
0^4	61	8	1,7097	3	0,3894	74	0,0020
$5xI$	12,59	2,782		0,298		23,90	
0^4	36	4	0,4597	8	0,2315	39	0,0008
$1xI$	12,56	2,997		0,090		23,91	
0^5	98	8	0,2213	7	0,2155	74	0,0004
$5xI$	12,55	3,181		0,077		23,92	
0^5	08	3	0,0248	0	0,2033	96	0,0000
$1xI$	12,54	3,205		0,098		23,93	
0^6	84	6	0,0656	1	0,2018	12	0,0000
$5xI$	12,54	3,225		0,114		23,93	
0^6	65	9	0,1051	9	0,2006	25	0,0000
$1xI$	12,54	3,228		0,117		23,93	
0^7	62	5	0,1113	0	0,2004	27	0,0000
$5xI$	12,54	3,230		0,118		23,93	
0^7	61	7	0,1172	7	0,2003	28	0,0000
$1xI$	12,54	3,231		0,118		23,93	
0^8	60	0	0,1180	9	0,2003	28	0,0000

To compare the results contained in table 1 with table 15, it is possible to conclude, that for the relative roughness condition of 0.03, the approximation models could be classified as: Moody ($9.2441 \leq RE \leq 10.1094$) terrible result; Wood ($0.2888 \leq RE \leq 2.5029$) between perfect and weak; Churchill ($0.0002 \leq RE \leq 3.2856$) between perfect and terrible; Eck ($0.0657 \leq RE \leq 5.0913$) between perfect and terrible; Haaland ($0.2003 \leq RE \leq 0.6921$) between perfect and good; Tsal ($19.8440 \leq RE \leq 20.0698$) terrible result; Buzzelli ($0.0000 \leq RE \leq 0.0019$) perfect result.

From the analysis of the graph 22 and the table 15, it is possible to verify that the Moody and Tsal models generate results with greater errors in relation to the Colebrook - White equation, while the Haaland and Buzzelli models present good approximations.

Error for relative roughness of 0.04

The graph 23 shows the result of all models, including Colebrook - White, for the relative roughness of 0.04.

To compare the results contained in table 1 with table 16, it is possible to conclude, that for the relative roughness condition of 0.04, the approximation models could be classified as: Moody ($12.5460 \leq RE \leq 13.1564$) terrible result; Wood ($0.6899 \leq RE \leq 3.2310$) between good and terrible; Churchill ($0.0248 \leq RE \leq 3.1681$) between perfect and terrible; Eck ($0.0770 \leq RE \leq 4.7019$) between perfect and terrible; Haaland ($0.2003 \leq RE \leq 0.7851$) between perfect and good; Tsal ($23.8574 \leq RE \leq 23.9818$) terrible result; Buzzelli ($0.0000 \leq RE \leq 0.0020$) perfect result.

From the analysis of the graph 22 and the table 16 it is possible to verify that the Moody and Tsal models generate results with greater errors in relation to the Colebrook - White equation, while the Haaland and Buzzelli models present good approximations.

Error for relative roughness of 0.05

The graph 24 shows the result of all models, including Colebrook - White, for the relative roughness of 0.05.

The data shown in graph 24, it is possible to observe that for the relative roughness of 0.05, Moody's, Wood's and Tsal's method presented a more discrepant result when compared to the Colebrook-White data.

Graph 24—Comparison of the friction factor models for relative roughness of 0.05.

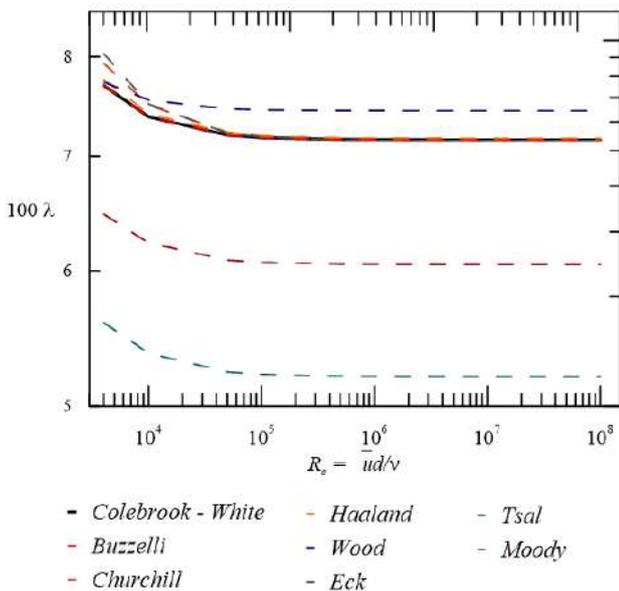


Table 17 shows percentage values of the relative error between the models.

Table 17 - Values (in %) of the relative errors for the relative roughness de 0.05

Relative Error (values in %)for $\epsilon/D = 0.05$							
Re	Moody	Wood	Churchill	Eck	Haaland	Tsal	Buzzelli
4×10^3	15,89	0,447	3,0408	4,383	0,8418	27,30	0,0002
1×10^4	87	4		2		66	
1×10^4	15,61	2,287	1,5843	1,754	0,4299	27,23	0,0019
1×10^4	74	5		6		61	
5×10^4	15,47	3,590	0,3960	0,260	0,2425	27,27	0,0006
1×10^4	80	9		1		96	
1×10^5	15,46	3,782	0,1781	0,068	0,2211	27,29	0,0003
1×10^5	12	2		0		02	
5×10^5	15,44	3,946	0,0425	0,086	0,2044	27,29	0,0000
1×10^5	79	3		5		97	
1×10^6	15,44	3,968	0,0786	0,105	0,2024	27,30	0,0000
1×10^6	62	3		9		09	
5×10^6	15,44	3,986	0,1132	0,121	0,2007	27,30	0,0000
1×10^6	49	7		4		19	
1×10^7	15,44	3,989	0,1186	0,123	0,2005	27,30	0,0000
1×10^7	47	1		4		20	
5×10^7	15,44	3,991	0,1236	0,124	0,2003	27,30	0,0000
1×10^7	46	1		9		21	
1×10^8	15,44	3,991	0,1244	0,125	0,2003	27,30	0,0000
1×10^8	46	3		1		22	

To compare the results contained in table 1 with table 17, it is possible to conclude, that for the relative roughness condition of 0.05, the approximation models could be classified as: Moody ($15.4446 \leq RE \leq 15.8987$) terrible result; Wood ($0.4474 \leq RE \leq 3.9913$) between perfect and terrible; Churchill ($0.0425 \leq RE \leq 3.0408$) between perfect and terrible; Eck ($0.0680 \leq RE \leq 4.3832$) between perfect and terrible; Haaland ($0.2003 \leq RE \leq 0.8418$) between perfect and good; Tsal ($27.2361 \leq RE \leq 27.3066$) terrible result; Buzzelli ($0.0000 \leq RE \leq 0.0019$) perfect result.

From the analysis of the graph and the table it is possible to verify that the Moody and Tsal models generate results with greater errors in relation to the Colebrook - White equation, while the Haaland and Buzzelli models present good approximations.

IV. CONCLUSIONS

It can be seen how the Moody and Tsal method performs high errors as the relative roughness is increased. The Wood method oscillates between good and bad percentages of error, with greater emphasis on the bad results. Churchill

and Haaland methods show excellent results for all relative roughness intervals. The Buzzelli method is the model that performed best.

There are several other correlations, statistics, and values for relative roughness (absolute roughness and pipe diameter) and Reynolds number (turbulent fluid) that can be determined.

As future work it is possible to estimate such approximations, statistical calculations and Reynolds values, absolute roughness, and diameters, for a more statistically concrete analysis and / or a more specific analysis depending on the values adopted for relative roughness and Reynolds.

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Application of the overall equipment efficiency technique and theory of constraints to minimize Bottlenecks in a production line

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Abstract-One of the biggest concerns of the industries is to align the production flow with the demand, therefore, the main focus is to adjust all the processes so that they operate at the maximum installed speed, without generating bottlenecks. to ensure the reduction of waste, especially those related to the consumption of electricity. In this sense, this work aims to identify the production bottlenecks of the manual insertion process of the components - BMI of a factory in the Industrial Pole of Manaus, to apply the theory of restrictions - TOC and the Overall Equipment Efficiency index - OEE of the equipment. Based on the results obtained, it was possible to identify the bottlenecks and restrictions of the system and to propose suggestions for improvements in the process, in addition to improving the overall equipment efficiency index of the welding machine through fine adjustments in its setup, as well as software and hardware acquisitions. Installing sensors on the assembly line for monitoring and improving process and maintenance.

Keywords-Bottlenecks, Overall Equipment Efficiency Index, Theory of Constraints.

I. INTRODUCTION

From the first Industrial Revolution onwards, subsequent revolutions resulted in significant changes in manufacturing processes from water and steam powered machines to automated, electrical and digital production. As a result, advances in manufacturing process technology have become increasingly complex, automatic, and sustainable by operating machines in a simple, ceaseless, and efficient way [1] and [2].

According to Rashid and collaborators [3], changes in organizations are evident in all operational aspects. They need to improve their processes and their business model to meet demands and remain in the highly competitive market.

However, any industry, company or service provider is subject to restrictions that affect and limit the production process, known as bottlenecks, strangulation, or restrictions [4].

According to Chase and colleagues,[4] the bottleneck, constraint or strangulation are designations given to components that limit the performance or capacity of a productive system. In addition, in a production process, the

bottleneck is the activity with the lowest production capacity, preventing the company from fully meeting the planned demand [5]. The bottleneck is characterized as the slowest resource, in short, it is the one with the longest delay.

The restrictions are related to the operations of the equipment, which can generate some unforeseen events and become bottlenecks. For example, if an equipment has a market demand of 150 hours, but the availability is 200 hours, it is considered a non-bottleneck resource. However, if the equipment has difficulty maintaining this total availability, it is considered a restriction [6].

The problems caused by excess or lack of productive capacity exist in all companies, however, they can be minimized by scaling the investment in machinery and equipment in parallel with the management of bottlenecks or restrictions in the productive sectors [7] and [8].

The work aims to investigate the bottlenecks or restrictions of a production line of electronic products and to apply OEE with the TOC in the Manual Component Insertion (IMC) process to reduce waste. For example, in

the case where one of the resources of operations is considered slow, causing material and financial losses.

Therefore, to observe the bottlenecks of a slab production line and suggest new ways to minimize it, using the Theory of Constraints (TOC) aligned with the calculation of the Overall Equipment Efficiency Index (OEE), more specifically in the operations of the welding machine, with the aim of improving and guide the sectors involved in improving the manufacturing process.

II. BACKGROUND

2.1 Production Systems

According to Moreira and collaborators [9], the production system is a set of activities and interrelated operations involved in the production of goods (case of industries) or services. Some fundamental constituent elements are distinguished in the production system. They are the inputs, the creation or conversion process, the products and or services and the control subsystem. In this way, it can be said that a system is any activity or set of activities that receives an input (Inputs), usually raw materials, adds value to it and provides as a result the creation of products or services that are the outputs, to a particular customer [10].

In this sense, productive systems are taking on an important role in modern society [11]. Thus, the market demands continuous improvements in products in terms of quality, delivery costs, which can only be achieved in a flexible environment, capable of changing quickly, adapting to the process without losing its reliability [12] and [13].

Thus, the provision of efficient alternatives for the use of resources in their activities and support for the productive system's capacity for flexibility seems to be relevant for production management [14]. Intelligent production systems, as well as adapted engineering methods and tools are an important factor in successfully programming distributed and interconnected production facilities in future Intelligent Factories [14] and [15].

Smart factories combined with emerging technologies such as: Internet of Things, Intelligence and Computer Vision etc. They lead the organization to evolve in the maturity levels of Industry 4.0.

Thus, the exchange of data and information between devices in real time is the fundamental element of smart factories, as these data represent production status, electricity consumption behavior, material handling, customer orders, feedback, supplier data, etc. [15].

2.2 DMAIC Method

The DMAIC method, whose acronyms are: Define, Measure, Analyze, Improve and Control, came up with the task of reducing variations in manufacturing processes and aims to improve the process through the correct selection of projects and with steps directed to solving problems in a cyclical and continuous way [16], [17] and [18].

According to Escobar [19], the use of the DMAIC methodology is able to promote the reduction of defect and failure rates in products or services and processes, as well as in increasing productivity, reducing costs, among others. The five stages and their main characteristics are detailed below according to [20].

Defining is the first stage of DMAIC, which consists of identifying the critical processes responsible for generating bad results and defining the project's goal. Through the history of the problem and the presentation of possible restrictions and assumptions, as well as the work team is formed and the preliminary project schedule is defined.

The Measure is the second step of the method, because with the problem refined or focused, the team decides between collecting new data or using the existing ones in the company. In this step, data collection is essential to validate and quantify the problem or opportunity, aiming at defining priorities and making decisions about the criteria that are necessary [21].

Analyzing is the third step, in which the identification of the variables that affect the process is carried out, and it is necessary to find the causes of the problem by delving into the details, identifying its critical activities [21].

Improving is the fourth stage of DMAIC Initially, clear and objective proposals are created to solve and eliminate the causes found in the Analyze stage, of the identified problems. According to [22] the guarantee of improvement in the process is associated with a solution that is able to eliminate and prevent the occurrence of problems. Thus, ideas and solutions are analyzed, prioritizing potentials, assessing and minimizing their risks.

Controlling is the last step of the method, in this step the implementation of the improvement is confirmed, the problem is solved, the validation of the benefits achieved, the necessary changes to the procedures and work instructions, the implementation of the control tool, ending with the audit of the process and performance monitoring [23].

In summary, according to the author [24] DMAIC, if well used can increase the efficient and the profitability of companies making them more competitive.

2.3 Theory of Constraints

The Theory of Constraints (TOC) was developed by Eli Goldratt, to manage bottlenecks or restrictions in the

productive sectors [7]. In general, the TOC consists of a production scheduling system created from the analysis and restructuring of the restrictions found in the line [25].

According to Cox and collaborators [26], TOC is a theory rich in terms of actions, which can be developed in the current principles and methods that support the production sectors, being applicable in the identification of bottlenecks, as well as in any sector of the company.

For the Bertaglia,[27] the main idea of TOC is based on the fact that every tangible system has at least one restriction. Restrictions are factors that prevent resources from reaching the goal, they are responsible for determining the maximum levels of system outputs.

In short, restrictions can be any element or factor that prevents a system from achieving its performance with respect to its demand [25]. According to Caulliraux and colleagues, [28] TOC starts from the premise that in every system there is a bottleneck. However, to identify the bottleneck, an articulated view of the entire process is necessary. Thus, this vision is built from a network that represents resources, products, times, etc. [29].

Accordingly, Cox and collaborators, [26] the five steps to identify bottlenecks are:

1st Step: Identify the bottleneck or restrictions of the system, that is, the resource with the lowest capacity defines the maximum capacity of the system;

2nd Step: Decide how to exploit the system constraint, that is, maximize the performance of the system, in order to make the most of it;

3rd Step: Subordinate the entire system to what was decided in the 2nd step;

4th Step: Raise the system constraint;

5th Step: Return to the 1st step if the restriction is removed in any previous step and does not allow inertia to act again in the process.

The authors [30] show that many restrictions happen in operations involving machines that consume a lot of time for preparation. In this case, it is necessary to use quick changes and work with larger batches. Therefore, an hour lost in a bottleneck results in a loss in the entire production system, that is, a waste of time.

2.4 Bottlenecks

Bottlenecks, restrictions or bottlenecks are designations given to components that limit the performance or capacity of an entire production system [4].

According to De Paula Pessoa and collaborators [5] the bottleneck is any block in the production system that limits, determines its performance and its ability to obtain revenues for the company, that is, the bottleneck is the stage with the lowest productive capacity preventing the company in fully meet planned demand.

The author [31] points out that the bottleneck is the slowest activity in a production chain, although it can, in most cases, be a machine or part of the information flow, such as order processing.

For the authors [32], bottlenecks are defined as the operation performed on a given equipment that has less capacity for net production of goods, such as parts, circuit boards, services etc., restricting the production of the entire line.

Consequently, once the bottlenecks or restrictions in the production line have been defined, it is necessary to investigate and treat them, using tools that measure the OEE of the equipment.

2.5 Global Equipment Efficiency Index

The OEE, from Total Productive Maintenance (MPT) was created so that companies could measure the levels of efficiency of their equipment, being seen as a tool in the implementation of MTP. However, it was only in the late 1980s that OEE came to be recognized as a powerful tool in measuring the performance of equipment in the production system [33].

According to Pacheco and collaborators [34], the OEE is an operational indicator with application at several levels within a manufacturing system. In this way, OEE can be calculated on several production lines, to verify the actual levels of use of the industry's assets [35] and [36].

For the author [37] the calculation of OEE should be applied primarily to resource bottlenecks that restrict industry gains. Thus, the constant monitoring of resource efficiencies will provide relevant information for the elaboration of action plans that aim to reduce the insufficiencies of the productive systems [38]. This index indicates the efficiency of the equipment during its cycle of operations [39]. The calculation is done using Equation 1:

$$\mu_{global} = \frac{\sum_{i=1}^n tp_i \times q_i}{T} \quad (1)$$

Where:

μ_{global} = Global operating income index;

tp_i = cycle time of a product i ;

q_i = quantity produced of the product;

T = total time available for production

The OEE takes into account factors such as equipment production, availability and cycle time of the operation [39]. However, [38] points out that OEE should not be calculated in the same way for all jobs, as the available time T , to be considered in the equation, depends on whether or not time is a restrictive resource in the production flow.

Thus, the calculation of OEE is considered in the following cases: If the job is a critical resource bottleneck:

In this case, the denominator OEE is called TEEP- Total Effective Equipment Productivity. Thus, the time T considered in the Equation is the total time, either 24 hours / day or 1,440 minutes / day in the case of critical bottlenecks [40]. This is explained by the fact that, since the workstation is a bottleneck, all the time available must be used in production. Thus, this index indicates the time that can be gained to produce and corresponds to the real productivity of the productive system, from the bottleneck.

If the workstation is a critical resource, no bottleneck: In this case, the indicator is called OEE- Overall Equipment Efficiency. The time T considered in the equation is the time available, obtained by the difference between the total time and the time of the programmed stops. As it is not a bottleneck job, it is possible to schedule stops such as lunch breaks, workplace gymnastics, snacks etc., since the non-stop of this equipment would generate intermediate stocks before the bottleneck. Thus, this index indicates the equipment's effectiveness during the programmed operating time [38] and [34].

In summary, OEE, when applied to the bottleneck resource, can increase the system's gain [41]. In view of this, it can be concluded that the management of bottlenecks or restrictions suggested by TOC, in line with the OEE indicator can contribute to the effective increase in productivity, as well as to the profit of the system [34].

III. RELATED WORKS

The related works presented in this section were cataloged from the bibliographic review database in order to present the concepts and applicability of TOC and OEE.

The authors' work [42] aimed to apply TOC to a manufacturing line, through a case study in a war products industry, together with continuous improvement to reduce losses in the production process of a part, which restricted the production of one of the items produced in the company.

As a result, the authors applied TOC to the production line as follows: based on the production times of the company's system and the takt time (production rate), with the relationship between jobs, processing times and the production rate. production of each post.

Data collection was performed using the Enterprise Management System (EMS), which was used in the company, in which it was possible to simulate capacity in a graph, using the takt time to locate the system's bottleneck operations in relation to demand. The calculated times were divided into takt time to reach the monthly demand for 1600 products and the other for the goal imposed by the 2000 product team.

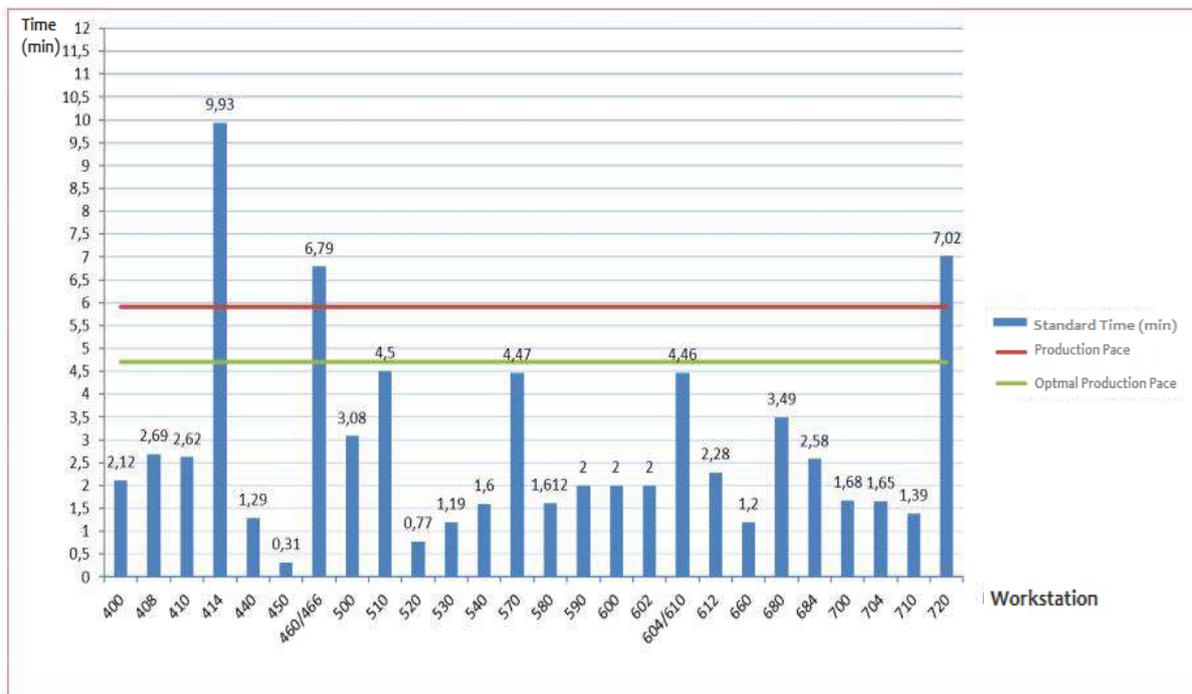


Fig. 1: Company productive capacity

Analyzing the graph of productive capacity, it is observed that three jobs met the demand proposed by the client, among the others, they were: the 414 station with

9.93 minutes; the post 460/466 with 6.79 minutes and the post 720 with 7.02 minutes, since they met above the takt

time. Fig.1 shows the company's productive capacity, before the TOC application methodology.

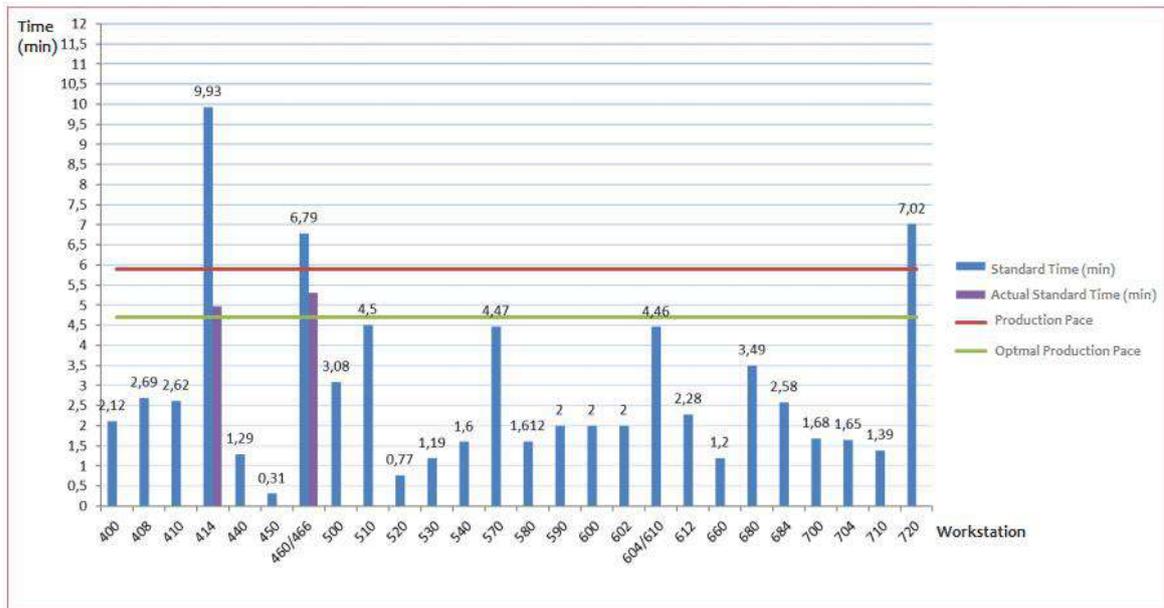


Fig. 2: Company productivity index

With the application of TOC methodology, productivity was higher, as shown in Fig.2, obtaining an increase of 80% with improvement, operational leverage of 37 products / day, the time of crossing parts dropped from 77.75 to 67.02 minutes , disregarding the movement time and Working in Process (WIP) won around 12%, in just three posts.

In the authors' work [39], a case study was presented in the production process of a manufacturer of capacitors resistant to high vibrations in the automotive industry. The objective was to find the path of efficiency, measuring the production cycles to identify flawed points, and then to propose actions aimed at the growth of OEE.

The authors balanced the flow, reduced losses and continued improvement. Data collection was carried out by monitoring the manufacturing sector for special elephant and soldering star capacitors.

The application of the method allowed to identify the bottleneck operation and other limiting points of the process, contributing to the leverage of efficiency in the company. As a result, the authors obtained eight types of tasks that represented losses, being classified into five distinct types: transportation, processing, defective product, stock and waiting.

The authors obtained as a result the excesses of rework and inspection of 84.5% while the operations that transform the capacitor were 15.5%. While the versatility of the welding process was the main cause of the failures, since 37.5% of its activities that do not add value are due to

the inefficiency of this equipment. According to the graph in Fig.3, the loss from defective products is the sector that most occurs in the system.

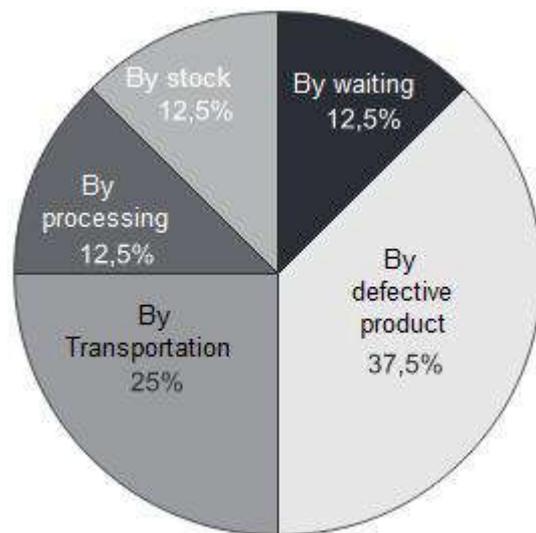


Fig. 3: System loss analysis

In addition, focusing on the optimization of the Capacity Restriction Resource (RRC) and the bottleneck, they obtained an increase of approximately 20%, as the current production increased from 3,500 to 4,189 pieces per shift.

In the work of Wolniak and collaborators [43], a study was presented with practical application of TOC to

improve the production process, in a company that produces electrical equipment to serve the mining industry. The equipment produced by the studied company is electrical equipment with dustproof enclosures, services related to the production of electricity and air conditioning systems for underground mining facilities.

The sector of the company in which the study was applied was the painting department, identified as a bottleneck with great financial and material loss, as well as customer complaints about product quality.

The focus of the work was divided into two aspects of the implementation of TOC. First, a new way of organizing work inside the painting shop was developed, according to table 1 presented below.

Table.1: Change in the working hours of the painting sector

Before implementation	After implementation	Duration
2nd Shift 22: 00-06: 00	2 ^{na} shift 18: 00-02: 00	8 hours
Lack of a break between shifts	Break between shifts 02: 00-06: 00, possibility of overtime when problems occur, drying the device after completion of work by the painter	4 hours
1stshift 06: 00-14: 00	1st shift 06: 00-14: 00	8 hours
Lack of drying after completion of work by the painter	Drying the devices after completion of work by the painter 14: 00-18: 00	4 hours

By employing changes in the paint shop in the second shift and by inserting an additional four (4) hour interval between shifts, as well as additional drying after the second shift, the company achieved an increase in efficiency of around 19% for a work shift.

By adding the possibility of overtime in the production process in the painting sector, the study made it possible to optimize the sector, enabling him to work 24 hours a day in shifts.

The second change applied was in terms of the quality of the painting of the products, but specifically in the validation of the double painting, in which the product was painted disassembled and subsequently assembled.

The application of TOC in the production process analyzed by the authors allowed to eliminate bottlenecks

and reduced the painting process of the pieces from eight to seven stages and the duration time from 1,145 to 1,051 minutes.

The related works presented in this work were compared according to the use of the TOC, DEMAIC and OEE tools regarding the approach used to improve the evaluated processes.

It is possible to observe that the use of TOC, DMAIC and OEE appear separately applied in the presented works and that only in [39] is the joint use of the two methodologies, TOC and OEE, in a case study of an automotive industry, which resulted in the reduction of losses and continuous improvement of the process, which is a good indicator for applying the methodologies together as proposed in this work.

The difference of the proposal of this work in relation to the other related works is in relation to the suggestion of improvements in the processes involving the DMAIC, OEE and TOC together to identify the bottlenecks and propose improvements in the process.

IV. METHODOLOGY

According to the author [44], scientific research is a reflexive and critical procedure in the search for answers to problems not yet solved. Thus, this research is characterized as action research, which aims to understand and intervene in the situation, with a view to changing it.

Action research is defined by a type of research with an empirical basis, which is carried out and conceived in close association with an action or with the resolution of a collective or individual problem, in which researchers and participants are cooperatively involved [45]. Thus, while performing a diagnosis and analyzing the problem, action research proposes changes that lead to the improvement of the analyzed processes [46].

The methodology for the development of this research consists of four phases. In the first phase, the search for articles that make up the bibliographic review was performed, which served as the basis for the development of this work.

In phase two, after the bibliographic review, the production operations related to the IMC process were analyzed, the production cycles were observed, considering the beginning and end of the cycle according to the guidelines on the operation sheets.

In the third phase, the analysis of the BMI process was carried out, in order to monitor the operations to identify possible bottlenecks or restrictions. Subsequently, data collection was carried out through observations of the process, interviews and survey of cycle times for each operation. In this stage, tools such as OEE were used to

assist in the continuous improvement of processes and equipment, the DMAIC method in identifying times, and the application of TOC principles.

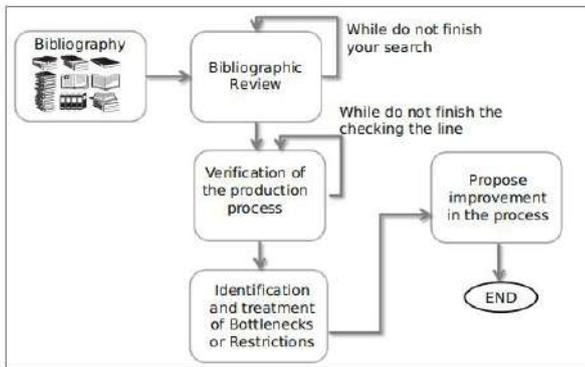


Fig. 4: Flow of the adopted methodology

The fourth phase consists of proposing improvements in the process based on the OEE calculation. Fig. 4 shows the flow of the steps of the methodology proposed in the work.

V. ANALYSIS OF THE RESEARCH RESULT

The company's manufacturing process uses Surface Mounting Technology (SMT). The SMT process begins with the Automatic Insertion of Components (IAC) on the Printed Circuit Board (PCI) to which the Surface Mounting Devices (SMD) components on the PCI are applied, by means of automatic insertion machines, known as pick-and- place. The next step is to make the plate go through the solder remelting oven, to fix the components on the PCI.

Subsequently, the plate goes to the Manual Component Insertion (IMC) process, where the components are inserted in which the machines cannot run in the IAC process. The process is finished with Final Assembly and Testing (MTF) of the plates, where they are performed tests to guarantee the functionality of the produced board, proceeding to the final packaging and transportation.

The IMC process studied it's composed by a production line.the batch consists of 36 boards per box and when completing a pallet (four boxes) they are sent to the MTF. Fig.5 shows the flow of the manual insertion process of the components.

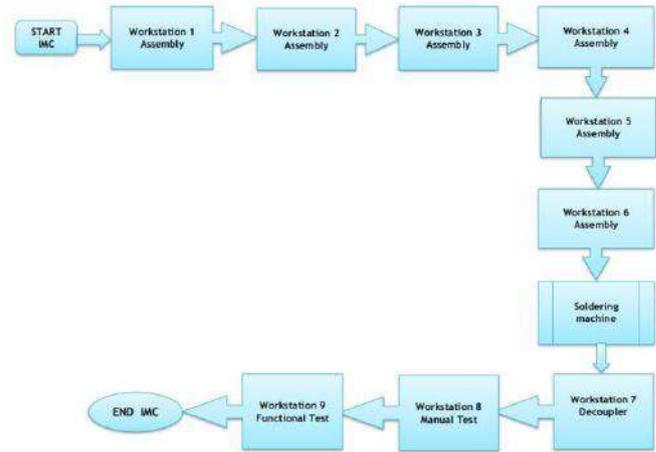


Fig. 5: Flow of the manual insertion process of the components

The IMC process starts from the output of electronic boards from the IAC process. This process is directed to the manual insertion of the components in the PCI, each board has positions defined according to the project, where the electronic components must be allocated.

The first six posts are responsible for inserting the Pin Through Hole (PTH) which means “terminal inserted into the hole” in the PCI. Although, with all the resources available in the IAC process, there are still other PTH components, which depend on manual assembly, as they do not fall within the component categories radial, jumpers, axial and SMD. After the components are mounted on the board, the last post is responsible for doing the overhaul test and packing.

After reviewing the last workstation, the board is directed to the welding machine, using a belt. The welding machine is responsible for fixing the components to the PCI. Thus, before entering the machine the board receives a spray, which is responsible for promoting the cleaning of the surface and the terminals, to avoid oxidation of the same and to ensure the quality of the PCI before passing through the welding tank.

Subsequently, the PCI goes on to preheat, in which the solder flow is activated to occur the deoxidation and cleaning of the board, after which it is directed to the passage in the melted solder tank.

Wave soldering is used in this process of fixing the electronic components on the board. In the process there is also manual welding, in which it is directed to necessary rework in the post-assembly of the board or for maintenance during the manufacturing process. Fig.6 shows the welding machine used in the IMC process line and the object of study in this work.

After the board leaves the machine, an operator is responsible for uncoupling it from the pallet and passing it through the scanner to count the number of boards.



Fig. 6: Welding machine

The next stages are related to the tests board inspection, the first is the manual and visual test, performed by three operators who analyze the boards, in this test a magnifying glass, good lighting and manual welding is used for possible reworks or flaws found on the board.

The second test is the functional test, used to eliminate defects in assembly and design because it checks the dynamic behavior of the circuit. This test is used at the end of the line to identify whether the circuit board mounted printed passed or failed. At the last station, an operator is responsible for applying the silicone glue to the board, to fix the components and then read them on the scanner the signs up until finalization of the batch. Fig.7 shows an example of a printed circuit board with welded components.



Fig. 7: Printed circuit board with soldered components.

This study was supported by the Production Engineering sector and the Factory Maintenance sector in the follow-up during visits.

Based on the on-site assessment and observations of the production line of electronics and informatics it was possible to define the data collection methods together with TOC, to identify bottlenecks and line limitations and subsequently propose improvements.

The DMAIC and OEE tools were also used to calculate the efficiency and quality of production, regardless of the results obtained in the responsible sectors, the company allowed the measurements to be performed with production in full operation and data collection in real time.

Monitoring in the company it was for four months and visits were divided once a week, in order to learn about the IMC manufacturing processes. The work was guided by the DMAIC tool, which is part of the Six Sigma methodology that directed bottleneck identification activities, to be later applied to TOC.

Observing Table 2, it is noted that the steps defined in the line verification were thought from the definition that is the first step of the DMAIC method, with the applications of TOC and the measurement with records and process mapping, and the analysis by timing each station on the production line to check the causes of bottlenecks and propose the necessary changes, aimed at improving and controlling waste.

For better targeting, the data for analysis were collected from the timing of the assembly times of the electronic components on ten boards.

Table.2: DMAIC methodology steps

Phases	Appetizer	Activities	Outputs
To define	-TOC application -Proposal for improvement	-Identify the bottleneck -Specify bottlenecks -Measure variables	-Definition of the problem - Project scope
Measure	- Records of the BMI process - Mapping the IMC process	- Collect data - Integrate data - Making tables and graphs	-Table with operating times for each workstation -Time charts of each workstation

Analyze	-Table with the operating times of each workstation -Time chart for each workstation	-Raise possible causes -Investigate the root cause -OEE calculation	- Root cause the generation of bottlenecks or restrictions
Improve	- Root cause of bottlenecks -OEE	- To propose improvements - Propose corrective actions	- Process improvement
Control	- Improvement of the process	-Meetings and accompaniments	- Effectiveness of the process through OEE and TOC

Table 3 presents the raw data collected from the production line for a given board model with the total thirteen jobs. The data were timed and transformed into the unit of seconds to facilitate OEE calculations.

Workstations were given letters of the alphabet from A to N, to maintain the confidentiality and integrity of employees who had their production times accounted for. To maximize collection, all stations were monitored and timed ten times, where P1 corresponds to the mounting board (board 1) to P10 (board 10), thus, the times were divided by the amount of collections made, and with that it was possible to obtain the average time for each station.

The evaluation of the data was on the first line from the non-automated workstations, considering the time of insertion of components on the board of each assembler and the position of the welding machine where the time of entry of the plate into the machine until its exit was evaluated, ending with the collection of testing time and the application of silicone and packaging.

Thus, as the object of study of the work is the welding machine, the timed time was from the entry of the plate in the automatic welding until its exit from the machine, totaling ten welded boards.

Table.3: Data collected from the production line.

Line 01											
Model plate	Time in seconds (s)										
Workstations	P1	P2	P3	P4	P5	P6	P7	P8	P9	P10	Average
A	14	13	15	26	21	15	21	13	26	20	18.4
B	14	17	15	18	19	17	18	15	19	15	16.7
C	18	15	17	18	19	17	15	18	18	19	17.4
D	18	22	18	15	19	18	22	18	15	18	18.3
E	11	11	13	11	9	11	12	11	13	14	11.6
F	8	14	14	16	14	14	16	14	14	16	14
Soldering Machine	136	137	138	137	136	137	137	138	137	136	136.9
H	11	10	7	9	7	11	11	10	7	9	9.2
I	34	19	30	47	21	34	30	19	47	21	30.2
J	11	19	16	20	17	19	16	17	20	19	17.4
L	86	79	89	86	84	86	86	84	89	91	86
M	77	81	89	81	77	81	89	97	88	89	84.9
N	11	10	18	14	14	18	14	14	18	14	14.5

During measurements, although the entire welding process is automatic, variations in operating time between 136 and 138 seconds were observed. It was also observed that this station is the one that demands the most time in the process, since in addition to welding, the plates undergo a flow of cleaning, preheating and ends with the cooling process until they arrive at the uncoupling station.

The graph shown in Fig. 9 shows the variations in the cycle times of the process, noting that it is not constant. This happens, because the operator of the previous station sometimes holds the process flow by pausing the conveyor, causing variation.

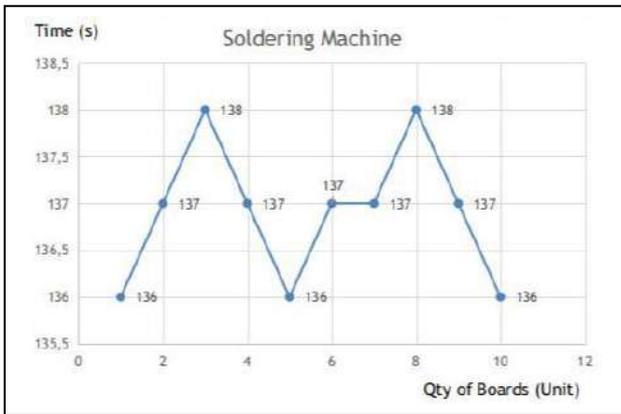


Fig. 9: Graphic of the welding machine

In addition to evaluating the operating time for each part produced at the welding machine station, it was necessary to calculate the OEE, which is obtained by multiplying the calculation of the performance, quality and availability of the equipment. Thus, it was identified that the welding machine has an overall efficiency rate of 73.43%.

Availability was obtained through Equation 2, where TC is the equipment load time given in hours and TPNP is the time of unscheduled stops. Applying the values obtained from the equipment specifications and data collections, TC = 3 hours and TPNP = 0.16 hours, the result is 0.95, which is equivalent to the availability of the equipment.

$$D = \frac{TC - TPNP}{TC} \quad (2)$$

The Performance is calculated using Equation 3, where QPP is the quantity of parts produced multiplied by TT, theoretical time and divided by TO, equipment operating time given in hours. Applying the values obtained from the equipment specifications and data collections, QPP = 26 pieces, TO = 8 hours and TT = 24 hours, the result of 78.0 is obtained, which is equivalent to the performance of the equipment.

$$P = \frac{QPP \times TT}{TO} \quad (3)$$

Quality was obtained using Equation 4 where PT is the total production subtracted losses and scrap PR divided by total PT production. Applying the values obtained from the equipment specifications and data collections, PT = 210 pieces, PR = 3 pieces, a result of 0.99 is obtained, which is equivalent to Production Quality using the equipment.

$$Q = \frac{PT - PR}{PT} \quad (4)$$

The total OEE index of the equipment is obtained by multiplying the results of availability, performance and quality. Thus, Equation 5 is used to perform this calculation resulting in 73.35% of the equipment's overall performance.

$$OEE = Availability \times Performance \times Quality \quad (5)$$

The evaluated data of the welding machine station show variations in timing, although in the machine setup the configuration allows to increase or decrease the production speed, however during operation this should not be done, as the operator of the station can pause the belt production to slow down.

The welding machine's OEE was 73.35% and according to the World Class OEE this index should fluctuate between 80% and 85%, because the higher the OEE index, the more efficient the machine is, however this can become a bottleneck, as it dictates the output of the pieces [48].

For the application of the TOC, a study flowchart was developed involving the identification of restrictions, the definition and ways of exploring them, subjecting the choices to management, leveraging the restriction and eliminating the identified restriction. Therefore, this happens in a cycle during the evaluation of the process. Fig. 10, adapted of the authors [42] demonstrates the flow used in this work.

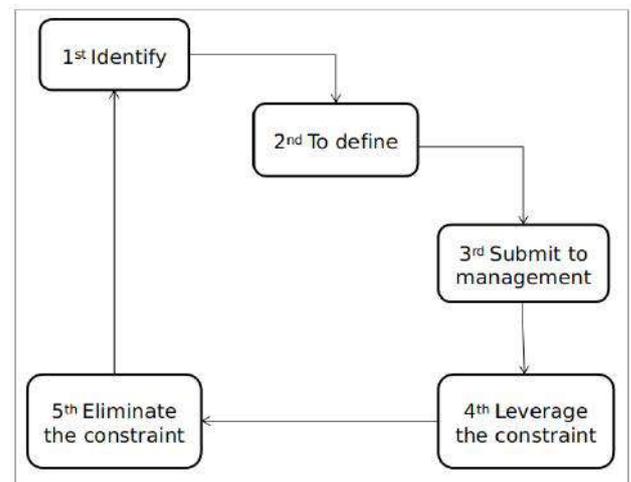


Fig. 10: TOC flow used at work

For application analysis, the production line stations were grouped and divided into three parts, as follows: the first process with the manual assembly of the components, the second with the welding machine and the third with the tests and application silicone and packaging. Based on the data collected and the evaluations, the automatic welding process was identified as a constraint, based on the OEE.

The automatic welding process was determined and obtained an average time of 136.9 seconds. In step two the constraint was explored and it was calculated that the machine uses 73.4% of its productive capacity, as follows:

- Improvement in the machine setup regarding the belt speed;
- The adjustment of the pallet that supports the plates during the welding process, to reduce unscheduled stops in the event of losses during welding;
- Welding machine monitoring software that allows messages to be sent to maintenance to predict failures,

(predictive maintenance with Industry 4.0 and IIoT). In addition to informing the consumption of electricity for the best management of this resource, minimizing waste;

- Decoupling the pallet plates using a robotic machine without the need for an operator (Industry 4.0 and IIoT).

In step three of the flowchart, the suggestions were submitted to the company, and are being implemented. In step four, a forecast was made based on the data collected on how the process can be improved, based on the decrease in the production time of the parts, with the solutions proposed in step two, improving the equipment efficiency index by approximately 12% and , therefore production.

The graph in Fig.11 shows the projection of the improvement of the times of the welding machine in relation to the average of the times collected with the operator and only with the welding machine with automated decoupling.

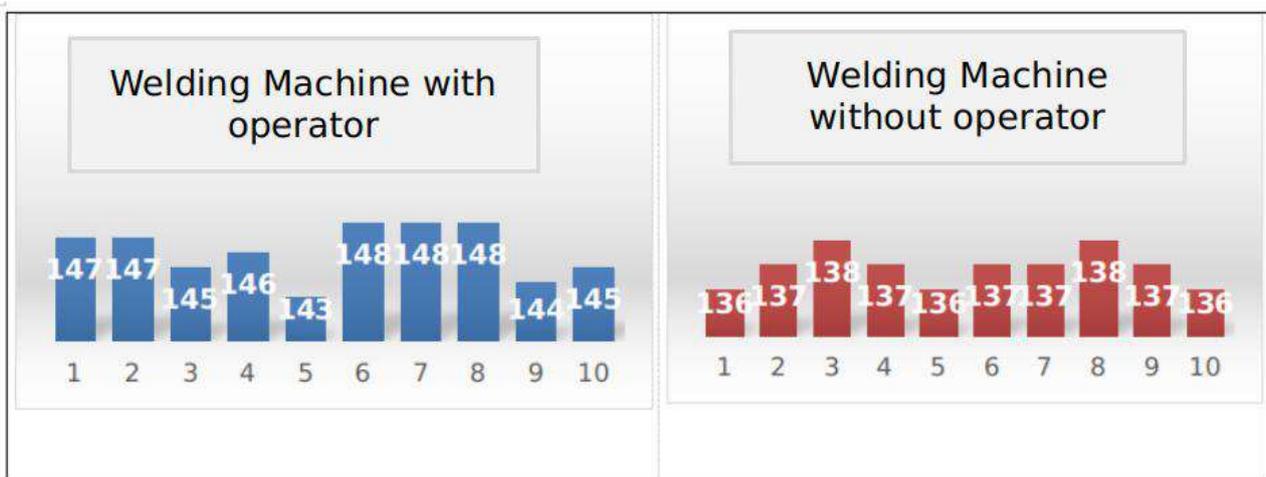


Fig. 11: Projection of improved welding machine times

In step five, based on the projection of the improvements mentioned above, the restriction of the welding machine is removed. Thus, the application of TOC and OEE in the BMI process of the investigated factory allowed the visualization of bottlenecks and restrictions in the production line of electronics and informatics.

Through TOC it was possible to identify and treat bottlenecks as well as suggest changes in the process with the application of training in the production line, interventions in the setup of welding machines and suggestions for the acquisition of software and sensors to adapt the line to the new concepts of the Industry 4.0 and IIoT.

In this way, the application of the concepts enables production managers to check the process continuously,

allowing it to be improved with each batch. In addition, it allows the team to be able to optimize production and configure the line more quickly avoiding waste.

Thus, continuous improvement in the production process is a major factor for the quality of products and, consequently, the company obtains greater profitability.

VI. CONCLUSION

The present work presented the application of the global performance index of the equipment together with the theory of restrictions in the process manual insertion of components of a factory in the Manaus Industrial Pole. Besides that, data were collected from a production line of electronics and informatics in order to identify bottlenecks

or restrictions and treat them using the TOC to then propose improvements in the process.

The results obtained were the improvement of the global efficiency index of the welding machine through fine adjustments in its setup, as well as the indication of the acquisition of monitoring software for maintenance.

As a recommendation for future work, it is intended to expand the study for the application of Industry 4.0 and IIoT in the studied line, and consequently expand to the other lines of insertion of the BMI process.

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Methodology for the Selection of Cots Components in Small Satellite Projects and Short-Term Missions

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Abstract— From a management point of view, considering increasingly lean and controlled budgets, and a restricted schedule there is a need to find cheaper and more viable alternatives for the present scenario related to commercial electronics parts. On the other hand, the increasing offer of COTS (Commercial Off The Shelf) and the higher quality manufacture are a good opportunity to use COTS components in electronic projects for small satellites in short and medium-term missions, through a coherent study that combines the restrictions and advantages mentioned above, a method that indicates the best COTS for the systems engineer and/or project can be of great usefulness.

Keywords— COTS Quality; Failure rate, Small satellites; Short-term mission, Taking decision.

I. INTRODUCTION

The current trend in the use of Commercial-Off-The-Shelf (COTS) components, due to its of cost management, development time, availability for purchase and higher quality and reliability achieved by its large scale utilization in automotive electronics, and mobile phone, generates a new approach allowing its use in short-term space projects.

On the other hand, COTS components does not follow the rigor established in the military standards in terms of tests, selection, documentation, and required quality levels , which makes it difficult to track the component since its manufacture and testing.

The main restrictions on the use of these components in the space area are due to the hostile environment to which they will be subject during their useful life since launch until orbit.

In the space environment, some of the main factors that degrade the components are:

- Vibration (acceleration) at launch;
- Thermal (during the life cycle of the satellite);
- Ionizing radiation (total accumulated dose - TID and single-effect events - SEE's) from the trapped particle in the radiation belt around the Earth and solar activity.

Considering these factors, the right choice of EEE components to be used in the design of satellite subsystems / equipment is a very important phase.

The choice of the best COTS components becomes a KEY OPERATION to guarantee the required reliability

In this study, we considered the design of an equipment / subsystem. The COTS component to be used in the equipment performs a specific function according to the electrical functional requirement of the proposed circuit in a given electronic module as a solution to the desired functionality.

II. OBJECTIVE

This paper proposal aims to present a methodology for the selection of EEE COTS components in small satellites and short duration missions.

III. DEFINITION

Important definitions of COTS according to NASA [1]:

3.1 COTS: A component designed for applications in which only the manufacturer of the item or supplier establishes and controls the specifications for performance, configuration and reliability (including design, materials, processes and testing), without additional requirements imposed by external users and / or organizations. For

example, any type of assembly or component through a catalog without any additional testing at the component level. Delivery of the component by the manufacturer as it is.

3.2 COMPONENT SELECTION: Consists of a series of tests and inspections to remove non-conforming components and/or early failure also known as infant mortality (components with defects that are likely to result in initial failures) and thus increase the reliability of the components selected for use.

3.3 COMPONENT BURN IN TEST: Test applied to the electrically polarized component (current or voltage) at an elevated temperature for a specified number of hours. It is a process of accelerated aging and it aims to make the component operate at a maximum nominal value of operating conditions, to reveal intrinsic failure in time and early defects during manufacturing (infant mortality: manufacturing defects).

3.4 COMPONENT CHARACTERIZATION: The process of testing a sample of components in a controlled environment (temperature and acceleration levels) is done using applications and / or setups to measure the electrical parameters of the component. Component characterization results are often used as a basis for establishing batch qualification tests.

3.5 COMPONENT SCREENING: A series of intended component-level tests and inspections to remove nonconformities and child mortality (defective components) and increase the reliability of the component selected for use.

IV. CONTEXTUALIZATION

There are three main reasons for using COTS components in space projects:

- Best performance;
- The absence of list of qualified parts for space;
- It has 1/10 of the cost of QPL equivalent for space

The first two items are the main reasons for use in space projects, the lowest cost being the main driver for satellite launchers and constellations (<http://wpolartechonology.com/accede>) [2].

Given the possibility of using some options available in the market, but different manufacturers and unknown quality levels in terms of reliability, we propose to discuss the following approaches:

4.1 Develop a method of choice based on the probability of failure instead of the reliability approach;

4.2 Use the FIDES guide [3] to calculate component failure rate based on physical failure mechanisms (Overstress: thermal, mechanical, relative humidity, subassembly of plates and weld points) and manufacturers' quality factors (manufacturing processes and quality) considering the life stages of the component;

4.3 Introduce a cost based choice of COTS in specific cases, for example the intended COTS of the project does not have sufficient data to prove or demonstrate the required reliability through accelerated environment tests for MTTF inferences and burn-in for the general cases (up screening).

V. METHODOLOGY

The selection of the appropriate COTS component is not a trivial task and was considered a decision-making process with several criteria. In our case, only two criteria: reliability and cost.

After allocating the reliability of the proposed electronic subsystems / modules, taking into account the minimum reliability established for the subsystem in question (our case study: power module - DC / DC converter), an analysis will be made using the FIDES method to find out the failure rate and a theoretical cost analysis related to the minimum tests necessary for screening in specific cases.

VI. FORMULATION

It has been formulated the selection model considering the following challenges associated with the problem:

5.1 Complexity: Integration level for IC and Hybrid integrated circuits (analog and digital circuits and logic gate No.);

5.2 Costs: Additional Electrical / Environmental Functional Tests - Burn-in and HALT/MTOL [4];

5.3 Evaluate quality level: (AHP or FIDES Guide [5]: manufacturer quality factors, features, and functionality preferences);

5.4 Operational profile: Mission time, Operating temperature, duty cycle and radiation exposure (tests and solutions known to mitigation);

Note: Bold item involve additional costs and will be treated with a comparative cost analysis to MIL STD 883 or ECSS-Q-ST-60-13C class 3 [5]

VII. CHOICE PROCEDURE

7.1 FMECA shall be done to indicate the critical parts that can lead to catastrophic failure of the system/subsystem;

- 7.2 Calculate the importance of reliability of each component (Birnbaum measure) based on the failure rate (λ) of an equivalent component MIL 883 (HDBK 217) [6].
- 7.3 Mapping of less critical components after the considerations earlier done;
- 7.4 Using the FIDES Guide to determine the failure rate by treating the physical failure mechanism besides the Karmiol / Bracha Method (adapted) with focus on the complexity the most important effect from the effects factors listed below, once that it will be treated of analogous way to component level:
 - 7.4.1 Operating time / duty cycle
 - 7.4.2 Operating Profile (Temperature Range)
 - 7.4.3 Component complexity;
- 7.5 Optimization method [7] based on two criteria: Reliability and Cost (testing), aiming at up-screening having reference to MIL 883 or ECSS-Q-ST-60-13 C class 3;
- 7.6 Decision making of proposed COTS components based on data obtained from manufacturers' audit by questions formulated in FIDES Method and expert opinion (using the AHP or WSM method).

Note: The FIDES Guide deals with manufacturer quality factors (Π_{PM} and $\Pi_{Process}$) together with the AHP method can be treated with the designers' preference functionalities of the component.

VIII. APPROACHES TO METHOD

In order to begin the discussion around the problem of choosing the appropriate COTS to meet the electrical and environmental functional requirements required in the project, we must stick to the sequence of steps necessary to achieve our goal starting with the allocation of reliability for each unit or subsystem of the mini-satellite so that the mission achieves its goal.

A reliability allocation study must be done previously on subsystem/equipment/ module level before the choosing of the COTS component can start.

Schematic diagrams of the problem and solution are shown in Figures 1, 2 and 3 as follow:

Propose Solution:

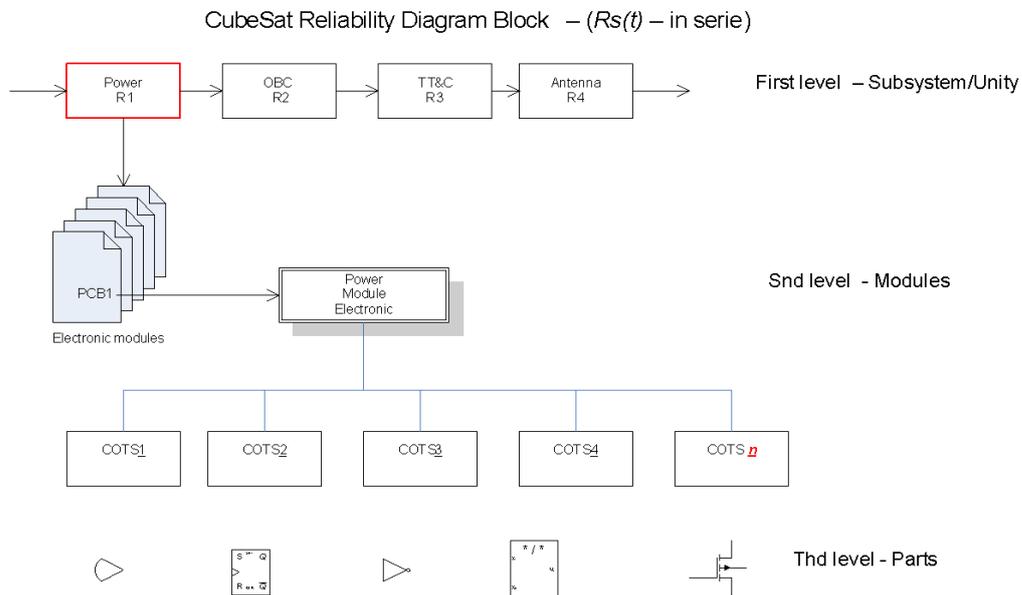


Fig 1: COTS to be used

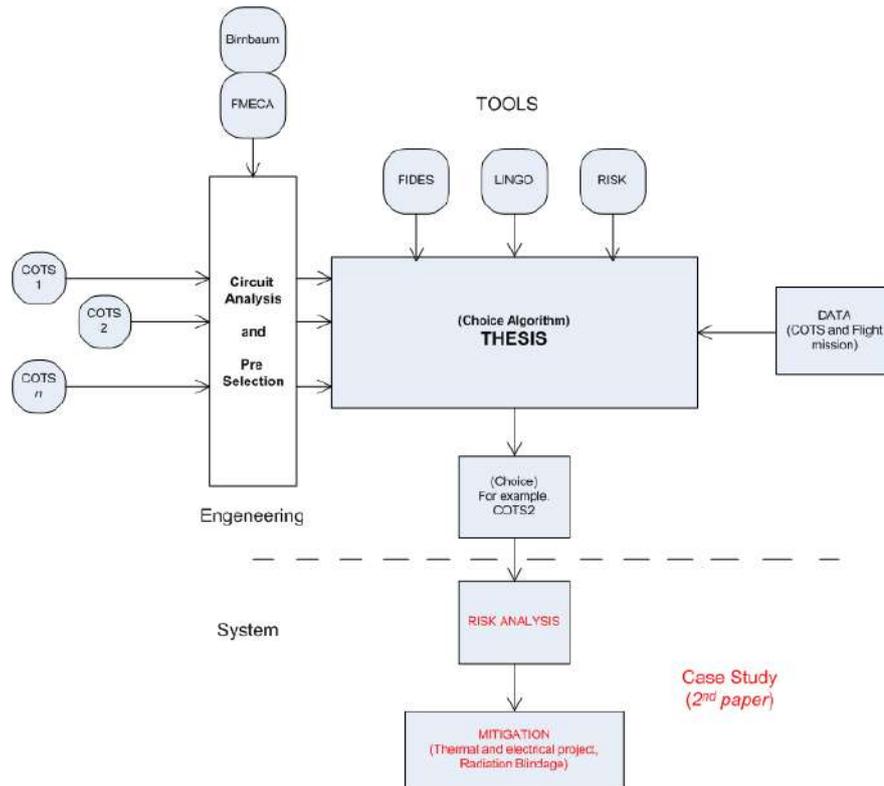


Fig 2: Methodology for choosing COTS

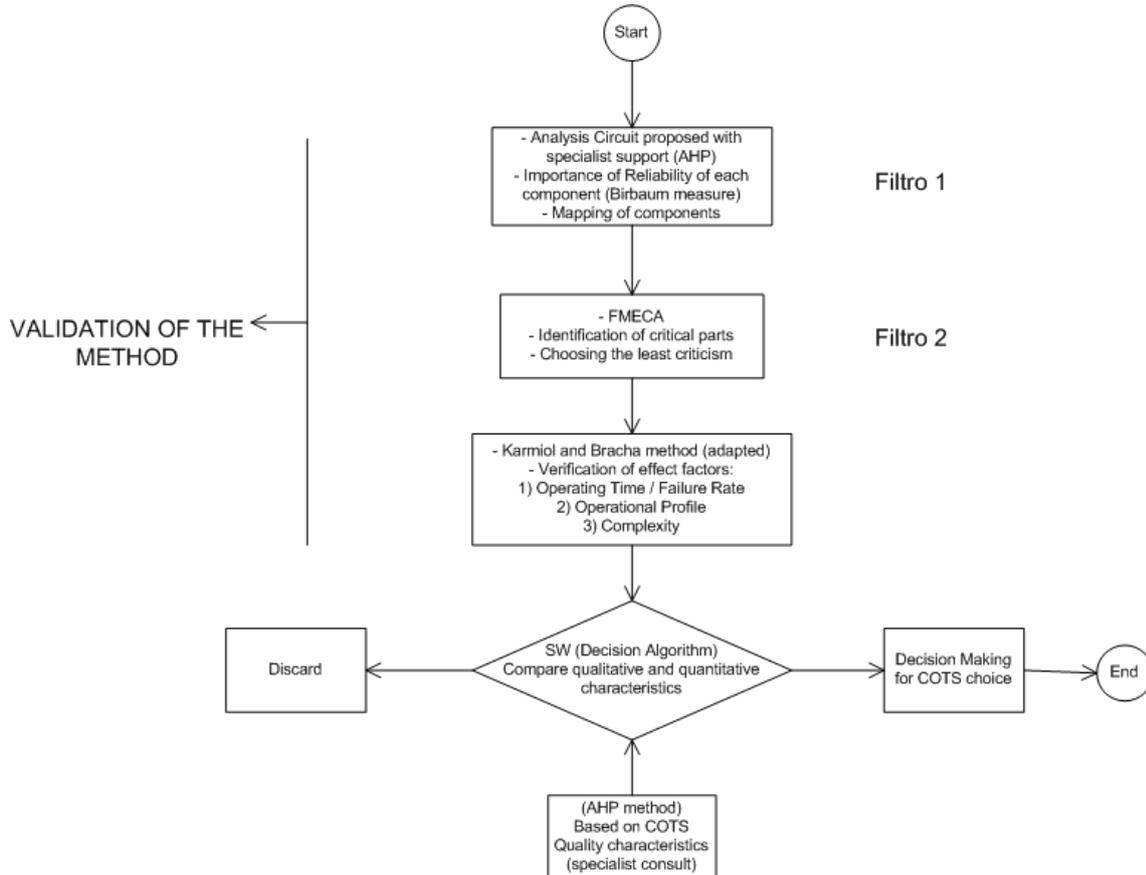


Fig 3: Flowchart COTS Algorithm of Choice

Once the number or figure of reliability of the subsystem under study is obtained it will be treated on the suggested procedure.

The reliability allocation method is called the AGREE method which is based on the complexity of the unit or subsystem rather than the failure rate. The importance or essentiality of the unit quantitatively defines the relationship between the unit and the target system failure rate and is explicitly considered in the AGREE allocation formula.

The allocation formula is used to determine the minimum acceptable average time of each unit to satisfy the minimum acceptable system reliability. The premise is that the unit within the system has an independent failure rate and operates in series with respect to its effects on mission success.

Unit complexity is defined in terms of the number of modules and associated circuits where a module can be a valve, a transistor or a magnetic amplifier. The unit importance factor is defined as the probability of system / unit failure if a particular unit fails. If the factor of the importance of a unit is 1 the unit must operate satisfactorily for the system to operate satisfactorily otherwise if the factor of 0 then the failure of the considered unit does not interfere with satisfactory system operation.

The specific basis of allocation is to require each module to make an equal contribution to the success of the mission and the equivalent requirement would be for each module to have the same expected average life or failure rate.

The mathematical model for the method considering the approximation:

$$e^{-x} = 1 - x \tag{1}$$

Where:

x is small and less than 1

The allocated failure rate of this unit is shown in AGREE.

$$\lambda_j = \frac{n_j[-\log_e R^*(T)]}{NE_j t_j} \tag{2}$$

Where:

n_j = number of modules (module = electronic component) of subsystem / unit, jth;

N = total number of components in the system;

E_j = Importance factor of jth unit,

and

t_j = number of hours the jth unit will be required to operate in T system hours (mission time) (0 < t_j (duty cycle) ≤ T)

The allocated reliability for the jth unit (subsystem) for t_j (duty cycle) unit operating hours, R (t_j), is given by

$$R(t_j) = 1 - \frac{1 - [R(T)]^{n_j/N}}{E_j} \tag{3}$$

IX. BIRNBAUM MEASURE

The importance of a component should depend on two factors [8]:

- The location of the component in the PCA / Unit; here we are concerned with a good thermal design in order to reduce thermal stress, understanding that temperature is one of the main factors for component reliability;
- The reliability of the component in question.

Birnbaum (1969) proposed the following measure of reliability importance of a component

Birnbaum's measure of the importance of a component i at time t is:

$$I^B(i/t) = \frac{\partial h(p(t))}{\partial p_i(t)} \tag{4}$$

Birnbaum's measurement is then obtained from the partial differentiation of system reliability with respect to p_i (t). This approach is well known as a classical sensitivity analysis. If I^B(i/t) is large, a small change in component reliability will result in a large variation in system reliability over time. Let's consider each independent component for analysis, this means that there is no independence between components (obviously this approach does not reflect the actual behavior of systems, this is the interdependence between modules or series components) but already points to a degree of importance. reasonable in its determination.

By noting the fault tree, Birnbaum's measurement [9] can be rewritten:

$$I^B(i/t) = \frac{\partial Q_0(t)}{\partial q_i(t)} \tag{5}$$

Where:

q_i (t) = 1 - p_i (t)

Q₀(t) = 1 - p_s(t) = 1 - h(p(t))

Birnbaum's measure is named after the Hungarian-American professor Zygmund William Birnbaum (1903-2000)

Thus, the next step in this methodology would be the search for options for DC/DC converters in the component market that would meet the functional electrical and environmental requirements of the project. For this, we need to find out a failure rate related to DC/DC Converter prescribed and to check if that value is appropriate in our case it means if the value has not compromised the reliability allocated for the unit. Otherwise, it continues to choose another part that meets this requirement.

X. FAILURE SURVEY OF COTS [FIDES GUIDES]

Reliability Prediction Using the FIDES 2009 Guide.

The FIDES evaluation model proposes a reliability prediction with constant failure rates. Therefore, the probability of failure is independent of the number of hours of a component in operation. This means that only random failures during the life of a component are considered and early failures (infant mortality) and wear failures are not included.

This methodology for reliability evaluation in electronic components has two components:

- Component reliability prediction guide,
- Reliability process control and audit guide.

Although component prediction models allow component failure rates to be calculated based on component characteristics and application-related data (eg, applied thermal and electrical stress), the reliability process control and audit guide assess component manufacturing quality and the effects of all processes throughout the life cycle from the design specification phase to maintenance and support activities. The FIDES Guide aims to enable a realistic assessment of the reliability of electronic equipment, including systems operating in harsh environments (defense systems, aeronautics, industrial electronics, transportation, etc.). The general model of FIDES is expressed by the equation:

$$\lambda = \lambda_{physical} * \Pi_{PM} * \Pi_{Process} \tag{6}$$

In this case, our components for study: a DC / DC converter (hybrid), A / D Converter (IC) and a semiconductor we apply to formulas to find the failure rate, as follows:

Hybrid

$$\lambda_{Physical} = \sum_i^{Phases} \left(\frac{t_{annual}}{8760}\right)_i * [(\lambda_{0TH-TCy} * (Y_{TH} * \Pi_{TH} + Y_{TCy} * \Pi_{TCy}) + \lambda_{0M-RH} * (Y_M * \Pi_M + Y_{RH} * \Pi_{RH})) * (\Pi_{Induced})_i^{-1}] \tag{7}$$

Integrated Circuit and Semiconductor

$$\lambda_{Physical} = \sum_i^{Phases} \left(\frac{t_{annual}}{8760}\right)_i * [(\lambda_{0TH} * \Pi_{TH} + \lambda_{0TCyCase} * \Pi_{TCyCase} + \lambda_{0TCySolderjoints} * \Pi_{TCySolderjoints} + \lambda_{0RH} * \Pi_{RH} + \lambda_{0Mech} * \Pi_{Mech}) * (\Pi_{Induced})_i^{-1}] \tag{8}$$

Nota: All factors (sensitivity, location, technological, physical stress) and basic failure rate associated with the assembly will be requested in the algorithm of choice. The $\Pi_{PM} * \Pi_{Process}$ parameters are quality factors of the manufacturer and of the component and are calculated based on evaluations and audits at the manufacturer when possible, if not, we use default values suggested by FIDES.

XI. COMPLEXITY FACTOR

We will make an analogy with the Karmiol / Bracha [9] (the method used to determine effects factor weights to obtain unreliability and subsequently allocate reliability to subsystem/unit) with the complexity of a component understanding that the problem handling can be analogous. We introduce this factor to increase the stiffness in the reliability calculation since we cannot increase reliability in the usual ways as a redundancy.

Karmiol/Bracha(adapted) considers four effect factors, namely:

- a) **Sublevel Complexity;**
- b) Operating time;
- c) Operational profile;
- d) Criticality and State of art

Understanding that items b, c, d are somehow already covered in the physical failure rate model through the failure mechanisms addressed by the FIDES method, we focus our efforts on **complexity**.

$$C = 1 - e^{-K_b + 0.6kp} \tag{9}$$

Where:

K_b and K_p should be estimated at the beginning of the development stage.

$$K_b = 10 n_{bi}/n_{bc}$$

n_{bi} = Number of components at sub level i;

n_{bc} = Number of components in the most complex sub level

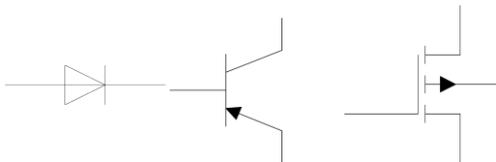
*Kp = Number of redundant components

*The Kp factor will not be used because the component functionality internal is not being redundant. We understand that the complexity of the component is associated with the levels of integration of the various functions performed by the component, for instance, hybrids and microcircuits.

So the complexity factor is:

$$C = (1 - e^{-K_b})$$

Therefore, for a semiconductor type, we have for example:



Bipolar, Transistor and Mosfet

Fig 4: Semiconductor Schematic Symbols

Kb=10

$$C = (1 - e^{-0.00004539993}) = 0.9999540007$$

In other words, the complexity of the component in this case is low and therefore coherent with the semiconductor diode component. On the other hand, components that are more complex tend to zero.

Low Complexity= 1

High Complexity≈ 0

For an integrated circuit, we have:

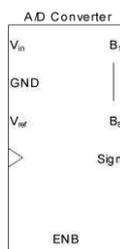


Fig 5: (MAX1112) [10]

Functional Diagram

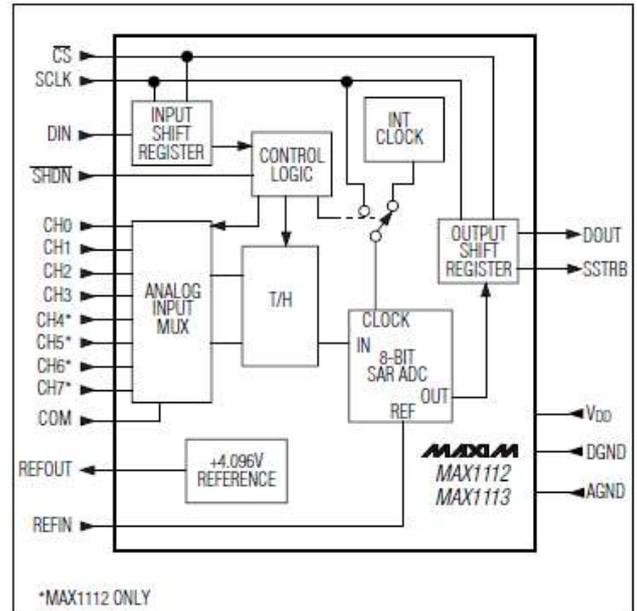


Fig 6: Ex.: Schematic symbol of an A / D converter

Kb=10

nbi = 8 [n. of elements at sub level i (functional blocks)]

Active Components:

Input Shift Register, Output Shift Register, Logic Control, I / O Multiplexer, Voltage Reference, 8-bit A / D Converter, Clock Generator, T / H,

Passive Component:

Analog switch

nbc = 300 [number of elements (discrete components) in sub-level most complex]

$$K_b_i = 10 n_{bi}/n_{bc}$$

$$K_b_i = 10(8/300)$$

kbi = 0.26

$$C = (1 - e^{-K_b})$$

$$C = (1 - e^{-0.26})$$

$$C = 0.23$$

For a Hybrid type circuit (DC / DC Converter) we have:

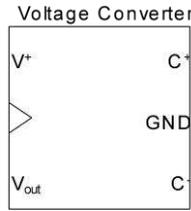


Fig 7: Ex.: DC / DC Converter Block

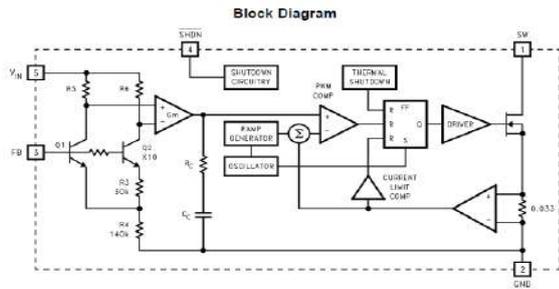


Fig 8: Block diagram of the DC / DC Converter (LM2731) [11]

$$C = (1 - e^{-K_b})$$

$K_b = 10$

$n_{bi} = 22$ (n. of elements in 1st level)

Active Components:

Comparator, PWM, FF (RS), Oscillator, Adder, Ramp Generator, Current Limiter, Shutdown Circuit, Driver, Transistors and FET

Passive Components:

Resistors and Capacitor

$n_{bc} = 148$

$K_{bi} = 10 \ n_{bi} / n_{bc}$

$K_{bi} = 10 \ (22/148)$

$K_{bi} = 1.4$

$$C = (1 - e^{-K_{bi}})$$

$C = 0.75$

After we have been able to determine a failure rate for the COTS via the FIDES method we multiply the result by C (complexity factor) and close the loop in the choice algorithm to see if the value still meets the allocated reliability for the module/circuit in question (one mix between two methods FIDES and HDBK 217). Another

thing that must be observed in the case of less complex digital components is that the number of gates will be used as a stiffness factor in the failure rate. Otherwise, we start with a new choice from the available manufacturers. If not apply additional tests like Burn-in or (HALT or MTOL) for MTTF inference and cost analysis, optimizing Reliability versus Cost and having as a reference to MIL 883 or ECSS-Q-ST-60 -13C Class 3

The decision making in choosing the COTS would then be after the analysis of the component failure rate via FIDES Guide and its consistency with a decision based on functional component preferences by the designer through an analysis via AHP and the listed criteria.

XII. COTS RADIATION

Considering the cost of testing in a qualified laboratory in the order of USD1500 per hour and minimum test time required of 60 hours, one can have an idea of the final cost of one of these non-destructive tests since one would be curious to see the functional behavior (some electrical parameters) of a specific component under radiation levels that must be found in the environment provided for in the mission based on Software such as SPENVIS of ESA, OMERE and ANGEL [12]

Some radiation of the type TID, SEU and SET can be mitigated by means of some known solutions, such as:

- 12.1 Physics: - Metallic shield (Titanium sheet);
- 12.2 Better Physical Positioning of the radiation sensitive (critical) electronic module inside the satellite (small satellites) - Software: GEANT 4, TRAD'S and FASTRAD [13];
- 12.3 Coding: EDAC, Watchdog Timers, TMR and HDL

XIII. ENVIRONMENTAL TESTS FOR SPECIFIC COTS

We will start by treating Burn-in tests as the main test for the elimination of defective components (infant mortality), understanding that eliminating the components that may have manufacturing defects, the rest according to the bathtub curve (failure rate versus time curve).) remains constant with constant failure rate during its "useful life" and "wear" at the end of the project's useful life.

It is understood that the rate of thermal variation predicted in the Burn-in tests (cycle: hot ↔ cold) will induce the mechanisms of physical failure of the component in addition to an acceleration in the aging of the component.

Additional accelerated thermal tests in order to verify the MTTF and estimate a batch failure rate will also be carried out and inspections based and adapted according to the reference ECSS-Q-ST-60-13C Class 3

XIV. COST ANALYSIS

All of these tests generate costs so a balanced cost analysis of the type of optimization will be necessary and a risk analysis associated with the problem will be implemented.

Total cost of a Burn in test:

$$C = Ax + L[(1 - R(X))] \tag{10}$$

Where:

A: is the cost of Burn in per unit time

L: is the cost of a failure during Burn in

R (X) = Distribution curve Probability of Failure (eg: Weibull) [17]

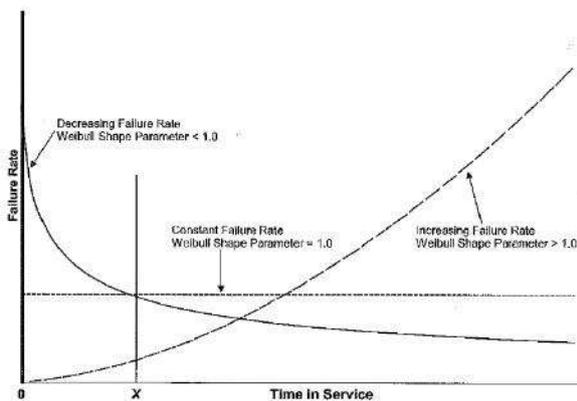


Fig 9: Failure rate characteristic

Table 01. ECSS-Q-ST-60-13 (today) applicable for active EEE

	Class 1	Class 2	Class 3
Evaluation	Complete	Complete	Partial
Justification	data collection	data collection	data collection
Screening	Complete	Partial	Light
Lot test	Complete	Complete	Partial

Summary of tests and inspections to be applied in the COTS:

14.1 Incoming inspection: date code, dimensional and visual characteristics (oxidation of leads and visual aspect of the encapsulation);

14.2 Specific Electrical Tests (digital and analogic);

14.3 PIND and Hermeticity test (if applicable);

14.4 Burn in and HAST test (special cases);

14.5 Documentary verification (manufacturer data collection)

XV. RISK ANALYSIS

This paper proposal aims to present a methodology for the selection of EEE COTS components in small satellites and short duration missions.

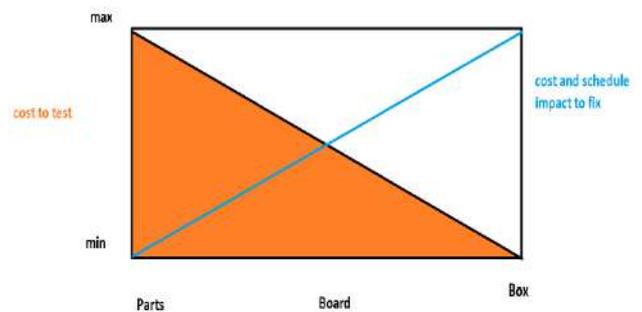


Fig 10: Notion of cost / schedule and its impacts by developing tests at the level of Components, Cards (PCA) and Boxes [14]

Figure 10 shows in the simplified representation that the cost to test decreases while the impact on cost and schedule for correction increases as component, board, and box level testing is performed. This occurs in components because the number of independent tests required decreases when moving to a higher level of testing. The cost of testing may be lower, but the cost and schedule consequences of a failure occurring increase dramatically. Total cost is lower if no problem or failure is detected at higher levels of testing.

We conclude that testing is important for minimizing future impacts and consequences. Therefore, there is a need to find a compromise or to measure and quantify the necessary tests in order to have a reasonable level of confidence for decision making when choosing the COTS to be used.

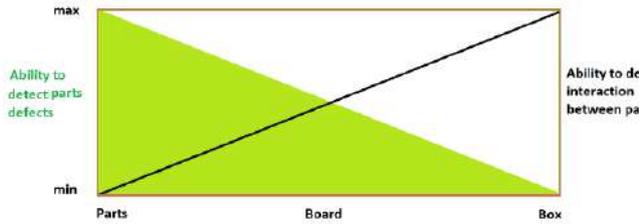


Fig 11: Notion of ability to detect defects in components and Interaction between components when developing tests at the level of components, PCA and Box

Figure 11, in a simplified representation, shows that testing at lower levels of integration improves the ability to detect component defects. Many partial defects are masked

at higher levels of integration, but identifying these defects will increase system reliability, reducing the likelihood of latent failures. On the other hand, testing at higher levels of integration is more effective at detecting interactions between component manufacturing and assembly defects that affect reliability.

XVI. DECISION MAKING

As mentioned earlier AHP method [15] can be useful to decision making in the choice of COTS by experts

The following is an AHP model for choosing the COTS according to the listed criteria:

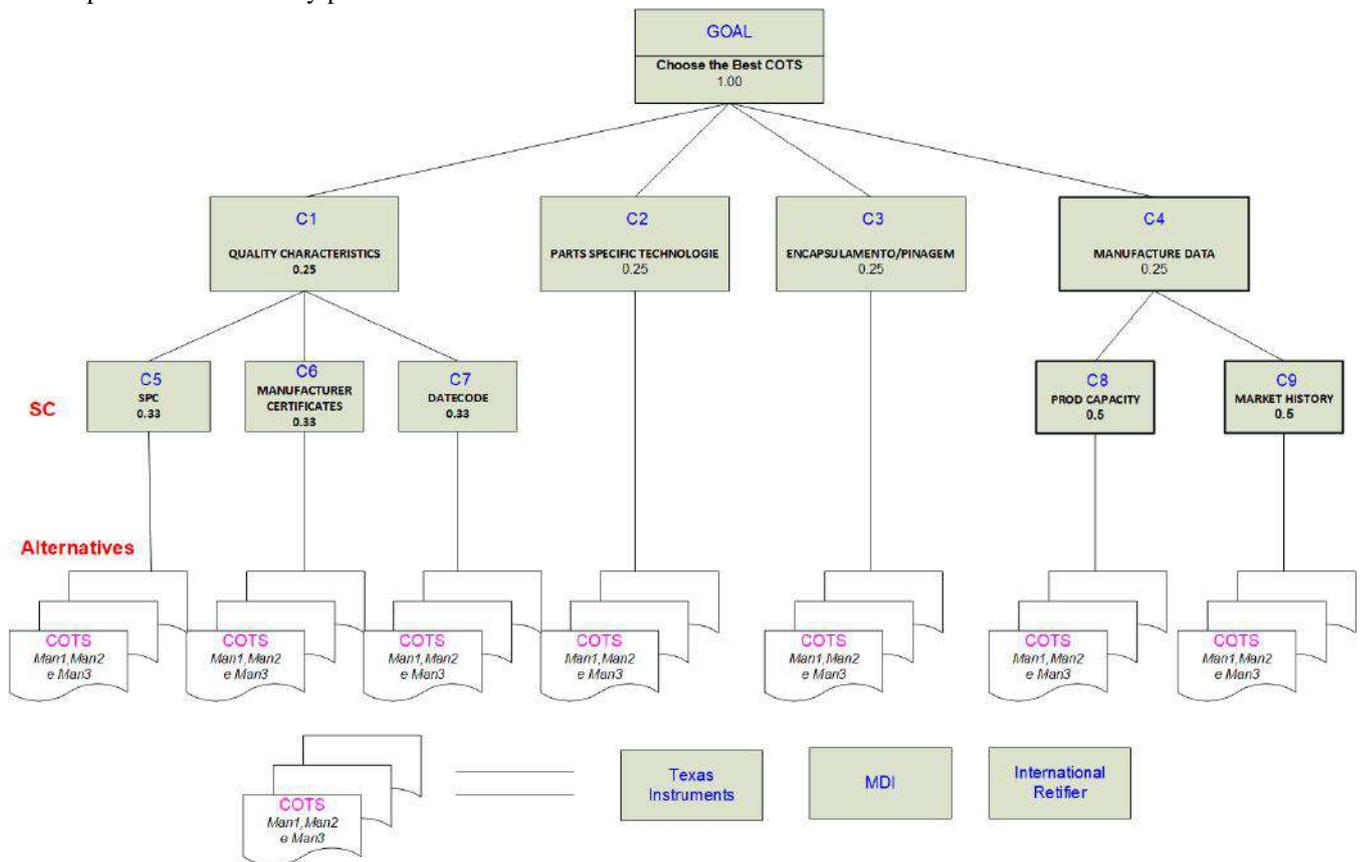


Fig 12: AHP structure model for choosing COTS

XVII. CONCLUSION

This methodology approach is a convenient way to express the system reliability as a function of component reliability and the independence structure between the functional levels considered (subsystem/equipment/module/component) of course there is an interaction among levels but in this study, the values were negligible. Another important point that must be appointed is about the making decisions under many

uncertainties considered in this model. By the other hand, these ways suggested give us a possibility to find out the best solution to the designers in the utilization of COTS in an electronic circuit searching a balance among Cost, Reliability, and Risk

XVIII. CASE STUDY:

Value = 4.75525

C = 0.75

Output data:

Part Failure Rate = 2567.9183

(2567.9183x 10⁻⁹ or 2.567 x 10⁻⁶)

For a Hybrid type circuit (DC / DC Converter) we have:

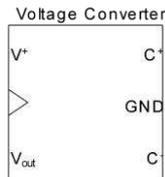


Fig 15: Ex.: DC / DC Converter Block

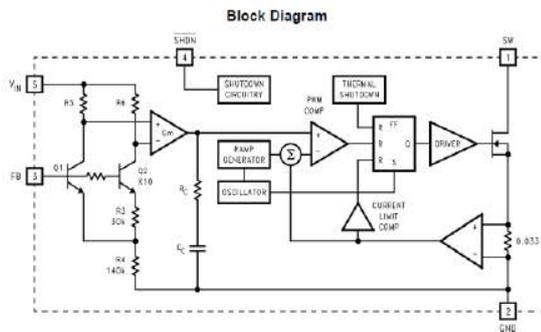


Fig.8: Block diagram of the DC / DC Converter (LM2731)

$$C = (1 - e^{-Kbi})$$

Kb = 10

nbi = 22 (n. of elements in 1st level)

Active Components:

Comparator, PWM, FF (RS), Oscillator, Adder, Ramp Generator, Current Limiter, Shutdown Circuit, Driver, Transistors and FET

Passive Components:

Resistor and Capacitor

$$\begin{aligned} nbc &= 148 \\ Kbi &= 10 \quad nbi / nbc \\ Kbi &= 10 \quad (22/148) \\ Kbi &= 1.4 \end{aligned}$$

$$C = (1 - e^{-Kbi})$$

Therefore, in accord to proposal of this paper, we have:

Failure Rate = FR/C

FR = 2.567/0.75

FR = 3.42 FITs (1/10⁶)

For instance: Tancredo-I (Tube Sat)

Table 03. Reliability Allocated

System: (Payload) Langmuir Probe – (Ubatubasat)				
Primary Mission: Medição de Plasma				
Reliability requirement: R*(8760 hr) = 0.9				
Subsystem	Number of parts, nj	Operating time, hr, tj	Essenciality, Ej	Allocated reliability, Ri(tj)
Power	81	8760	1	0.95
Transmissor/Receptor	46	8760	1	0.97
Controller	48	8760	1	0.97
Antenna	7	8760	1	0.97
	N = 182	8760	1	0.99

So, for the Tancredo I (Tubesat) power subsystem, we have:

$$\begin{aligned} nj &= 81 \\ N &= 182 \\ EJ &= 1 \\ tj &= 8760hr \end{aligned}$$

For the power subsystem, the reliability rate allocated considering reliability for the whole system of R (t) = 0.9, we would have:

$$\begin{aligned} R_1(8760tj) &= 1 - \frac{1 - (0.9)^{81/182}}{1.0} \\ R_1(8760tj) &= 0.95 \end{aligned}$$

N = total system components

(1/2) Power PCA Rate failure λ = 0.32 change to

λ = 3.74 after calculate failure rate to DC/DC Converter suggested

$$P(t=8760h) = 1 - e^{-\lambda t} = 1 - e^{-(3.74 \times 10^{-6} \times 8760)}$$

$$P(t=8760h) = 1 - e^{-0.029}$$

P (t = 8760h) = 0.029, that is, the DC / DC converter has around 3% probability of failing up to 8760h (one year) of use considering only one of the power cards (1/2). So it would serve this mission well, as the reliability allocated to the power unit was 95%.

Therefore, can we see that after a new failure rate calculated does not have a great impact on reliability

allocated to power supply. In this case, the DC/DC Converter found to power supplier PCA will met the reliability requirement established to mission time duration so it could be used

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Multi-function Hybrid Microgrid with Four-Leg Voltage Source Inverter

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Abstract—Unintentional islanding of distributed generation systems is generally avoided as a safety measure implied by worldwide electrical standards. Considering current grid technologies with better sensing capabilities and semiconductor devices with novel capabilities that allow faster response times and higher maximum ratings, there are some applications where distributed resources could improve reliability in the case of intentional islanding. Safe microgrid equipment with better isolation and control features allows efficient use of energy surplus whenever grid fault events occur, feeding emergency energy to critical loads. In this context, a 20 kW hybrid on-grid/off-grid multi-function microgrid is presented along with a simplified approach for designing the contained power inverter used with intentional islanding function.

Keywords—Distributed generation, hybrid inverter, microgrid equipment.

I. INTRODUCTION

The market of distributed generation (DG) in Brazil is in constant growth, reaching sales of 1.07 billion dollars in 2018, with turnover exceeds up to 978 MWp (megawatt peak), according to a study published by Greener Brasil (based on data from Federal Revenue Service, Greener Brasil, and ANEEL) [1], where growth continues at extremely high rates, despite Brazil's economic and political situation. In 2017 there were approximately 21,998 DG connections and in December of 2018, they totaled 52,852 (a growth rate of 140%), with a variation from 184.8 MWp installed capacity to 545.6 MWp between 2017 to 2018, respectively. Substantial growth is occurring even in a period of recessive economy, with the evolution of micro and macro economic reforms in progress, especially what will ensue the recent approval of the Brazilian pension reform bill. A positive impact is expected for maintaining the incentives for generation systems because their market is small compared to other developed countries. Estimates point more than 80 million consumer sites where it would be viable to have energy production reconciled with consumption, therefore there is still a gigantic potential for growth of the accumulated DG market (MWp).

A developed microgrid system meets five aspects solved by market only through distinct equipment: 1) solar inverters operating with nominal power of 20 kW, that can be cascaded in modules with total power up to 2MW; 2) uninterruptible power supplies (UPS); 3) local and remote power flow management; 4) auxiliary power unit integration, such as battery banks and fuel cells, to extend reserve power; 5) automatic transfer switch systems for utility grid interconnection. Developed technology consist in a set of control boards: central microprocessor control module, gate drive, sensor data module, communication interface, and human-machine interface. This device is suitable for integrating distributed generation of solar energy networks as a local source, providing greater energy efficiency and, consequently, accelerated investment gains, whose development initially targets theoretical studies to integrate DC photovoltaic generation and battery storage systems. Fig. 1 presents the hybrid microgrid topology to feed critical loads through a solar energy source and battery.

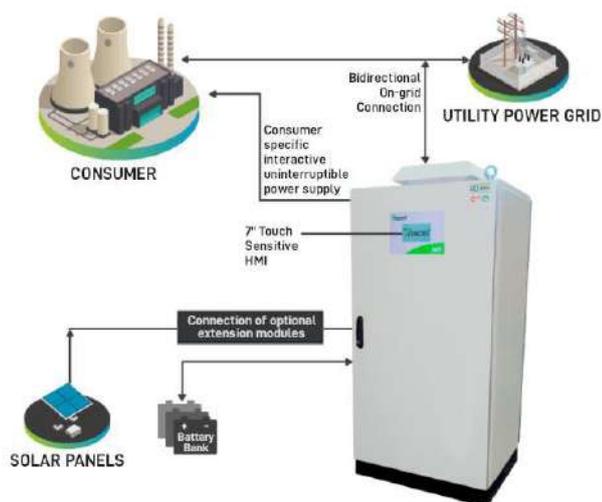


Fig.1: Presented hybrid multi-function microgrid.

A main component of the system is the four-leg voltage source inverter. Two types of power inverters are generally available in market when considering main grid connection or isolation: off-grid and on-grid inverters. Off-grid inverters are intended to provide energy from DC-generated sources such as photovoltaic power to isolated consumers in alternating current, referred to as island mode operation. On the other hand, on-grid inverters use energy from DC sources to feed alternating current as well as to inject, if possible, surplus energy to the main grid. Although not yet officially available in the Brazilian market, on-grid inverters with off-grid function allow both modes of operation, connected or isolated from the main grid. Unintentional islanding of distributed generation systems is generally avoided as a safety measure implied by worldwide electrical standards. Considering current grid technologies with better sensing capabilities and semiconductor devices with novel capabilities that allow faster response times and higher maximum ratings, there are some applications where distributed resources could improve reliability in the case of intentional islanding. In this paper, we propose a simplified methodology to develop power inverters and a working prototype four-leg voltage source inverter used with the hybrid microgrid system that ensures safe isolation and power to critical loads during grid fault events. The remaining of this paper is organized as follows: Section II presents the power inverter market in Brazil and functionality, Section III the considered power inverter design approach, Section IV case study of the microgrid system, simulations and obtained results for the 20 kW prototype.

II. POWER INVERTER MARKET AND FUNCTIONALITY

An important share of the renewable sources applied in distributed generation market, solar energy in Brazil has great prospects. According to the US Department of Energy, Brazil has a significant potential for renewable energy generation, where in 2024 is estimated at 7GWp of installed capacity. With current legislation and regulations, the investment forecast for the year 2030 is \$21 billion. There may be a variation in growth of this market with the revision of Resolution 482/2012 of ANEEL, currently underway, which is expected to introduce a form of compensation to the electric distribution companies from using the grid to compensate energy generation and consumption. This change probably will reduce investment returns on systems as of 2020.

Current business models must comply with standards as well as design, manufacturing and installation restrictions of system components, where modular configurations are more capable of adapting to different applications. Among existing equipment configurations, the DC power supply type may vary considering the ability to integrate photovoltaic generator units, wind generators, hydrogen fuel cells, biofuel motor-generator sets. Other equipment include battery banks, DC/DC converters, Uninterruptible Power Supply (UPS) controllers, and rectifiers depending on load type and expected power availability.

In Brazil, UPS is commonly referred as no-break, and attend a significant portion of the commercial, industrial and residential sectors, such as apartment complexes and rural businesses. Today, according to [3], this market is estimated at \$400 million, with production of large equipment (from 3 to 500 kVA) around 100,000 units/year. An important feature of a UPS is the time to reestablish energy, which should be less than one period of the sine waveform – given the standard 60 Hz grid frequency would correspond to approximately 15ms. There are recent products in the market promoted as short-breaks, which, for less demanding applications, energy is reestablished in a longer period, usually two or three periods (30-45ms), maybe providing an ideal cost-benefit for systems that can support brief discontinuities.

The presented inverter topology consists of a bridge configuration, whose main advantage according to [4] is to lessen wear of commutating components, such as from current spikes, overvoltage and over temperature. Fig. 1 is the basic arrangement used for the hybrid inverter considered for the project, denominated as the Three-phase Four Leg Voltage Source Inverter (FLVSI). Circuit input is a DC voltage source with a cap filter, followed by

switching components and output stage with caps that correspond to each phase. Switching components consist in Isolated Gate Bipolar Transistors (IGBTs), which allow high frequency modulation, available in market with efficiency and life cycle characteristics that present good performance for power converter equipment.

One of the main challenges in DC/AC converter design is minimizing switching losses and parasitic circuit elements, which prevent efficient operation in high power applications. The so-called "dead times" during switching cycles can be seen as short-circuits to the source caused by premature state changes, which should be avoided. Another point to have in mind is that inverter operation should suffer little influence from the applied load, where the extreme conditions would be damage to the components when there is no load present (open circuit) and when load low impedance (short circuit).

There are several techniques used to generate high-frequency switching, the simplest known as Pulse Width Modulation (PWM). There are several PWM techniques, among them the most implemented [6] is the sine wave PWM, or SPWM, due to its relative simplicity. The modulating signal to control gate triggering is from the comparison of a sine wave ($V_{control}$) with a triangular carrier wave (V_{tri}), illustrated by Fig. 2. Upper gate devices are turned on releasing current when polarization voltage is positive and blocked when voltage is negative. Lower gate devices have a similar scheme to conduct negative voltage when upper gates are blocked.

When the output phases are not balanced, even though the angular difference is 120° , there is an undesirable common mode voltage fed to consumers that can damage equipment. To reduce common mode voltage, [7-11] suggest that the neutral connection obtained from the inverter topology be controlled from a fourth leg parallel to the switching bridge, providing a means to adjust the neutral voltage point so that it is symmetrical with respect to the phases.

III. POWER INVERTER DESIGN APPROACH

When designing a new inverter, this primarily involves determining switching element specifications and the thermal dissipation layout. After defining the inverter topology type, the next step is to solve (1)–(12) to obtain an estimate of IGBT characteristics, to select a semiconductor for this design, and (13)–(21) to obtain a suitable heatsink. Among other variables, the DC source characteristics, expected input voltage, and voltage and power requirements at output are needed to begin.

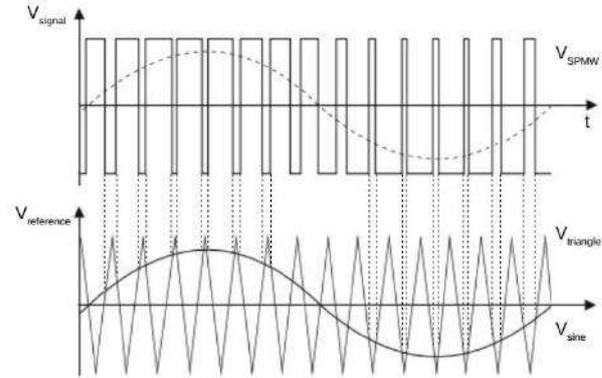


Fig. 2: Control signal obtained from sine wave reference and triangular carrier wave.

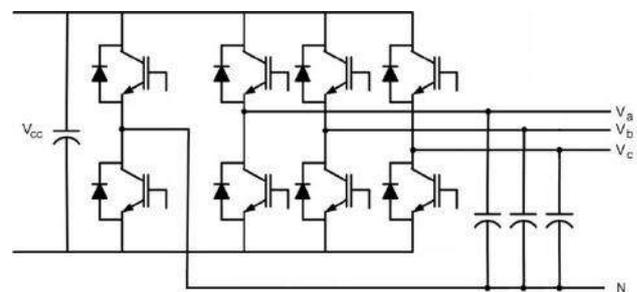


Fig. 3: Basic full bridge switching topology.

A. Determining Switching Element Specifications

The amplitude modulation index (m_a) can be expressed by the ratio of theoretical output peak-to-peak voltage and the input voltage:

$$m_a = \frac{\sqrt{2} \cdot V_{O_{RMS}}}{\sqrt{3}} \frac{2}{V_{i_{min}}} \quad (1)$$

where $V_{O_{RMS}}$ is the nominal AC output voltage and V_{imin} is the minimum DC input voltage. The inverter must supply output the specified voltage when the input voltage is at its lowest, this constraint is not a problem when the input voltage is higher.

The modulation index should not exceed 1.0, in this case there is over modulation which means that with the SPWM technique the amplitude of the first harmonic is not linearly proportional to the modulation index [11]. There are improvements such as third-harmonic injection (THI-SPWM) where the idea is to add a third harmonic of the reference sine wave to flatten the region of peak voltage, increasing linear range of operation. Because third harmonic components are equally applied to the three phases this would not compromise output phase generated by the inverter. Since the objective was to present a simple

methodology of inverter design, the details regarding these techniques is out of scope of this paper.

The output voltage wave form with SPWM modulation for a given phase is expressed by:

$$V_{O_{peak}} = m_b \cdot \frac{V_i}{2} \cdot \sin(\omega t + \phi) \quad (2)$$

where ϕ is the waveform phase and V_i the DC input voltage. The theoretical apparent power (P_{AP}) is estimated from:

$$P_{AP} = \frac{P_{AT}}{\cos \theta} \quad (3)$$

where P_{AT} is the expected active power and $\cos \theta$ is the expected power factor. The nominal current is expressed by the equation:

$$I_{ORMS} = \frac{Pot_{AP}}{\sqrt{3} \cdot V_{ORMS}} \quad (4)$$

Output equivalent load and inductance is, respectively:

$$Req = \frac{Pot_{AP}}{(\sqrt{3} \cdot I_{ORMS})^2} \quad (5)$$

$$Leq = \frac{\sqrt{P_{AP}^2 - P_{AT}^2}}{(\sqrt{3} \cdot I_{ORMS})^2} \cdot \frac{1}{(2\pi \cdot F_o)} \quad (6)$$

The current applied to the IGBT module is equivalent to output peak current, thus:

$$Ip_{IGBT} = I_{ORMS} \cdot \sqrt{2} \quad (7)$$

Freewheeling diodes in parallel to the IGBTs at peak power dissipate approximately the same peak output current:

$$I_{peak\ diode} = I_{O_{peak}} \quad (8)$$

Nominal and average current integrations for the IGBT modules considering SPWM switching [12] are:

$$I_{RMS} = \frac{\sqrt{2}}{2} \cdot \sqrt{\frac{1}{\pi} \left(\frac{1}{4} \cdot I_{O_{peak}}^2 \cdot \pi + \frac{2}{3} \cdot I_{O_{peak}}^2 \cdot m_a \cdot \cos \theta \right)} \quad (9)$$

$$I_m = \frac{1}{2\pi} \left(I_{O_{peak}} + \frac{1}{4} I_{O_{peak}} \cdot m_a \cdot \cos \theta \right) \quad (10)$$

Nominal and average current integrations for the freewheeling diodes considering SPWM switching [12] are:

$$I_{RMS\ diode} = \frac{\sqrt{2}}{2} \cdot \sqrt{\frac{1}{\pi} \left(\frac{1}{4} \cdot I_{O_{peak}}^2 \cdot \pi + \frac{2}{3} \cdot I_{O_{peak}}^2 \cdot m_a \cdot \cos \theta \right)} \quad (11)$$

$$I_{mdiode} = \frac{1}{2\pi} \left(I_{O_{peak}} - \frac{1}{4} I_{O_{peak}} \cdot m_a \cdot \cos \theta \right) \quad (12)$$

B. Thermal Dissipation Layout

The cooling of the device occurs through forced air conduction through heatsinks in contact with the active elements. The next equations followed the schematic shown in Fig. 4, where R_{th-jc} is the thermal resistance of each component to its packaging; R_{th-cs} – thermal resistance of the packaging; R_{th-ds} – thermal resistance of the heatsink; T_j – junction temperature; P_{igbt} – power dissipated by the IGBT; P_{diode} – power dissipated by the freewheeling diode; P_{mod} – power dissipated by the IGBT-diode pair module.

The sum of the power dissipation occurring in conduction and switching in each IGBT is described by (13-14), considering the adjustment of the parameters E_{on} and E_{off} , the dissipated energies for switch turn on or off, respectively, corrected for the chosen operating voltage and current.

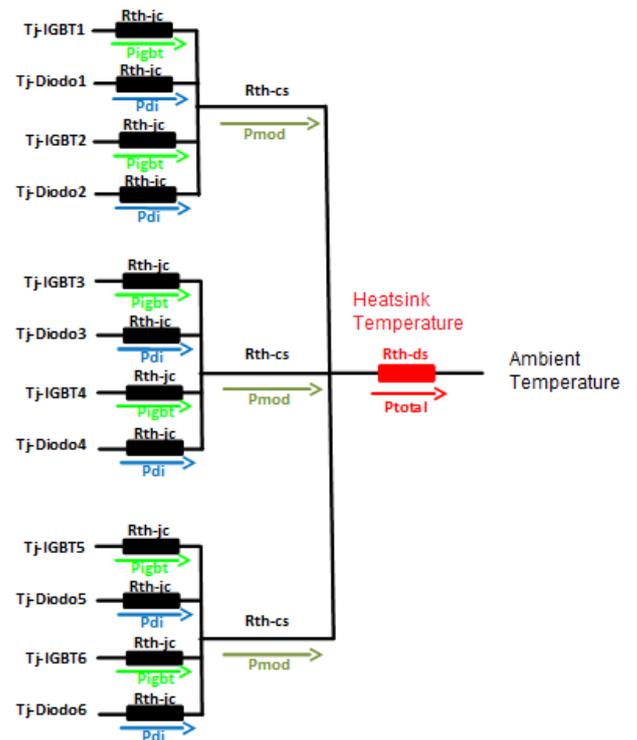


Fig. 4: Thermal schematic to determine heatsink characteristics.

$$P_{IGBT} = V_{CE0} \cdot Im_{IGBT} + R_{ce} \cdot I_{RMS}^2_{IGBT} + P_{E_{IGBT}} \quad (13)$$

$$P_{E_{IGBT}} = Fch \cdot (E_{on} + E_{off}) \cdot \left(\frac{V_{in}}{V_{IGBTmax}} \right)^{K_v} \cdot \left(\frac{Ip_{IGBT}}{I_{IGBTmax}} \cdot \frac{\sqrt{2}}{\pi} \right)^{K_i} \quad (14)$$

where V_{CE0} is the collector-emitter voltage and R_{ce} is the collector-emitter impedance of each IGBT obtained from the manufacturer datasheet. K_V and K_I are constants equal to 1.4 and 1.0, respectively.

The power dissipated from each freewheeling diode, considering the influence of the parameter E_{rec} , reverse energy recover, for operating voltage and current conditions:

$$P_{diode} = V_{to} \cdot I_{m_{diode}} + R_t \cdot I_{rms_{diode}}^2 + P_{E_{diode}} \quad (15)$$

$$P_{E_{diode}} = E_{rec} \cdot \left(\frac{V_{in}}{V_{dode_{max}}} \right)^{K_V} \cdot \left(\frac{I_{pdode}}{I_{dode_{max}}} \cdot \frac{\sqrt{2}}{\pi} \right)^{K_I} \quad (16)$$

where V_{to} and R_t are the voltage and impedance of forward polarization of the diode obtained from the datasheet specifications.

The module type chosen is a pair of IGBTs and diodes. The dissipated power by a single module is:

$$P_{mod} = 2 \cdot (P_{IGBT} + P_{diode}) \quad (17)$$

The total dissipation in a switching cycle is given by:

$$P_{total} = 3 \cdot P_{mod} \quad (18)$$

The junction temperature can be estimated as 85% of the maximum junction temperature specified for the IGBT, as a reasonable margin. The thermal resistance of the heatsink ($R_{th_{diss}}$) is in function of a chosen ambient temperature (T_{AMB}):

$$R_{th_{diss}} = \frac{T_{j_{IGBT_{max}}} - (T_{AMB} + P_{IGBT} \cdot R_{th_{IGBT}} + P_{mod} \cdot R_{th_{mod}})}{P_{total}} \quad (19)$$

We can calculate the junction temperature of the IGBT with the obtained with the heatsink's thermal resistance:

$$T_{j_{IGBT}} = T_{AMB} + R_{th_{diss}} \cdot P_{total} + P_{mod} \cdot R_{th_{IGBT}} + P_{IGBT} \cdot R_{th_{mod-IGBT}} \quad (20)$$

The heatsink's temperature estimate is expressed by:

$$T_{diss} = T_{AMB} + R_{th_{diss}} \cdot P_{total} \quad (21)$$

With the determined thermal resistance and temperature, a sufficient heatsink model can be chosen. An additional module to increase cooling may be required according to the application, whether it be forced ventilation or liquid cooling, to protect components from overheating.

IV. CASE STUDY OF THE HYBRID MICROGRID SYSTEM

Simulations were performed with the PSIM™ software Version 9.1.1.400 where the detailed schematic can be seen in Fig. 5 and 6. Input power is a set of photovoltaic panels

with sum of nominal power above 20 kW. The parameters used for the load cell block available in the software took into consideration solar farm plans of 3 rows with 17 panels in series each:

- Open Circuit Voltage: 647,7 Vdc (38,1 Vdc per panel);
- Short Circuit Current: 54.9 A (18,3 A per row);
- Maximum Power Voltage: 521,9 Vdc (30,7 Vdc per panel);
- Maximum Power Current: 51 A (17 A per row).

No specific IGBT model parameters were used, and only cable resistance and inductance were considered. Power dissipated by output filter capacitors are concentrated in series resistors. The MPPT (Maximum Power Point Tracking) strategy programmed into the control block consisted in the Incremental Conductance technique. Resulting simulation waveforms can be seen in Figs. 7 and 8.

Figures 10-13 present data obtained from the Fluke Series II 434 Analyzer, output phase and neutral voltages, output currents, voltage and current harmonic distortion. An image of the 20 kW prototype is presented in Fig. 13.

The inverter's intention is to withstand tests defined by the Conformity Assessment Regulations described in the INMETRO Ordinance No. 357/2014 [13], related to the Conformity Assessment Program for Photovoltaic Energy Systems and Equipment. In addition to the standards ABNT NBR 16149:2013, ABNT NBR 16150/2013 and ABNT NBR IEC 62116/2012.

According to [13], for equipment conformance labeling, the Conformity Assessment Requirements apply to the following equipment: Photovoltaic modules; Battery Charge/discharge Controllers; inverters for autonomous systems with nominal power between 5 and 10 kW; inverters for systems connected to the grid with rated power up to 10 kW; Battery bank systems. The following procedures for the tests are based on the minimum requirements of the equipment according to current standards:

1. Flickering;
2. DC component injection;
3. Harmonics and waveform distortion;
4. Power factor;
5. Reactive power injection/demand;
6. Over/under voltage;
7. Over/ under frequency;

8. Control of the active power in over frequency;
9. Reconnection;
10. Out-of-phase automatic reclosing;
11. Active power modulation;
12. Reactive power modulation;
13. Disconnection of the photovoltaic system from the grid;
14. Requirements for back-up due to faults in the network;
15. Protection against reversal of polarity;
16. Overload;

17. Anti-islanding. Items 1 through 14 are further defined in standards ABNT NBR 16149/2013 and ABNT NBR 16150/2013, items 15 and 16 are uniquely specified in the same ordinance and item 17 is described in the standard ABNT NBR IEC 62116/2012.

Although there is no precise specification of the standards for hybrid generation and storage systems equipped with static transfer switches, the different test procedures were carried out to ensure the safety and quality of the equipment. Test results for the three-phase four-leg voltage source inverter demonstrated stable operation of the equipment as specified as designed.

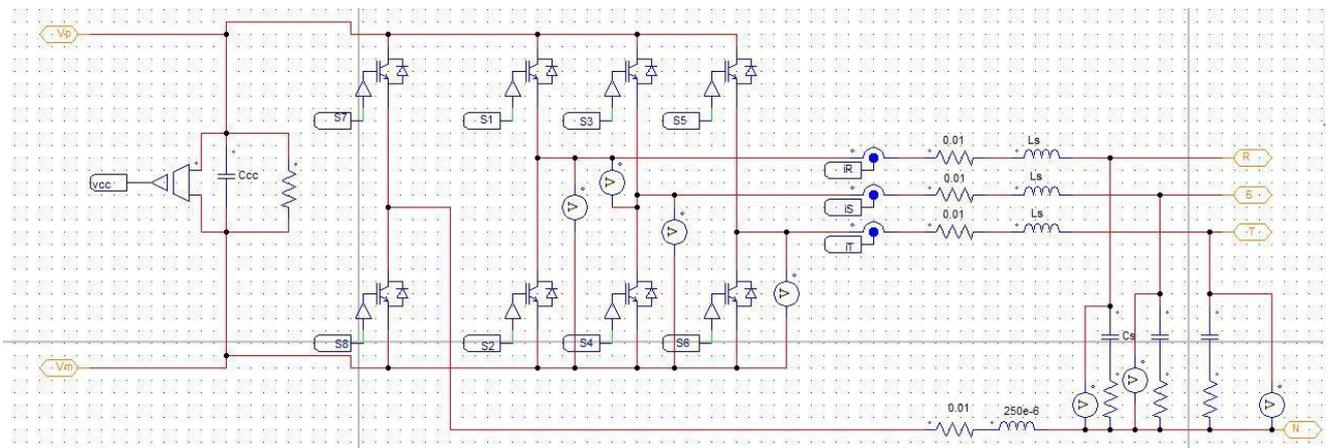


Fig. 5: Hybrid Inverter topology simulation schematic.

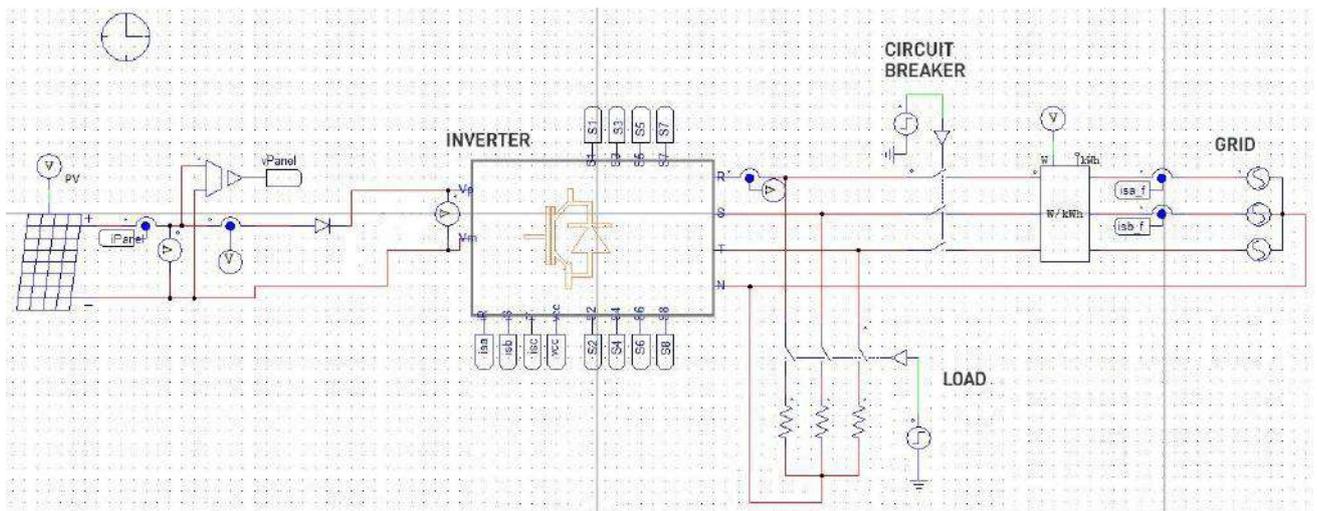


Fig. 6: FLVSI inverter simulation submodule schematic.

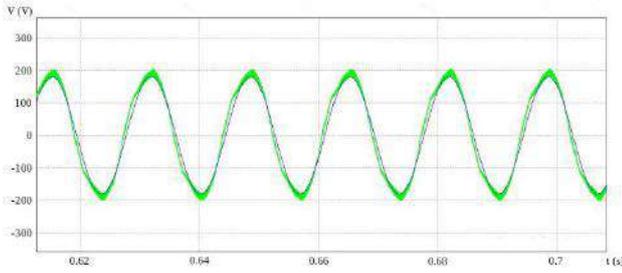


Fig. 7: Simulated single phase voltage and current output.

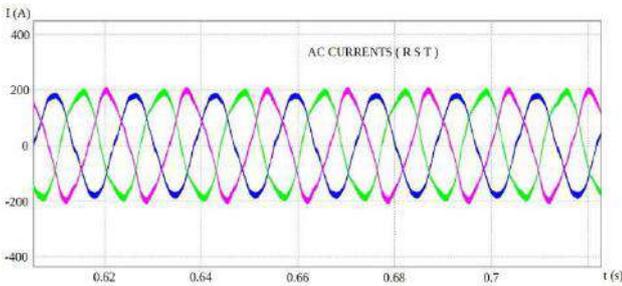


Fig. 8: Simulated output three-phase current.

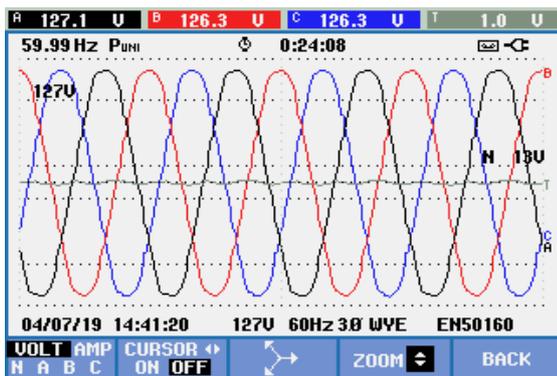


Fig. 9: Prototype output phase and neutral voltages.

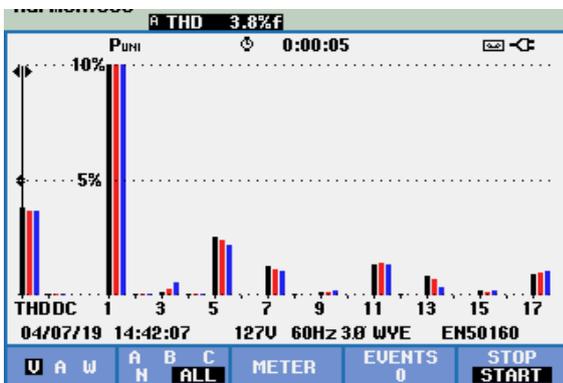


Fig. 10: Voltage Harmonic Distortion.

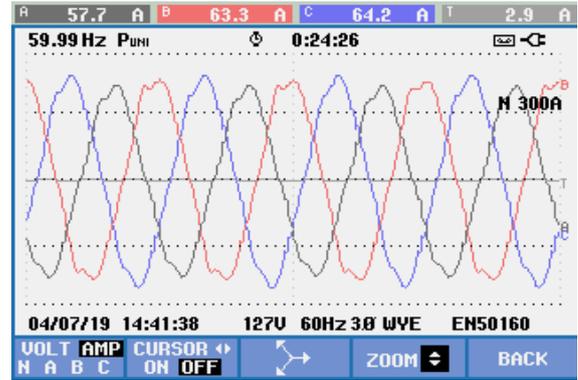


Fig. 11: Prototype output currents.

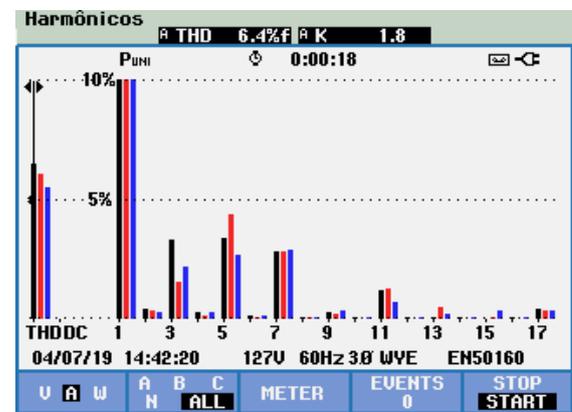


Fig. 12: Current Harmonic Distortion.

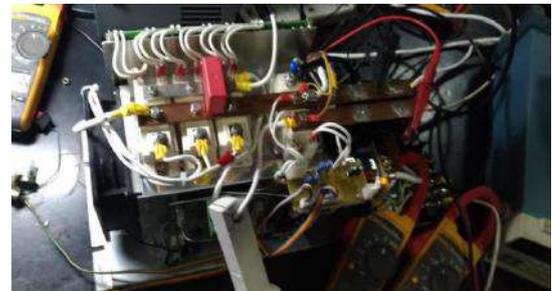


Fig. 13: Experimental setup of the FLVSI Inverter.

V. CONCLUSIONS

We thereby present a simple design methodology for power inverters and a working prototype with perspective to contribute to the development of Brazilian regulations regarding solar inverters above 10 kW and hybrid on-grid/off-grid systems.

In order to certify distributed generation equipment, it is necessary to submit them to the tests specified by [13], not designed specifically for hybrid inverters. Regulations also do not require certification of inverters above 10 kW.

We hope that our development will contribute to develop certification processes in Brazil regarding applied technologies.

[13] In Portuguese: INMETRO Ordinance No. 357/2014, "PortariaInmetro nº357, de 01 de agosto de 2014," www.inmetro.gov.br, Aug. 2014.

ACKNOWLEDGEMENTS

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Piezoelectricity in gadolinium ferrite: A computational study

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Abstract— Douglas-Koll-Hess (DKH) second-order relativistic scalar approach was used to investigate piezoelectricity in gadolinium ferrite ($GdFeO_3$). To adequately represent the polyatomic environment studied – ($24s13p$), ($29s17p12d$) and ($32s22p16d10f$)– basis sets were built for the atoms O (3P), Fe (5D), and Gd (9D), then contracted to [$4s2p$], [$12s6p5d$], and [$19s12p8d4f$], respectively. The qualifying of the contracted basis sets for $GdFeO_3$ crystal studies was conducted in three moments, namely: quality evaluation in molecular calculations, made in $^1FeO^{1+}$ and $^1GdO^{1+}$ molecular fragments; the choice of polarization function used in the [$4s2p$] basis set for O (3P) atom; the choice of diffuse functions used in the [$12s6p5d$] and [$19s12p8d4f$] basis sets for Fe (5D) and Gd (9D) atoms, respectively. The qualified contracted basis sets gave rise to the molecular [$4s2p1d$]/[$13s7p6$]/[$20s13p9d5f$] basis set which was then used to describe geometric parameters of the $GdFeO_3$ crystal. The good performance of the [$4s2p1d$]/[$13s7p6$]/[$20s13p9d5f$] basis set in describing the geometry of the material of interest led to calculations of the material properties: total relativistic energy, dipole moment and total atomic charge. The analysis of the results for these properties showed that the possible piezoelectricity in $GdFeO_3$ can be caused by electrostatic interactions of its atoms.

Keywords— Piezoelectricity, Gadolinium ferrite, Qualified basis sets, Computational study, Perovskite.

I. INTRODUCTION

Since the discovery of the piezoelectric effect on Barium Titanate ($BaTiO_3$) ceramics by Roberts in 1947 [1], a large number of perovskite oxides presenting this property have been obtained. Perovskites are of great interest in materials science because they are relatively simple crystalline structures and exhibit many properties such as electrical, magnetic, optical, and catalytic properties among others [2-7].

Certain crystalline materials have the ability to develop an electric charge proportional to a mechanical stress called piezoelectricity. It has been realized that materials showing this phenomenon must also show the converse, a geometric strain (deformation) proportional to an applied voltage [8].

The perovskite structure is a network of corner linked oxygen octahedra, with the smaller cations filling the octahedral holes and the large cations filling the dodecahedral holes [9]. The piezoelectric properties in perovskite structure result from uncentrosymmetric characteristics [10].

We have reported in the literature computational investigations on piezoelectric properties in perovskites. In these studies, the importance of the set of atomic bases developed exclusively to adequately represent the polyatomic environment has been pointed out [11, 12]. The details of this subject can be found elsewhere [13].

Results from the theory can help experimentalists better design their experiments to rationalize the use of time and resources to study a system under investigation.

[4s2p] basis set for O (3P) atom. It was extracted from de primitive basis set. The adequate exponent was chosen through successive calculations for $GdFeO_3$ by using different primitive functions, taking into account the minimum energy criterion at DKH second-order scalar relativistic level. The polarization function obtained by this strategy is $\alpha_d = 0.396928$.

In order to describe the configuration of a metal in a polyatomic system it is necessary to include diffuse functions in the basis set for the metal. The configurations of the metals in $GdFeO_3$ were adequately described by adding a function by symmetry to the basis set of each metal atom. The diffuse functions obtained through the total energy optimization of the ground state anions Fe^{1-} and Gd^{1-} by GCHF method. For the 12s6p5d and 19s12p8d4f basis sets, the diffuse functions are: $\alpha_s = 0.0145512$; $\alpha_p = 0.115324$; $\alpha_d = 0.0538269$ and $\alpha_s = 0.00873780$; $\alpha_p = 0.0617874$; $\alpha_d = 0.262367$; $\alpha_f = 0.118836$, respectively.

In this work, atomic calculations (contraction of the basis sets and choice of diffuse functions) were performed with the ATOMSCF program [21], while calculations with molecular systems were carried out with the Gaussian program [22].

III. RESULTS AND DISCUSSION

Before starting the presentation and discussion of the results obtained in the investigation of piezoelectricity in $GdFeO_3$, objective of this work, it is important to note some considerations about the fragment model that was used in the representation of the crystalline system under study.

Fig. 1 shows the fragments we have used as a model to simulate the conditions necessary to the existence of piezoelectricity in ABO_3 perovskites [11, 12, 23, 24]. In Fig. 1 (A); (a) represents the $[GdFeO_3]_2$ fragment having the Fe atoms fixed in the space; (b) represents the $[GdFeO_3]_2$ fragment in which the Fe atoms are being moved $+0.005 \text{ \AA}$ in the symmetry X axis, while the Gd and O atoms are maintained fixed; (c) represents the $[GdFeO_3]_2$ fragment in which the Fe atoms are moved -0.005 \AA in the symmetry X axis and Gd and O atoms are maintained fixed. Fig. 1 (B) represents the $[GdFeO_3]_2$ fragment having the bond lengths $r(Fe_1O_3)$, $r(Fe_1O_4)$, $r(Fe_2O_4)$ shortened in 0.005 \AA . The same fragment model was used in the study developed with $SmTiO_3$ [11], $YFeO_3$ [12], $BaTiO_3$ [23] and also in investigations with $LaFeO_3$ [24]. In this report, the model represents the crystalline 3D periodic $GdFeO_3$ system. The Fe atom is located in the center of the

octahedron, being wrapped up by six O atoms arranged in the reticular plane (200) and two Gd atoms arranged in the reticular plane (100).

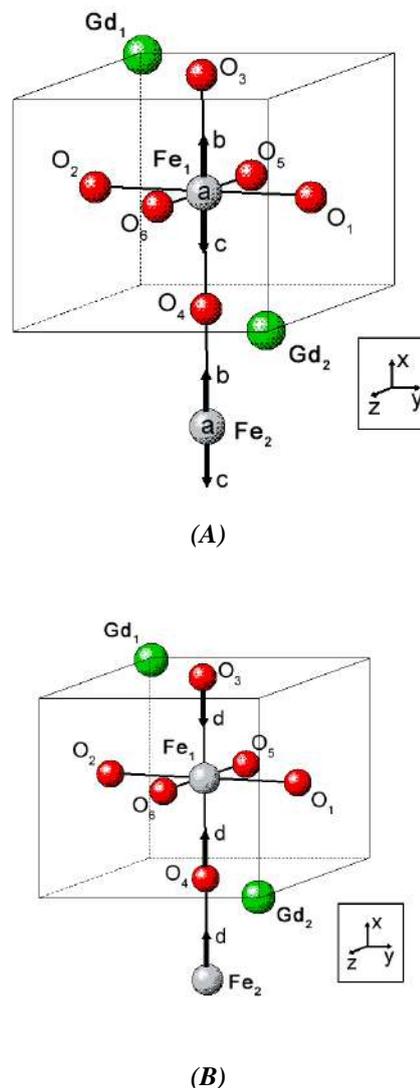


Fig. 1. The octahedral $[GdFeO_3]_2$ fragment. (A): (a) represents the $[GdFeO_3]_2$ fragment having the Fe atoms fixed in the space; (b) represents the $[GdFeO_3]_2$ fragment in which the Fe atoms are being moved $+0.005 \text{ \AA}$ in the symmetry X axis, while the Gd and O atoms are maintained fixed; (c) represents the $[GdFeO_3]_2$ fragment in which the Fe atoms are moved -0.005 \AA symmetry X axis and Gd and O atoms are maintained fixed; (B): represents the $[GdFeO_3]_2$ fragment having the bond lengths $r(Fe_1O_3)$, $r(Fe_1O_4)$, and $r(Fe_2O_4)$ shortened from 0.005 \AA

It is important to note that in order to study the crystalline 3D periodic $GdFeO_3$ system it is necessary to choose a fragment, a molecular model, capable of adequately represent the physical property of the crystalline system as whole.

We still would like to point out three very important strategic aspects in our theoretical approach in the study of gadolinium ferrite piezoelectricity, namely:(i) Firstly, we consider that the piezoelectric properties in GdFeO₃ result from uncentrosymmetric characteristics presented by central ion and the probable polarization of the crystal when submitted to mechanical stress.(ii) Secondly, the geometry optimization of the [GdFeO₃]₂ fragment in the C_s symmetry and electronic state ¹A' was carried out. (iii) Finally, single-point calculations were performed with the optimized geometry, according to the descriptions shown in Fig.1, and their results were analyzed from the point of view of strategy (i).

We will now return to the presentation and discussion of the results obtained in this study with the

Table 2. Theoretical and experimental bond length (Å) for ¹FeO¹⁺ and ¹GdO¹⁺ molecular fragments

Molecular fragment	Bond length		
	Theoretical	Experimental [25]	Δr
r(¹ FeO ¹⁺)	1.9063	1.9495	4.32 x 10 ⁻²
r(¹ GdO ¹⁺)	2.1852	2.2652	8.00 x 10 ⁻²

Δr = |Theoretical – Experimental|

TABLE 3 presents the dipole moment and the TER energy of the [GdFeO₃]₂ fragment. It can be seen from this table that the result with Fe³⁺ central ion at (b) or (c) is 0.014 and 0.35 hartree, respectively, more stable than at (a), pointing out that the Fe³⁺ central ion is not centrosymmetric. This evidence is confirmed by the decrease in dipole moment at positions (b) and (c) when compared to the Fe³⁺ central ion position at (a). In addition, the table also shows that the

Table 3. Dipole moment (D) e TER (hartree) of the [GdFeO₃]₂ fragment

Fe atom position	μ _x	μ _y	μ _z	μ	TRE
(a)	-0.25	4.19	2.08	7.61	-24609.25295
(b)	-0.613	-1.86	1.87	7.46	-24609.26693
(c)	-2.04	0.718	0.0311	2.16	-24609.60649
(d)	2.99	3.51	1.14	4.75	-24609.66129

TABLE 4 shows the total atomic charges of the [GdFeO₃]₂ fragment when Fe³⁺ central ion is at positions (a), (b), and (c), and for the shortened r(Fe₁O₃), r(Fe₁O₄), and r(Fe₂O₄) bond lengths, position (d). In this table, when the Fe³⁺ ion central is moved to position (b), atomic charges migrate from the Fe₂, Gd₁, and Gd₂ atoms to the O₂, O₃, O₄, O₅, and O₆ atoms. On the other hand, when the Fe³⁺ central ion is moved to position (c), a migration of atomic charges from

perovskite GdFeO₃. Initially, we would like to highlight the comparison of calculated and experimental bond length (r) values [25] and then examine the quality of the contracted basis set supplemented with polarization function and diffuse functions, [4s2p1d]/[13s7p6d]/[20s13p9d5f], in describing the geometry of the system under investigation. In TABLE 2, we show and compare results for r(¹FeO¹⁺) and r(¹GdO¹⁺). In this table, the theoretical results reproduce very well the experimental values with differences (Δr) of 4.32 x 10⁻² Å and 8.00 x 10⁻² Å, respectively, showing the good performance of the molecular [4s2p1d]/[13s7p6d]/[20s13p9d5f] basis set in the description of the geometry of the [GdFeO₃]₂ fragment studied.

decrease in r(Fe₁O₃), r(Fe₁O₄), and r(Fe₂O₄) bond lengths, the calculations at the atomic position (d), provoke a migration of atomic charges among the atoms of the [GdFeO₃]₂ fragment and, consequently, a decrease of the dipole moment. These results suggest that there is a probable polarization of the GdFeO₃ crystal when submitted to mechanical stress.

the Fe₂, Gd₁, and Gd₂ atoms to the O₂, O₃, O₅, and O₆ atoms also occurs. Shortened r(Fe₁O₃), r(Fe₁O₄), and r(Fe₂O₄) bond lengths, position (d) provoke a charge migration from the Fe₂, Gd₁, and Gd₂ atoms to the O₂, O₅, and O₆ atoms. We can notice that, according to TABLE 4, the oscillation of the Fe³⁺ central ion and the shortening of the bond lengths caused by mechanical stress provokes a rearrangement of the total charges on atoms compared with

the position (*a*) of the $[\text{GdFeO}_3]_2$ fragment. The rearrangement of the charges at (*d*) as well as the decrease of the dipole moment can lead us to suppose that the decrease of $r(\text{Fe}_1\text{O}_3)$, $r(\text{Fe}_1\text{O}_4)$, and $r(\text{Fe}_2\text{O}_4)$ bond lengths provokes a polarization of the $[\text{GdFeO}_3]_2$ fragment. We can also report that the electron density does not change significantly at atomic positions (*b*) and (*c*) – the Fe^{3+} central ion is deviated from the main axis of X symmetry – when compared with the atomic position (*a*). This is an indication that the nature of Fe-O and Gd-O chemical bonds does not change when the Fe^{3+} central ion deviates from the X symmetry of the $[\text{GdFeO}_3]_2$ fragment. At (*d*) position, the decrease of the $r(\text{Fe}_1\text{O}_3)$, $r(\text{Fe}_1\text{O}_4)$, and $r(\text{Fe}_2\text{O}_4)$ bond lengths provokes the deviation of electronic density in the $[\text{GdFeO}_3]_2$ fragment, indicating the nature of the Fe-O and Gd-O chemical bonds was altered.

Table 4. Total atomic charges from $[\text{GdFeO}_3]_2$ fragment

Atom	Atom position			
	(a)	(b)	(c)	(d)
Fe_1	1.60	1.57	1.49	1.48
Fe_2	0.339	0.551	0.571	0.584
Gd_1	1.32	1.68	1.41	1.42
Gd_2	1.21	1.38	1.39	1.43
O_1	-1.06	-0.652	-0.974	-0.979
O_2	-1.32	-1.34	-1.49	-1.49
O_3	-0.247	-0.267	-0.284	-0.168
O_4	-0.416	-0.779	-0.122	-0.359
O_5	-0.968	-0.973	-0.984	-0.97
O_6	-0.864	-0.870	-0.953	-0.949

Thus, we can notice that electrostatic interactions play an important role in the constitution of the electronic structure of the $[\text{GdFeO}_3]_2$ fragment. This is consistent for two reasons, namely: (1) due to the repulsive effect of d and f electrons in both high-spin and low-spin octahedral species of ML complexes (M=metal and L=ligand), all d and f electrons density will repel the bonding electrons density [26]; (2) in lanthanide complexes, chemical bonds of ionic nature predominate [27].

Analysis of the oscillation of the Fe^{3+} central ion between the positions (*b*) and (*c*), and the shortening of the $r(\text{Fe}_1\text{O}_3)$, $r(\text{Fe}_1\text{O}_4)$, and $r(\text{Fe}_2\text{O}_4)$ bond lengths in the $[\text{GdFeO}_3]_2$ fragment, position (*d*), showed that the occurrence of the uncentrosymmetrical-centered cation (Fe^{3+}) and the polarization of the $[\text{GdFeO}_3]_2$ fragment produce an electric current, leading us

to infer in this work evidence that GdFeO_3 may present piezoelectricity caused by electrostatic interactions of its atoms.

IV. CONCLUDING REMARKS

The use of DKH second-order scalar relativistic approach together with qualified basis sets to represent the GdFeO_3 polyatomic system allowed the simulation of the conditions necessary for the existence of piezoelectricity in this material. The calculated properties allow us to infer that:

1. The Fe^{3+} central ion in the $[\text{GdFeO}_3]_2$ fragment has uncentrosymmetrical characteristics. In addition, when submitted to mechanical stress, the $[\text{GdFeO}_3]_2$ fragment presents polarization, which leads us to suggest the existence of piezoelectricity in GdFeO_3 , caused by electrostatic interactions.

2. The results of the computational investigation presented in this work, punctuating the possible piezoelectricity in GdFeO_3 through the use of the fragment model used to investigate this property in BaTiO_3 , LaTiO_3 , and SmTiO_3 corroborate the viability of the model and methodology to investigate possible piezoelectricity in other ABO_3 perovskites.

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Characterization of solid waste from the beaches of Itapuã, Stella Maris and Flamengo in Salvador/Bahia/Brazil

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Abstract—*The disposal of solid waste in the sand strips of the beaches tends to cause environmental, social, economic and public security damages. This can lead to risks of contamination by infectious diseases and a demotivating look at the natural wealth of the marine environment. In this way, this work aimed to characterize the solid residues of the beaches of Itapuã, Stella Maris and Praia of Flamengo, aiming to provide subsidies for Environmental Education campaigns, in order to sensitize the population. This research is of qualitative and quantitative nature, being also exploratory and of field. The survey results indicated that the most representative classes found on the three study beaches were plastic and wood, followed by non-recyclable waste. The cigarette filters were classified as not recycled and were expressive in numbers of the category in quantity in the three beaches. In this way, the significant amount of solid waste on Itapuã beach can be attributed to its geographical location with easy accessibility to its regulars and traders, in addition to the quality of the water for bathing, low level of turbidity of the waters and small height of waves.*

Keywords—*Beaches, Environmental education, Solid waste.*

I. INTRODUCTION

The Brazilian coastal zone comprises a strip of 8,698 km in length and variable width facing the Atlantic Ocean (ACUÑA, 2017), while the city of Salvador comprises a coastal zone with a strip of 50 km in length and 23 beautiful bathed beaches through the waters of Todos Santos Bay (DUTRA, 2008 apud FREITAS, 2016).

However, the environmental quality of these beaches after use is threatened due to the disposal of solid waste left by the population (residents, stallholders, bathers, tourists and street vendors) that end up polluting and causing negative impacts to the marine environment and tend to

cause damage of order environmental, social, economic and public security (SANTANA-NETO et al., 2011).

Marine solid waste is of anthropogenic origin introduced by urban drainage, beach users, boats and platforms, being subdivided into classes such as plastic, paper, metal, glass, organic material, wood and non-recyclable waste, and consisting mainly of material little degradable or non-degradable, which inevitably accumulates in the environment can cause major problems (ORTIZ, 2010).

The presence of solid residues found in coastal and marine environments, in addition to polluting the sand and coastal waters, causing the risk of contamination by skin

diseases and other diseases, creates an unpleasant visual effect, diminishing the scenic beauty of the beaches and demotivating the presence of tourists (SOUZA; SILVA, 2015).

This type of pollution can compromise the quality of coastal and marine ecosystems, changing the life of microorganisms and sand microfauna, as well as attracting the presence of disease-transmitting animals, such as rats, pigeons and vultures (SOUZA; SILVA, 2015).

The characterization of solid waste arising from inadequate disposal on the beaches of Itapuã, Stella Maris and Praia do Flamengo, will have socio-environmental relevance, since, after identification, they will provide subsidies for Environmental Education campaigns, in order to raise awareness among the local population (residents and tents) and floating (bathers, tourists and street vendors) of the importance of correct disposal to minimize present and future environmental, social, economic and public safety losses.

In this way, this work aimed to characterize the solid residues of the beaches of Itapuã, Stella Maris and Praia do Flamengo, aiming to provide subsidies for Environmental Education campaigns, in order to raise awareness and make the population sensitive to environmental issues. In this sense, this research is of a qualitative and quantitative nature, being also exploratory and field.

Based on the bibliographic surveys, we can observe the interest of studies carried out by the scientific community on marine solid waste on the beaches of the Northeast, with emphasis on the works carried out by Caldas (2007); Souza; Silva (2015); Santana Neto et al., (2011); Santana Neto (2009); Brito (2014); Barros et al., (2012); Santiago

et al., (2012); Araújo (2003); Lime; Silva (2016), Silva et al., (2009), and others in the southeast region by Santos; Bonetti (2018); Martins et al., (2010); Leite et al., (2011); Ferreira; Ramires (2017); Fernandinho (2012); Farias (2014); Ortiz (2010); Neves et al., (2011); Silva et al., (2018); Bruno; Santos (2012).

Thus, the results found indicate that the most representative classes found in the three study beaches were plastic and wood, followed by non-recyclable waste. Cigarette filters were classified in the non-recycled class and were expressive in numbers of the category in quantity in the three beaches.

Therefore, the expressive amount of solid waste on the beach of Itapuã is attributed to its geographical location in the capital of Bahia with easy accessibility to its regulars and traders, in addition to the quality of the water for bathing, low level of turbidity of the water and small height of waves. Furthermore, the high levels of the plastic waste class, such as disposable cups, straws and their packaging, the non-recyclable waste class, such as cigarette filters, and the wood class, such as barbecue and popsicle sticks, are associated with products frequently sold on the beaches by street vendors.

II. MATERIALS AND METHODS

2.1 STUDY AREA

This study was carried out on the beaches of Itapuã with Latitude: 12 ° 57'2.86 "S and Longitude 38 ° 22'0.86" O; Stella Maris with Latitude 12 ° 56'52.40 "S and Longitude 38 ° 20'23.34" O and beach of Flamengo with Latitude: 12 ° 55'18.97 "S and Longitude: 38 ° 18'45.84" O (Fig. 1).



Fig.1: Location of beaches and collection points

Source: Jambeiro (2019)

2.2 SAMPLING

The collections took place in February 2019 on the beaches of Itapuã (Fig. 2), then the beach of Stella Maris and ending on the beach of Flamengo, obeying a 3-hour workload during the day shift through the scanning method at foot parallel to the sea line, covering a certain area of the beach around 1 km from each one, allowing better displacement and visualization of the solid residues found (MARIANO, 2000 apud CALDAS, 2007).



Fig.2: Collection of solid waste in February 2019 at beach of Itapuã, Salvador/BA.

Source: Jambeiro (2019)

The collected residues were separated and qualified and qualified in loco (Fig. 3) using the collection form, being subdivided into classes such as plastic, paper, metal, glass, organic matter, wood and non-recyclable waste

according to CONAMA Resolution No. 275, of April 25, 2001. That resolution establishes the color code for the different types of waste to be adopted in the identification by collectors and transporters, as well as in information campaigns for selective collection. After this qualification process, the residues were quantified by units in each class, which were again bagged and transported for weighing and ending with the appropriate destination.



Fig.3: qualification of waste in loco at Itapuã beach, Salvador/BA.

Source: Jambeiro (2019)

III. RESULTS AND DISCUSSIONS

A total of 4,840 kg were collected, with a greater amount of solid waste found on Itapuã beach with 2,820 kg (58,26%), followed by Stella Maris beach 1,820 kg (24,38%) and Flamengo beach 0,840g (17 , 2%) (Table 1, 2 and 3).

Table 1: Classification and quantification of solid waste collected at Itapuã beach, Salvador, BA, Feb. 2019

BEACH	CLASS	WASTE	AMOUNT	TOTAL WEIGHT	% WEIGHT
ITAPUÃ	PLASTIC	PET BOTTLE COVER	45	2,82 Kg	58,26
		PLASTIC CUP	56		
		CANUDES	49		
		CUTLERY	33		
		LOLLIPOP STICKS	6		
		BAGS	4		
		PICOLE PACKING	13		
		BRASS	3		
		CHICLET PACKING	8		
	FRAGMENTS	48			
	TOTAL PLASTIC		265		

	METAL	BEER SEALS	9		
		BEER COVERS	17		
		BEER PROTECTOR SEAL	77		
		DANONE PACKING	1		
		FRAGMENTS	1		
	TOTAL METAL		105		
	WOOD	BARBECUE STICK	126		
		POPSICLE STICK	148		
		CLOTHING PREACHER	1		
	TOTAL WOOD		275		
	ORGANICS	REST OF FOOD (BONES)	1		
	TOTAL ORGANICS		1		
		CIGARETTE PORTFOLIO	1		
	NON-RECYCLABLE WASTE	CIGARETTE FILTER	63		
		BLOWING BALL	3		
	CONDOM	1			
	ISOPOR FRAGMENT	1			
TOTAL NON-RECYCLABLE		69			

Source: Jambeiro (2019)

Table 2: Classification and quantification of solid waste collected at Stella Maris beach, Salvador/BA, Feb. 2019

BEACH	CLASS	WASTE	AMONT	TOTAL WEIGHT	% WEIGHT
STELLA MARIS	PLASTIC	PET BOTTLE COVER	17	1,18 Kg	24,38
		PLASTIC CUP	15		
		CANUDES	29		
		CUTLERY	11		
		LOLLIPOP STICKS	6		
		BAGS	3		
		PICOLE PACKING	5		
		BULLET PACKING	5		
		BEER PACKING	8		
		CANUDO PACKING	33		
		MINERAL WATER LABEL	1		

		FRAGMENTS	34		
		PET BOTTLE COVER	17		
	TOTAL PLÁSTIC		161		
	PAPER	FLYERS	3		
		NAPKIN	14		
		PACKING OF PEANUTS	5		
		FRAGMENTS	5		
	TOTAL PAPER		27		
	METAL	BEER SEALS	7		
		BEER COVERS	11		
		BEER PROTECTOR SEAL	21		
		FRAGMENTS	1		
	TOTAL METAL		40		
	WOOD	BARBECUE STICK	19		
		POPSICLE STICK	28		
		CHAMPAGNE STOPPER	1		
		CLOTHING PREACHER	1		
		TOOTHPICK	1		
	TOTAL WOOD		50		
	ORGÂNICS	REST OF FOOD (BONES)	2		
	TOTAL ORGANIC		2		
	NON-RECYCLABLE WASTE	PORTIFOLIO CIGARETTE	1		
		CIGARETTE FILTER	157		
		MONEY RUBBER	1		
		ISOPOR MARMITEX	1		
	TOTAL NON-RECYCLABLE		160		

Source: Jambeiro (2019)

Table 3: Classification and quantification of solid waste collected at Flamengo beach, Salvador, BA, Feb. 2019

BEACH	CLASS	WASTE	AMONT	TOTAL WEIGHT	% WEIGHT
FLAMENGO	PLASTIC	PET BOTTLE COVER	3	0,84 g	17,2
		PLASTIC CUP	28		
		CANUDES	18		
		CUTLERY	2		

		BAGS	5		
		PICOLE PACKING	5		
		PACKAGE OF SNACKS	1		
		CANUDO PACKING	12		
		REFRIGERANT LABEL	2		
		FRAGMENTS	5		
	TOTAL PLASTIC		81		
	PAPER	NAPKIN	12		
		BEER LABEL	4		
		PAPER FRAGMENTS	10		
	TOTAL PAPER		26		
	METAL	BEER COVERS	11		
		FRAGMENTS	1		
	TOTAL METAL		12		
	WOOD	BARBECUE STICK	7		
		POPSICLE STICK	8		
		CHAMPAGNE STOPPER	1		
	TOTAL WOOD		13		
	ORGANICS	FLOWER	1		
	TOTAL ORGANIC		1		
	NON-RECYCLÁBLE WASTE	CIGARETTE FILTER	32		
		ISOPOR MARMITEX	3		
		TISSUE FRAGMENTS	2		
	TOTAL NON- RECYCLÁBLE		37		
	Source: Jambeiro (2019)				

The results obtained show a high value of solid residues present at Itapuã beach (715 units), followed by Stella Maris (440 units) and beach of Flamengo (170 units) (Fig. 4). This high value of urban waste collected on the beach of Itapuã may be related because it is in an urbanized environment with houses, inns, hotels, restaurants and beach huts and many street vendors on the sand strip, facilitating the availability of public transportation on site.

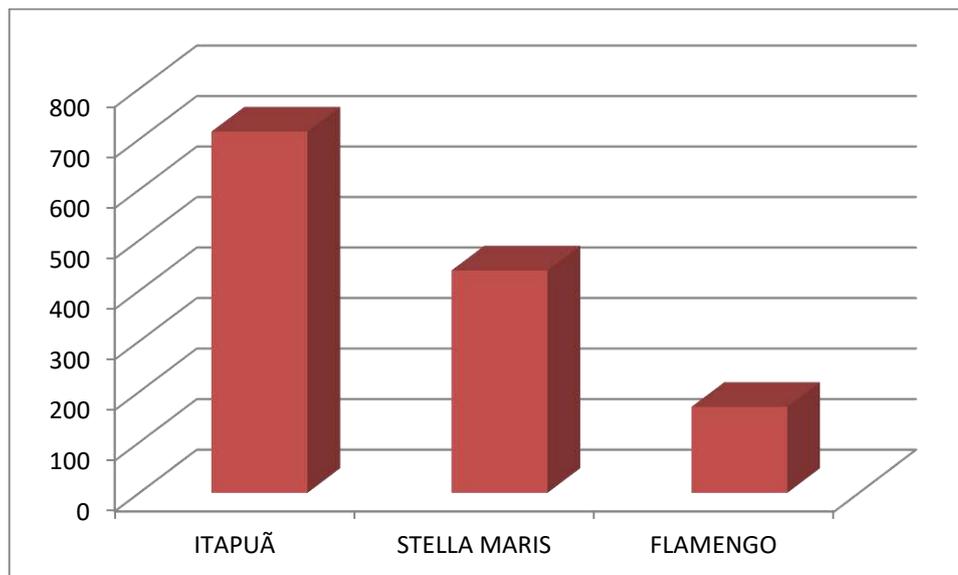


Fig.4: General quantity in units of waste collected on the beaches in Salvador , BA, Feb. 2019

Source: Jambeiro (2019)

Another important and positive fact was highlighted in the work developed by Silva et al., (2009), which are the characteristics of the coastal zone that Itapuã beach presents as the good quality of the water for bathing, low level of turbidity of the waters and small height of waves. On the other hand, the Urban Cleaning Company - LIMPURB also responsible for coordinating the cleaning and ordering teams on the coastal strip in Salvador listed Itapuã beach in 2017 as one of the beaches where the

greatest amount of solid waste is usually removed in the month of February.

As for the classes: plastic, paper, metal, glass, organic matter, wood and non-recyclable waste, plastic stands out as the most representative with 507 units, followed by wood with 388 units, non-recyclable with 266 units and metals with 157 , the other classes such as paper and organics collected were represented by numbers below 100 units (Fig. 4).

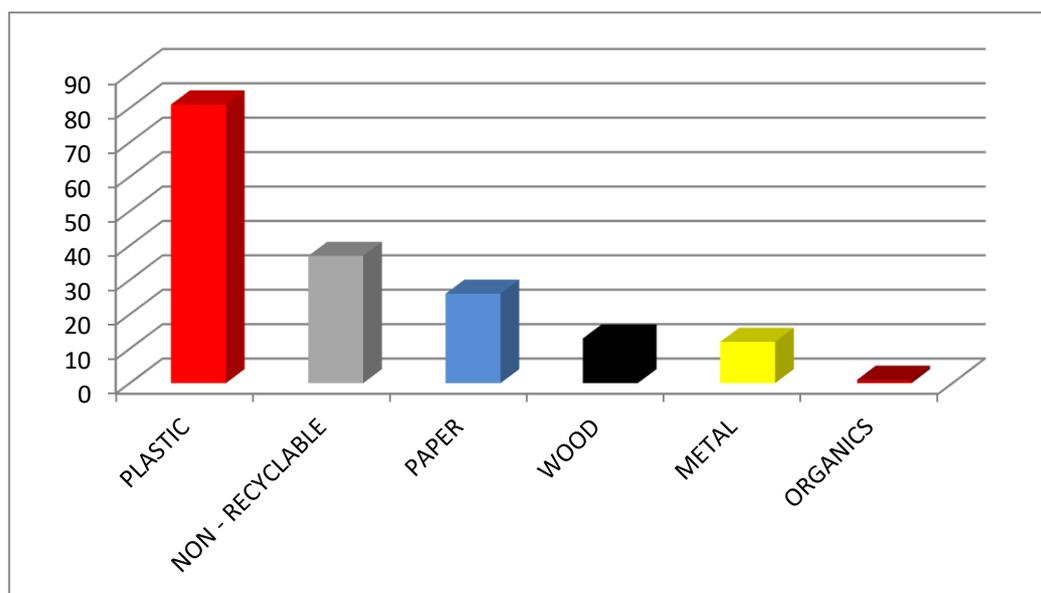


Fig.4: General graph of waste classified by classes collected on the beaches of Itapuã, Stella Maris and Flamengo, Salvador , BA, Feb. 2019

Source: Jambeiro (2019)

Plastic and wood residues, followed by non-recyclable residues, were found in greater quantities, similar to the works carried out by Caldas (2007); Santana Neto (2009) and Brito (2014) also on the beaches of Salvador - BA.

Among the classes of waste characterized as glass, it was the only class not found on the three beaches, corroborating the similarity of the work of Cerqueira (2015) carried out on the beach of Itapuã, Salvador - BA.

Waste of the non-recyclable class totaling 266 units collected, with 252 units being cigarette filters, which correspond to 94.73% collected. The large quantity of cigarette filters was also cited in the works carried out by Santos and Bonetti (2018) in São Paulo on the beach of Guaratuba and, in Salvador, on the beach of Porto de Barra, authored by Santana Neto (2009).

IV. CONCLUSION

The results obtained indicate that the beaches have high tourist and recreational potential due to the easy access to several communities in Salvador, metropolitan region and proximity to the International Airport of the capital and, therefore, a tourist attraction in which factors that collaborate in the significant quantification of waste and in diversification as to their classes. Therefore, visitors to the three beaches studied have a behavior in which, after use, they do not collect the waste generated, disregarding the care with the preservation of the environment.

Thus, the high levels of the class of plastic waste such as disposable cups, straws and their packaging, the class of non-recyclable waste such as cigarette filters and the wooden class such as barbecue and popsicle sticks are associated with products often sold on the beaches. by street vendors. Among the most commonly found materials associated with human consumption are cigarette filters (252 units), popsicle sticks (184 units), barbecue sticks (152 units), disposable cups (99 units), straws (96 units) and lids. pet bottle (65 units).

Given the above, it is necessary to intensify awareness campaigns with the support of the principles of environmental education in neighborhoods and streets close to the beaches through frequent dialogues with the local population (residents and tent workers) and floating (bathers, tourists and street vendors). Other tools would be easily accessible advertising campaigns and social media as technological resources showing the importance of not generating waste, conscious consumption and correct disposal of products consumed on the beaches.

In addition to the participation of the population, it is also of fundamental importance to take as a starting point

the actions promoted by public management in the management and correct disposal of waste collected in the capital of Bahia, especially on the seafront, since activities aimed only at cleaning the place do not has guaranteed the partnership with the employees of the recycling services of the collected products.

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Analysis of the Effectiveness of Different Endodontic Irrigation Techniques in Smear Layer Removal: Literature Review

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Abstract— One of the main objectives of endodontic treatment is the decontamination of root canal systems. The removal of the smear layer is important, as it acts as a barrier, interfering in the diffusion of antimicrobial agents and in the adequacy between the filling materials and the canal walls. In this way, different irrigation techniques and devices have emerged to increase chemical disinfection and improve cleaning after mechanical instrumentation. The main objective of the present study was to analyze the effectiveness of different endodontic irrigation techniques in removing smear layer. As an inclusion criterion, articles from the PubMed and Google Scholar database were used. In PubMed, 397 articles were found, 10 were selected and in Google Scholar, 857 articles were found, 11 of which were selected for the research. Thus, a final sample of 21 articles inserted in the work was obtained. It is concluded that all endodontic irrigation techniques removed more smear layer compared to conventional irrigation, but none was able to remove it entirely. Further laboratory and clinical studies are needed to prove the effectiveness of removing this layer with the standardization of clinical protocol.

Keywords— Irrigation Technique, Endodontics, Smear Layer.

I. INTRODUCTION

One of the main objectives of endodontic treatment is the decontamination of root canal systems (SCR), to reestablish the function of the tooth instead of opting for its extraction. Disinfection is done through the use of manual and mechanical instruments with the association of irrigating solutions (URBAN et al., 2017).

Along the chemical - mechanical preparation of the root canal system, an amorphous and irregular layer is formed on the root canal wall (CR), known as the smear layer. The smear layer is composed of organic and inorganic substances originating from dentin, odontoblastic processes, necrotic dentrites and microorganisms, together with their metabolic products (AHUJA et al., 2014; YILMAZ et al., 2017). This smear layer can retain bacteria inside the dentinal tubules, act as a barrier against disinfectant agents and interfere with the adhesion of the filling materials. Therefore, it must be removed due to its potential for contamination and to enhance the effect of irrigants and medicines (PRADO et al., 2016).

Irrigation becomes an essential complement to the success of the treatment, as it has several important functions, which may vary according to the solutions used: it reduces the friction between the instrument and the dentin, improves the efficiency of cutting files, dissolves the tissues in addition, it has a washing effect and an antimicrobial/antibiofilm effect (HAAPASALO et al., 2014).

Among the various options, sodium hypochlorite (NaOCL) is the most used at the present time and the closest to being an ideal solution, in association with ethylenediaminetetraacetic acid (EDTA) (HARGREAVES; COHEN, 2011).

The conventional irrigation method, using a syringe and needle, has not proved to be sufficiently sufficient to clean the inaccessible areas of the SCR. In this way, different irrigation techniques and devices have emerged to increase chemical disinfection and improve cleaning after mechanical instrumentation, such as manual dynamic activation (MDA), passive ultrasonic irrigation (PUI), sonic activation system with the EndoActivator device ,

apical irrigation by negative pressure (ANP) with the EndoVac device, among others (AHUJA et al., 2014; SCHMIDT et al., 2015; YILMAZ et al., 2017; URBAN et al., 2017).

Therefore, the present study intends, through the literature review, to analyze the effectiveness of different irrigation techniques in removing the smear layer

II. MATERIALS AND METHODS

In order to produce a literature review, the research was carried out in databases such as Pubmed (Medical Publications) and Google Scholar. The articles were attached in different folders by the name of the database.

In PubMed the keywords (irrigation techniques, endodontics and smear layer) were used, where 397 articles were found being selected 10. In Google Scholar the keywords were used (irrigation technique, irrigation solution and smear layer), where 857 articles were found and 11 were selected.

As an inclusion criterion, a scientific article and books were included that contained the keywords delimited from the year 2005 until the year 2020.

III. RESULTS AND DISCUSSION

To extract data from the main references included in the review based on the level of evidence (systematic review), we used a research instrument containing the identification of the article, the objectives, the methodological characteristics, results and the conclusions of the authors. The summary is shown in table 1.

During the endodontic treatment through instrumentation, a smear layer is formed, which consists of organic and inorganic substances, including fragments of odontoblastic processes, microorganisms, their by-products and necrotic materials (SABER; HASHEM, 2011; YILMAZ et al., 2017).

According to the authors of the research, it is important to remove the smear layer, as this layer can form a barrier and promote the invasion of bacteria in the dentinal tubules. Therefore, its removal will promote greater contact and action of irrigating substances, allow greater penetration and action of intrachannel medications and also promote a better seal between dentin and filling material (ODA et al., 2016; PRADO et al., 2016; URBAN et al., 2017; YILMAZ et al., 2017; SCHIAVOTELO et al., 2017).

In endodontic treatment, instrumentation and irrigation can be considered the most important parts for

the successful treatment of the root canal (HAAPASALO et al., 2014). Irrigation has several functions that vary according to the type of irrigation solution, the most important of which are to dissolve tissues and have an antimicrobial effect. Thus, irrigation is essential to remove the smear layer (AHUJA et al., 2014).

The use of irrigating solutions during biomechanical preparation is important for cleaning and eliminating microorganisms present within the root canal system. There are several types of irrigating solutions, the most used being sodium hypochlorite (NaOCl), chlorhexidine (CHX) and ethylenediaminetetraacetic acid (EDTA) (CÂMARA; ALBUQUERQUE; AGUIAR, 2010).

Sodium hypochlorite has been used for many years as an irrigant due to its action characteristics, such as dissolving organic tissue and having antimicrobial action (GATELLI; BORTOLINE, 2014). In their study, Gatelli and Bortoline (2014) through a literature review concluded that chlorhexidine has been indicated as an alternative to sodium hypochlorite, because unlike sodium hypochlorite it does not dissolve organic tissue, but it has a good antimicrobial activity against Gram-positive and Gram-negative bacteria and its main advantages are biocompatibility and substantivity. EDTA promotes the removal of only the inorganic part of dentin and smear layer and has no significant bactericidal or bacteriostatic activity (CÂMARA; ALBUQUERQUE; AGUIAR, 2010; HAAPASALO et al., 2014). In the study by Bonan, Batista and Hussne (2011) it was confirmed that, like chlorhexidine, sodium hypochlorite is also incapable of remove the smear layer completely, requiring the use of ethylenediaminetetraacetic acid (EDTA) after biomechanical preparation.

However, different irrigation management techniques and devices have been suggested to increase the flow and distribution of irrigation solutions in the root canal system, thereby increasing chemical disinfection and improving cleaning after instrumentation (SABER; HASHEM, 2011; AHUJA et al., 2014).

A few years ago, research sought to compare and evaluate the efficiency of different irrigation activation techniques in removing smear layer (AHUJA et al., 2014; EKIM; ERDEMIR, 2015; RÖDIG et al., 2010; SABER; HASHEM, 2011; SCHIAVOTELO et al., 2017; SCHMIDT et al., 2015; URBAN et al., 2017; YILMAZ et al., 2017), obtaining significantly positive results in relation to new techniques and irrigation management devices.

To assess the removal of the smear layer, the research included in our literature review (AHUJA et al.,

2014; EKIM; ERDEMIR, 2015; RÖDIG et al., 2010; SABER; HASHEM, 2011; SCHIAVOTELO et al., 2017; SCHMIDT et al., 2015; URBAN et al., 2017; UZUNOGLO et al., 2015; YILMAZ et al., 2017) used the Scanning Electron Microscope (SEM). This Scanning Electron Microscope (SEM) is used to identify this layer on the CR walls after endodontic preparation, allowing to obtain detailed images with greater magnification of the dentinal tubules (EKIM; ERDEMIR, 2015).

Conventional irrigation with a syringe and needle remains a widely accepted technique (YILMAZ et al., 2017). However, for some research authors, its effectiveness in removing the smear layer is still questionable (AHUJA et al., 2014; EKIM; ERDEMIR, 2015; PRADO et al., 2016; SABER; HASHEM, 2011).

Saber and Hashem (2011), compare in their research the removal of the smear layer using apical negative pressure (ANP) with the EndoVac device, manual dynamic agitation (MDA) and passive ultrasonic irrigation (PUI) using 2.5% NaOCl and 17% EDTA as irrigating solutions, and according to the data obtained, EndoVac and MDA removed the smear layer better than PUI. A possible explanation for what happened was that both techniques reach full working length of the instrumented channels and, therefore, allow for adequate replacement of the irrigator, which is not possible or recommended with conventional needle irrigation devices or ultrasonic agitation. Ahuja et al. (2014) obtained similar results in their study, in which the EndoVac was more effective in removing smear layer followed by MDA and PUI, also using 2.5% NaOCl and 17% EDTA as irrigators.

The study by Schiavotelo et al., (2017) compared non-activated irrigation, passive ultrasonic irrigation (PUI) and EndoActivator to remove the smear layer using 17% EDTA followed by 2.5% NaOCl as irrigating solutions, found it was found that the EA was more effective in removing the smear layer in the cervical and middle third

of the instrumented root canals compared to the PUI and the non-activated irrigation, however, there was no statistically significant difference in the removal of the smear layer between the techniques of irrigation tested in the apical region. Controversially, Urban et al., (2017) in their study sought to evaluate manual irrigation (MI), EndoActivator (EA), EDDY sonic activation and passive ultrasonic irrigation (PUI) using only 3% NaOCl and obtained the result that all techniques were superior in removing the smear layer compared to manual irrigation, but did not completely remove the smear layer. They also observed that PUI and EDDY performed equally and that both achieved significantly better scores compared to manual irrigation.

When studying a topic, we are often faced with contradictory results. One of the best ways to try to clarify and rely on better quality studies related to the subject. It refers to a type of investigation focused on well-defined issues that aims to identify, select, evaluate and synthesize the relevant evidence that is available (GALVÃO, PEREIRA., 2014). To elucidate the main references included in this literature review, we selected randomized clinical trials using an instrument containing the identification of the article, the objectives, the methodological characteristics, results and the main conclusions of the authors.

According to data obtained from randomized clinical trials on the efficiency of different irrigation activation techniques in removing smear layer (AHUJA et al., 2014; EKIM; ERDEMIR, 2015; SABER; HASHEM, 2011; SCHIAVOTELO et al., 2017; URBAN et al., 2017; UZUNOGLO et al., 2015) allow us to consider that in addition to endodontic irrigation being significantly important, the activation of irrigating solutions is also important, improving its action in removing the smear layer.

Table.1: Summary of the main articles found

Author / periodic / Year	Study Objectives	Research Method	Results and Conclusions
Ahuja et al., Journal Of Dentistry 2014	-Compare the removal of the smear layer after the final irrigation with techniques of negative apical pressure (ANP), manual dynamic agitation (MDA), passive ultrasonic irrigation (PUI) and needle irrigation in curved root canals.	Randomized Clinical Trial	* ANP (EndoVac) showed the greatest efficiency in removing the smear layer. Followed by MDA and PUI, which were not statistically significant. Removing the smear layer was less effective with the NI technique. * EndoVac resulted in better removal of the smear layer in curved root canals when compared to manual dynamic agitation, passive ultrasonic irrigation and needle irrigation.
Ekim, S N A; Erdemir, A Microscopy Research And Technique 2015	- Evaluate the efficiency of different irrigation activation techniques in removing smear layer	Randomized Clinical Trial	* Activation with PUI, ANP, Nd: YAG, Er: YAG and PIPS (Photon-induced photoacoustic streaming) has been shown to be effective in removing the smear layer and ANP is the most efficient technique for removing the smear layer in the apical part of the root canal system
Saber, S E; Hashem, A A R Journal Of Endodontics 2011	-Compare smear layer removal after final irrigation activation with negative apical pressure (ANP), manual dynamic agitation (MDA) and passive ultrasonic irrigation (PUI).	Randomized Clinical Trial	* PI and PUI had the highest smear scores, with no significant differences between them. This was followed by the MDA and, finally, the ANP, which showed the lowest statistically significant mean score. * They concluded that the final activation of the irrigant with ANP and MDA resulted in a better removal of the smear layer than with PUI or PI.
Schiavotelo et al., The Open Dentistry Journal 2017	- Compare the effectiveness of one non-activated irrigation technique and two activated in removing the smear layer after alternative instrumentation of single file in curved root canals.	Randomized Clinical Trial	* No statistically significant difference was found in the effectiveness of irrigation techniques for removing the smear layer for the apical third. * The effectiveness of the EndoActivator system in removing the smear layer in the cervical and middle third of the instrumented root canals with alternating movement was significantly greater than PUI or non-activated irrigation. Both the EA and the PUI had a similar performance in the apical third.

<p>Urban et al., Clinical Oral Investigations 2017</p>	<p>-Evaluate the effectiveness of different final methods of activating irrigation in removing debris and smear layer in the apical, middle and coronal portion of the straight root canals.</p>	<p>Randomized Clinical Trial</p>	<p>* Removing the smear layer with PUI, EA and EDDY was not significantly different, but only EDDY and PUI were superior to IM. * All activation methods created channel walls almost free of debris and were superior in comparison to manual irrigation.</p>
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IV. CONCLUSION

Most of the authors researched in this literature review consider that all techniques had superior results in removing the smear layer compared to conventional irrigation with a syringe and needle. However, none of the techniques was able to completely remove the smear layer from the inside of the root canal. Thus, the following conclusions could be reached:

1. All endodontic irrigation techniques had superior results in smear layer removal compared to conventional syringe and needle irrigation.

2. None of the techniques were able to completely remove the smear layer from the inside of the root canal.

3. It is necessary to standardize the clinical protocol using the same irrigating solutions in the same sequence.

4. Further laboratory and clinical studies are needed to prove the effectiveness of removing the smear layer.

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Strategic Risk Management in Engineering

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Abstract — Risk management theme is broad. The study of risks, although it has been treated more recently, with modern techniques and specific methodologies, as well as analyzes aided by mathematic modeling and predictability resources, became possible with the advent of computing. The concept of risk can be better understood through the ABNT-ISO (2018) standard, which tells us that risk is the effect of uncertainty on the organization's objectives. Engineering risk management must strive for excellence in project management and quality maintenance, in addition to ensuring an environment conducive to the development and improvement of production methods.

Keywords — risk, management, engineering.

I. INTRODUCTION

The study of risks, although it has been treated more recently, with modern techniques and specific methodologies, as well as analyzes aided by mathematic modeling and predictability resources, became possible with the advent of computing. The concept of risk can be better understood through the ABNT-ISO (2018) standard, which tells us that risk is the effect of uncertainty on the organization's objectives.

The engineering projects consider an entire technical and scientific basis to identify, evaluate and control the risks that exist throughout its development and consequently minimize them.

Tavares et al (2001) believes that faced with a multiple and varied set of events that can influence companies, there is an urgent need to know how to decide, in order to choose the best path and to take advantage of what, until now, was a source apprehension and fear.

According to Sánchez (2008), risk is conceptualized as the contextualization of a danger situation, that is, the possibility of the materialization of the danger or an event unwanted occur.

According to ISO 31000: 2018, risk management involves the systematic application of policies, procedures and practices for communication and consultation activities, establishment of context and assessment, treatment, monitoring, critical analysis, registration, and risk reporting.

In the historical context, foreseeing the future was a gift intended only for oracles and diviners who held a monopoly over all human knowledge and had the ability to make predictions about possible future events. However, due to the development capacity of the human being to think, analyze and make his own decisions and responsibilities, assuming the consequences of his acts and attitudes, this prognosis started to be studied in the mathematical and statistical context giving rise to the development of risk perception. (BERNSTEIN, 1997 apud BENTES, 2007)

Stefano et al (2020) believes that the introduction of new technologies created new opportunities, but also increase numbers of variables that need to be evaluated. Due to that, these risks need to be accounted, managed, and treated accordingly to their specificities.

According to Gregório et al (2013), the performance of an organization is closely related to the dominance over its respective processes and activities, its strategic positioning and relationship in the environment where it operates, the adequacy of its products / services to the needs and desires of its customers and other interested parties, the fulfillment of requirements normative and legal, as well as its ability to improve its processes and products / services in a continuous and innovative way.

In a pragmatic approach, understanding risk is associated with statistical study and its use as a science. It is obvious that humanity has always faced different dangers, be it the involuntary risks resulting from catastrophes, earthquakes, volcanic eruptions, hurricanes - whether those associated with wars, the vicissitudes of everyday life or even volunteers, resulting from what we now call "style of life". However, these events were not referred to as risks, but rather referred to as hazards, fatalities, "hazards" or difficulties, not least because the word risk was absent in the vocabulary of the ancient languages. (SPINK, 2001 apud BENTES, 2007)

De Bakker et al. (2010) separate project risk management into two approaches: i) that of assessment, where information about the history of failures and their causes in past experiences is used in checklists or used to assemble the project structure futures and manage their risks; ii) management, which considers the risk management of a particular project.

II. STRATEGIC RISK MANAGEMENT

Risk management aims primarily to promote better conditions in productive environments. Many companies disregard limits to meet the purely financial interests of production. Ruppenthal (2013), defines risk management as a methodology that aims to increase the reliability of an organization with respect to factors related to predicting, prioritizing, and overcoming obstacles to achieve your goals.

According to Silva (2012), risk management will not remove all risks from projects; its main objective is to ensure that risks are managed in the most efficient way. The client and his project manager must recognize that there are certain risks that must be insured by the customer and that obviously should be considered in the project time and cost estimates.

The risks arising from the most diverse projects in the field of engineering will always exist, however it is necessary to know them. For this, evaluation and control

techniques are used, if it is desired to achieve satisfactory results in general terms in the enterprise.

Dinizio e Martins (2020) believes that risk management presupposes a plan capable of enabling the investigation of the risks of the organizational project, beginning for the identification, analysis of specific risks of the design and treatment approaches, as well as for the monitoring, control and monitoring of risks, if defined those responsible updating the plan and how often risks should be reported

Paté-Cornell (2002) explains that risk analysis in engineering is performed for two reasons: to demonstrate that a system is sufficiently secure or to establish priorities in terms of risk management, identifying weaknesses and optimizing allocation of resource.

In civil construction companies, disbelief as to trying to manage something that is unknown and uncertain leads managers to treat risk management as something expensive and unnecessary. (ALMEIDA E MOTA, 2008) For Cooke-Davies (2003), construction companies have a low degree of maturity in risk management, and generally have a resistance to accepting complex risk analysis techniques.

Silva (2012) understands that management is essential for construction, as it acts in the early stages of the project, studying and reflecting what are the strengths and weaknesses of it. Before acting and starting to develop projects it is. It is fundamental to define procedures and action plans, which allow the detection of possible problems and anticipate responses to them.

Souza and Ripper (2009) understand the failures generated in engineering works permeate causes, however still within the scope of the project it is possible to highlight the specification of elements of inadequate designs, lack of compatibility between structure and architecture, specification inadequate materials, insufficient or wrong detailing, unworkable construction details, the lack of standardization of the representations until the sizing errors.

According to Morano (2003), the use of risk analysis techniques in the implementation of construction projects is still incipiently applied in the industry Brazilian construction companies.

It can be said that risk management and quality management are interconnected. Quality Management refers to the process of identifying and managing activities to meet the organization's quality objectives. The main objective of quality management is to achieve

competitiveness by improving quality performance (LEONG et al, 2012; CAGNIN et al, 2015).

To Almeida e Mota (2008), the identified risks need to be explored to be categorized and thus prioritized. This categorization refers mainly to the risk dimension and the objectives affected.

Palomo (2007) states that risk can be measured through the product of probability with the impact related to the risk event and that for this one must discover in addition to the objectives affected, the degree of impact and the likelihood of it occurring.

In view of the great importance of assessing the risks involved in engineering, risk management studies, as well as adequate standardization and use of assessment and control tools can assist managers in the decision making of their enterprise. It can be said that the risk assessment proposes to systematize knowledge and uncertainties about phenomena, processes, activities and systems under analysis, aiming to estimate potential dangers and threats, their causes and consequences, creating conditions to distinguish what is tolerable and acceptable and compare options for decision making (AVEN, 2011; ROSA and TOLEDO, 2015).

The elements “communication and consultation” and “monitoring and critical analysis” are considered agents of continuous action in the risk management process. Communication and consultation involve internal and external stakeholders, aiming to consider their points of view, knowing their objectives through planned involvement (PURDY, 2010; ROSA and TOLEDO, 2015)

Lopes (2015) states that the depth and level of analysis of technological threats will depend on the particularities and specific situations of the evaluation site. Anyway, this stage requires detailed knowledge of the operational and maintenance situation of the equipment and systems, as well as existing safety devices.

It can be said that a series of small and unpredictable failures can lead to the occurrence of catastrophic events. Mainly because complex technologies are found in the industry and demand management practices also with a high level of complexity, the possibility of accidents becomes real and inherent in such industrial activities (PERROW, 1984; LOPES, 2015).

Risk management in engineering must also be concerned with identifying potential areas prone to disasters. Patrícia et al (2014) understands that the characterization of areas susceptible to disasters and the constant registration of occurrences that tell the history of the place, avoiding wrong decisions, is an imposing,

especially given the specific climatic and geomorphological conditions of municipalities and regions, however, most Brazilian municipalities lack banks structured data that includes the history of occurrences, a powerful tool for research and early diagnosis of risks and disasters.

KEZNER (2009) understands that the qualitative analysis methodology applied to risks is commonly used to estimate the severity of uncertainty, probability of occurrence situation and consequences arising from the fact. These analysis outputs are important for structuring a risk analysis and mapping matrix that is essential for the follow-up and monitoring of the project.

III. CONCLUSIONS

Engineering risk management must strive for excellence in project management and quality maintenance, in addition to ensuring an environment conducive to the development and improvement of production methods.

The manager must stick to the results found during the identification and subsequent assessment of risks. Kleindorfer and Saad (2005) understand that prevention is better than cure in the field of risk management. This fact is relevant, mainly because it is linked to the reduction of human and financial losses in engineering, in general.

The main objective of risk assessment is to help understand the factors that lead to the occurrence of a specific risk, while providing information on their impact, in order to avoid them or reduce the effect of their consequences by contingency strategies (ZSIDISIN et al., 2004 apud).

We can say that risk management in the engineering field is associated with investment in strategic and preventive actions. Therefore, companies that are concerned with planning their actions well and adopt efficient management mechanisms are collaborating for the well-being of not only them but also those who depend on them.

It can be said that the risks will always be inserted in the engineering projects and the prevalence of these risks will be associated with the levels of demand and responsibility of the managers. The use of risk identification, assessment and control techniques are important for the achievement of the project and maintenance of minimum acceptance levels, thus guaranteeing safety and quality.

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Comparative Analysis between Ribbed and Steel Deck Slabs

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Abstract—The work which is being presented have as objective compare two slab types that have your use turned to bigger spans. The goal is show up how the steel deck slab, even with low percentual of use, can offer benefits and superior advantages when compared to ribbed slabs, a type of slab that is used on long scale to hit the actual architecting demand, which requires even bigger spans. Besides that, the steel deck slabs can offer rationalized and versatile maintenance, complying with the demand, in view that the constructions are used to search for increasingly rationalized and a low period. The Steel deck utilization tends to grow because of the current interest of have a low-cost production and bigger efficiency. By the way, that system does not have a massified utilization because the current Brazilian cultural panorama majority watches for armed structures and put mixed structures on second plan because of having a predefined concept which they have even bigger cost. The article was based on careful bibliographic research, making it possible to define comparative variables of the two slab systems, ribbed and Steel deck. Analytical verification of the types of slabs studied was carried out. Analyzing the data to enable the description of the construction systems and comparative designs, focusing on methodology, performance, time, and financial scope.

Keywords—Ribbed Slabs. Steel Deck. Reinforced concrete. Comparative analysis.

I. INTRODUCTION

Brazil is one of the largest producers of iron ore in the world, but also a major producer of cement. Costa et al. (2016) points out that the association of concrete with steel bars is called reinforced concrete, widely used in construction in the country. There are also mixed steel-concrete systems in which rolled, bent, or welded steel profiles work together with concrete. In addition to these, there are hybrid structural systems, which are formed by reinforced concrete elements and purely steel or mixed elements of steel and concrete. Although Brazil is part of

the world's largest steel producers, there is a large-scale use of reinforced concrete in civil construction. This is due to a strong cultural burden. Reinforced concrete is the most convenient material for Brazilian circumstances, in view of safety, to be relatively inexpensive and to be undemanding in terms of labor. However, Santos (2008) Apud Espíndola (2015) points out that the hegemony of concrete increased the gap between constructive practice and technical knowledge, disqualifying construction workers.

Structures made purely of reinforced concrete are mostly used in Brazil. The negative aspects that they

present do not suppress their use on a large scale. However, about 70% to 80% of the works could be carried out in mixed steel-concrete systems, for both simple and bold structural systems. In Brazil there are three forms of mixed structures most used, which are mixed beams, mixed slabs, and mixed pillars. These structural elements have been gaining strength, and are being used in several types of constructions, mainly those that have a higher load on the structure, such as buildings and bridges, due to their dimensional accuracy, reduced weight and increased construction speed. (PINHO, 2013).

Whether in metallic structures or in reinforced concrete structures, the slab is an essential element in most buildings, often regardless of its size. In multi-storey buildings or with large spans, slabs are responsible for a high share of concrete consumption. Using solid slabs in the pavements, this portion usually reaches almost two thirds of the total volume of the structure. Therefore, there is a need for the introduction of other types of slabs, which are used to obtain technical, effective solutions that optimize the economic return. (SANTOS, 2015). Architectural evolutions have forced the increase in spans, and the high cost of forms, making massive slabs economically unfavorable, in most cases. Thus, the ribbed slab appears as a direct alternative. However, many other innovations are emerging to achieve this goal with increasing efficiency. Knowing that the ribbed slab is an improvement of the solid slabs, it is noted that they encounter similar problems, such that they, with regard to time and versatility, end up opening space for other methods to be introduced. Steel Deck slabs fill these gaps, because when it comes to speed, aesthetics, and versatility, they outweigh the benefits of ribbed slabs.

From this, the present article aims to make a comparison between two types of slabs, the ribbed ones, composed of reinforced concrete, and the Steel Deck slabs, a mixed slab, which also presents itself as a great alternative to the constant constructive evolutions, due to versatility, simplicity and speed at the construction site.

II. THEORETICAL FRAMEWORK OF SLAB SYSTEMS

The universal concept of slab according to Martins et al. (2018, p.198), is defined by taking the slab as a work of reinforced cement that constitutes a compartment ceiling or floor. This concept denotes great simplification; however, it also imbues great objectivity, accurately translating what is and what a slab is for. In the same sense, he argues that the slabs are structural elements, with two-dimensional behavior, responsible for transmitting the

actions that act on it to the beams or directly to the pillars, in cases of slabs without beams, that is, it is a civil construction work. which serves as a basis for the construction of a ceiling or compartment floor.

2.1 Ribbed Slab Systems

The ribbed slabs (molded in place) have small transverse displacements, in addition to allowing a slightly more rational construction. It is known that the regions of the reinforced concrete elements submitted to bending efforts are almost always cracked, due to the low mechanical tensile strength of the concrete. According to Schwetz (2011, p. 20 and 29), it is for this reason that theories of reinforced concrete neglect the concrete's resistance to traction, attributing only the function of protecting the reinforcement, connecting it to the compressed areas, resistance to compression and to participate in the mechanism of resistance to shear forces and torsional moments.

This type of slab allows the structure's own weight to be reduced by suppressing in the stretched areas of the cross section, part of the concrete, which does not work in a structural way, remaining only a few sections of it, where the reinforcement will be grouped. The stretched regions, with concentrated reinforcement, are called ribs, creating the name ribbed slab.

The reduction of concrete through the hollow space between the ribs or its replacement by lighter materials reduces the consumption of concrete and the slab's own weight, as the volume of the concrete decreases, in addition, there is also an increase in inertia, since the slab has its height increased. However, Schwetz (2011) argues that this is due to the voids existing between the ribs presenting less resistance to torsion, which is the reason why a higher height is needed than the heights of other types of slabs. Furthermore, according to Tenório (2011, p. 5 and 6), this elimination of concrete that occurs below the neutral line, provides a better use of steel and concrete, since the tensile strength is concentrated in the ribs, and the materials of filling has the unique function of replacing concrete, without contributing to strength.

2.2 Steel Deck Slab Systems

A The mixed slab system results from the structural combination of two main elements: the metallic formwork (Steel Deck) and the concrete. The basis of this system is that its elements work together, taking advantage of each one of its best mechanical characteristics. The Steel Deck has a dual function, that of formwork for concreting, during construction and as positive reinforcement of slabs. (METFORM, 2019).

The metal formwork, which is incorporated into the concrete, generally has a trapezoidal or corrugated shape, designed to ensure greater stability of the structure both during construction and after curing the concrete, as shown in Figure 1.

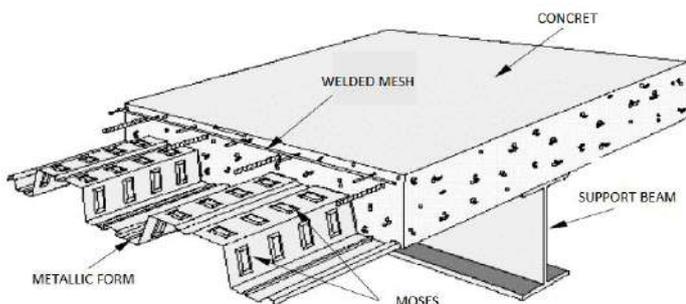


Fig.1: Elements of steel deck slabs

Source: Lemos, 2013, adapted.

In addition, the Steel Deck has wide ribs, allowing the use of Stud Bolts shear connectors, which allows the calculation of mixed beams and reduces the weight of the structure.

2.3 Elements of the structural slab system

The slabs are classified as two-dimensional flat elements, which are those where two dimensions, the length and width, are of the same order of magnitude and much larger than the third dimension, the thickness. They are also called surface elements. Its purpose is to receive most of the actions applied to a construction, usually people, furniture, floors, walls, and the most varied types of cargo that may exist depending on the architectural purpose of the space that the slab is part of. The actions are commonly perpendicular to the slab plane, and can be divided and distributed in the area, linearly distributed or concentrated forces. Although less common, external actions can also occur in the form of bending moments, usually applied to the edges of the slabs. (BASTOS, 2015, p.1).

2.3.1 Slabs as a Structural Element

The slabs are structures that receive forces that compress it vertically, perpendicular to the average surface, transmitting them to the supports. Therefore, they behave as a kind of plaque. In addition, they also act as a rigid horizontal diaphragm, as they distribute the horizontal actions to the structure's columns, in this sense, the slab has a sheet-like behavior. These behaviors are fundamental for the structure to be stable globally, especially in tall buildings. In addition, it is through the slab that the braced

pillars rest on the bracing elements, ensuring the safety of the structure in relation to the lateral actions. (AVILLA, 2016. p.18).

Among the most varied functions of the slabs, Guerrin (2002), highlights two as the main attributed functions: resistance function; the slabs support their own weight and accidental overloads and the insulation function; they insulate the different floors thermally and acoustically.

2.3.2 Design constraints for Ribbed Slab and Steel Deck Slab

The ribbed slabs, molded in place, have traditionally received the analysis that admits them, simplifying them, as massive slabs, determining the soliciting efforts and transversal displacements through the use of tables, of slabs elaborated from the use of plate theory thin, which considers them in an elastic regime; it is important to highlight that in this case the slab outline beams are considered non-movable, in the vertical direction, not corresponding to reality. This method, which is included in some bibliographical references, is also based on NBR 6118 (2003), which allows ribbed slabs to be calculated as solid, provided that some recommendations regarding the dimensions of the table and ribs and also the spacing between ribs are observed. (TENÓRIO, 2011).

Regarding the Steel Deck slab system, according to the Brazilian Association of Technical Standards 8800 (2008), mixed concrete slabs with incorporated steel formwork are defined as being basically composed of two elements: metallic formwork and concrete formwork. These are those in which, after the concrete reaches its design resistance, the formwork acts together with the first to resist bending. In the initial phase, before the concrete reaches 75% of the specified compressive strength, the steel formwork supports the permanent actions and the construction overload in isolation. Steel shapes must be able to transmit longitudinal shear at the interface between steel and concrete. In the case of the mixed slab, the adhesion between the steel and the concrete are not considered sufficiently effective for the mixed behavior of the structure, being necessary to guarantee by mechanical connection, which comes through the dents in the steel forms and by the friction due to the confinement of the concrete in the recessed steel forms.

2.4 Constructive methodology of the ribbed slab

The ribbed slab system is characterized using plastic cubes or buckets. According to Vizotto (2010), there are two methods of installing the cuvettes. In the first, the vats are positioned on a wooden platform, like the solid slab, which receives the support of beams and props generally metallic.

In the second method, there is the practice of directly supporting the vats on the metal beams, not using the wooden platform, however this method must be carried out with great attention in the locomotion of the workers during the assembly of the slab and concreting, so that avoid slipping the vats and accidents. Each vat has an approximate mass of 3.3 kg. These molds resist the load of fresh concrete, reinforcement, small equipment, and workers on them. After positioning the vat, a release agent must be applied to allow the vat to be removed, giving the opportunity for reuse. The reinforcement is positioned with the help of spacers. To execute the ribs, inert material can also be used as a lost form in the form of boxes. Ceramic brick, cement block and EPS block (Styrofoam). These are the most used as inert materials and the boxes are mostly made of propylene or metal.

2.5 Constructive methodology of the Steel Deck slab

The system basically consists of the use of a collaborative metallic form, with reinforcement on the junction of the steel deck sheets and around the pillars, galvanized steel mesh in order to avoid cracking, filled with concrete, as shown in Figure 2.

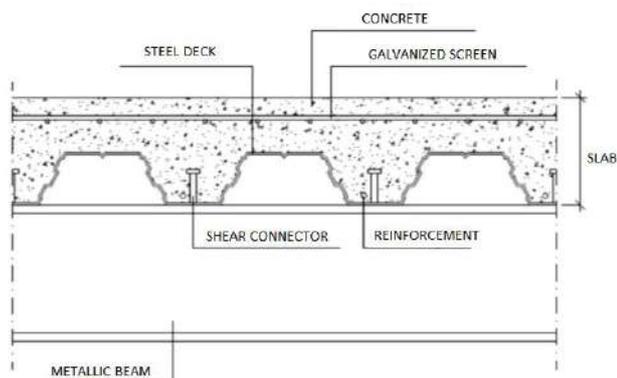


Fig.2: Steel deck slab

Source: Guimarães, 2016, adapted.

The plates are assembled from one corner of the buildings, creating the assemblers their own work platform with the first assembled plates. When they are placed in the final position, they are fixed before continuing to place the next ones, to avoid, for safety reasons, the existence of loose plates. (GUIMARÃES 2016, p. 37). According to Queiroz et al. (2012), for steel and concrete to work together, it is necessary to develop longitudinal shear forces. Although these materials have a relatively good adhesion, they are not considered in the dimensioning step, as they have little reliability. Therefore, the use of shear connectors should be provided according to the recommendations of ABNT NBR 8800: 2008. Stud Bolts

are a type of shear connector that works by absorbing the longitudinal shearing efforts and prevent the vertical spacing between the slab and the beam. They are fixed to the upper beam table by means of electro-fusion. These must be fixed after the formwork assembly is finished, before pouring.

2.6 Evaluation results: performance and cost estimation

The performance of the slabs is quite different, the ribs have a high volume of thickness, which added to the ceiling height reaches a relatively high height between the floors, which causes some consequences in the installations and facades. In contrast, Steel Decks in limiting their height perform better for pipeline passage and installations becoming better at that point. In addition, Steel decks have better functionality with respect to architectural flexibility, due to their architectural versatility. In contrast, the ribs encounter difficulties in flexibility for wet areas, due to the limitations imposed by the passage of hydraulic installations. (MARTINS et al. 2018, p. 206).

Steel Deck systems have a lower cost than ribbed slabs, corresponding to a 20.0% difference in spans less than 6 m, however, for larger spans, the relative cost of the Steel deck type slab increases significantly, reaching a difference of more than 70%. To define the cost comparison, according to Martins et al. (2018, p. 205), considering the labor and using values extracted from the inputs and services table of the National System of Research on Costs and Indices of Civil Construction (SINAPI), taking the variable loads in two extreme situations, according with NBR 6120 (1980) the following is noted: Steel deck slabs have a lower cost than ribbed slabs for spans smaller than 6m, with an approximate cost for a span of 4m, for example, R \$ 500, 00, while the ribbed slab is estimated to be approximately R \$ 800.00. For spans much larger than 6m there is a high increase in the cost of Steel deck slabs, while in ribs, this cost does not increase as much. In a span of approximately 10 m, for example, the estimated cost of the Steel deck slab, reaches approximately R\$ 2500.00 while the ribbed is estimated to cost approximately R\$ 1500.00. (MARTINS et al. 2018, p. 205).

In spite of this, a part of the engineering professionals, consider the cost consideration that evaluates the Steel deck slab by the square meter to be erroneous, because speed, cleanliness, reduction of manpower (since two people can assemble between 500 and 750 m² of slab / day) and construction time, among other factors, must be considered when calculating the cost. Brendolan (2010, p.1), states that about 50% of the cost is made up of steel sheet. Therefore, in the conventional solution, other items must be computed in the cost comparison, such as shoring

and the execution time factor, because shoring has a relatively high cost and their assembly and disassembly as well. For him, it should also be considered if the type of slab used in the comparison influences the cost of the structure, if so, it must be considered in the cost estimate.

2.7 Comparative discussions: advantages and disadvantages

As for the ribbed slabs, Nervo (2012, p. 36 and 37), lists a set of advantages and disadvantages, the advantages being: The shapes have a continuous plane, with cutouts only in the connections with the columns, so they present simplicity in execution and the withdrawal of forms; lower consumption of wood and lower incidence of labor, for making shapes; reuse of form; easy pouring, as it has a unique cloth; greater versatility in the floor due to the absence of beams, offering ample freedom in the definition of internal spaces, which reflects a strong commercial appeal; savings in installations, since the design and execution of installations are facilitated, as it reduces the number of bends and eliminates the drilling of beams.

However, even according to Nervo (2012, p. 36 and 37), these advantages, to really have an effect, need a certain preparation on the part of the executor and the designers, as well as a better qualification of the workforce. The disadvantages listed by Nervo (2012, p. 36 and 37) are: Less rigidity of the structure to the lateral actions in relation to the other structural systems, due to the reduced number of frames. In certain cases, the presence of rigid cores is required in the region of the stairs and the elevator shafts; puncturing the slab by the pillars; somewhat complicated frame, mainly on the pillars and in their surroundings; in general, higher consumption of steel and concrete. Silva et al. (2018), also cites some disadvantages that should be considered. According to him, normally the total height of the building is increased and there is also a difficulty in terms of compatibility with other subsystems such as installations, fences, and others. In addition to these mentioned disadvantages, the ribbed slabs still have the need for shoring in any dimension that is made, generating the precision of waiting a considerable time to remove the struts, not allowing one to work under the newly concrete slab in the following days, and the service area should be kept isolated. Furthermore, in the situation of non-placement of inert material, the formwork execution time is long, in addition to requiring a large consumption of wood.

Steel deck slabs eliminate some of these drawbacks, making the processes involved in building even more streamlined. According to Lemos (2013), there are several advantages of the system in relation to reinforced concrete,

where the ribbed slabs also fit. Some of them are: The steel plate is light, being easily handled and installed, allowing, therefore, greater constructive speed, giving financial return of the enterprise, in addition to working as a formwork for fresh concrete, and as it remains permanently, it eliminates the step of deforms; in many cases, it does not require the use of shoring; reduction of material waste; reduction or even elimination of the traction reinforcement in the region of positive moments; greater safety at work, as it works as a service and protection platform for workers who work on the lower floors; decrease in the weight and volume of the structure, with a consequent reduction in the cost of foundations.

In addition, the organization that the system gives to the construction site is a very positive point, since it is an industrialized element and its storage on site is more organized than, for example, the storage of forms for reuse. Another advantage that speeds up the execution time of the building is the ease of passing pipelines to the various building installations, in addition to having a high-quality finish on the slab. Furthermore, Costa et al. (2016) highlights the ease of installation, greater construction speed and the elimination, or reduction of the positive reinforcement in the finished slab, consequently reducing the cost, among other advantages.

The Steel deck system significantly reduces the execution time of the slab, we can mention as a recent example the construction of the Hotel Ibis, carried out in 2011, in the city of Canoas, Rio Grande do Sul. The seven-story project, with 30 meters of height, 15 wide and 40 long, it was built in just 67 days and 8 hours. During this period, the entire structure was completed, even the building's facade, saving approximately 60% of the time that would be required for the execution of the reinforced concrete structure for a work of this size. (LEMONS 2013, p. 23).

However, the Steel deck system, like all others, has its negative points, some of which are: Need for a higher level of specialization of the workforce, which can lead to an increase in the cost of the system, due to the scarcity of workers available for its execution; lower resistance of the slabs in fire situations.

In addition, Lemos (2013) highlights another disadvantage of Steel deck slabs in relation to reinforced concrete slabs, as there is a need for a greater number of secondary beams, in cases where shoring or forms of great height are not used, due to limitation of spans before curing concrete.

Regarding sustainability, ribbed slabs mitigate the environmental impacts generated by constructions made of

masonry by reducing the use of concrete and other materials, such as steel and wood, using forms that are reusable. Therefore, there is a smaller amount of these other materials, which contributes to a lower disposal for the environment. In the case of mixed slabs, a lower weight is observed, which reduces foundations and excavations, safeguarding the soil more, resulting in less soil removal. Consequently, Nakahara (2017) points out that this decreases the demand for truck trips for land extraction, reducing CO2 emissions, also decreasing the need for areas for disposal. Concomitantly, it is noted the sustainable effectiveness of the system with regard to the disposal of wood, as forms are part of the structure and there is the possibility of dispensing shoring, thus wood is no longer discarded, in addition to generating less debris and providing less leftover of material. When 1 shows a comparison of the two slab systems.

Table 1 - Comparison of Slab Systems

	Ribbed Slab	Steel Deck Slab
Cost	20% higher in spans of up to 6m. (disregarding secondary costs)	Spans larger than 6m the cost reaches 70% higher. (disregarding secondary costs)
Construction Height Characteristics	It has a great thickness. The sum of the thickness of the slab with the ceiling height establishes a considerable height between floors, causing consequences in the installations, facades, frames so on.	There are no height limitations and it is easy to pass the ducts to installations and, in return, asks for the fixation of a lower ceiling.
Shoring	Required in any dimension	Dismissed in most cases
Architecture Flexibility	It allows for a certain flexibility in relation to the layout of the designed architecture. However, for the wet areas of the building, this	They present excellent performance due to flexibility, permeability and monolithicity

	flexibility decreases due to the limitations imposed by the passage of hydraulic pipes.	due to their architectural versatility
Lining finish	Lining should be used, either by applying cement paste to smooth the surface or plates to hide the pipe	Easy pipeline passage and ceiling fixing.
Time	Steel deck takes twice as long to assemble	Regarding the ribs, it takes half the time to assemble

Source: Martins et al, 2018.

III. METHODOLOGY

The article was based on an accurate bibliographic search, which made it possible to define comparative variables for both slabs, ribbed and Steel deck systems. In addition, analytical verification of the two types of slabs studied was carried out. The data collected were analyzed to enable the description of the construction systems and comparative designs, focusing on the methodology, performance, time, and financial scope.

IV. CONCLUSION

When comparing the two slab systems, it is clear that the Steel deck slabs show superiority in relation to the ribbed slabs, in different requirements, with greater versatility, speed, less time, ease of installation, architectural flexibility and; in addition, it fulfills the need for greater span spans. The low use of this system is due to some factors, such as the cultural factor, which concerns the great hegemony of reinforced concrete and the cost, which is the one that greatly influences the choice of any element of the construction. In addition, in most cases, budgets do not take into account some secondary costs, considering only the slab itself, creating a disturbance for the choice of the Steel deck slab, which besides being in recent use in Brazil, when not construction is considered as a whole, having a higher cost in larger spans.

Steel deck slabs are a great option, although they are still beginning in Brazil. The cultural reality of Brazilian construction is a supremacy of reinforced

concrete. However, there is a tendency for mixed slabs to be more valued, as time and rationalization have been increasingly enhanced in buildings. This is likely to be the factor that will attract the most attention to this system. Therefore, there is a high probability that there will be a significant increase in the use of mixed slabs, so that they will gain prominence in the Brazilian market.

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Feasibility Study of Scrap Tires in Civil Construction

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Abstract — This article describes the research carried out, aiming to give an appropriate destination through recycling for the large number of discarded tires. In Brazil, most of the waste tires are reused in different ways, however, there is still a portion that is discarded in an irregular way, therefore, a tire roof was proposed, aiming to lessen the environmental impacts by the disordered disposal and to propose a solution sustainable and more economical than conventional building roofs. The eco-tile presents itself as a technologically viable project, with the greatest obstacle to cultural aspects that are still decisive for the market to adopt this type of solution with recycling of waste tires that are discarded every year. The methodology used was through bibliographic verification in several scientific sources. Based on this, a study was developed with data collected from the company Reciclanip, which reveals the normative responsibilities of the national environment council, highlighting the importance of recycling. Finally, an alternative method was considered to recycle waste tires, using them to create a sustainable eco roof, comparing it with conventional roofs in price, resistance, and durability, highlighting the innovation.

Keywords — Roof. Tire. Useless. Recycling.

I. INTRODUCTION

Today, recycling is becoming more and more necessary and even a good business alternative. Waste, whether solid or liquid when disposed of in nature, usually causes damage and in extreme cases, irreversible. The development of new products in the recycling area has been stimulated as an important means for sustainable development and productive competitiveness.

Tenório & Espinosa (2010), point out that man is the only agent that generates waste caused by the consumption patterns of today's society. It is estimated that each year, approximately sixty million tons of waste are produced on Brazilian soil. Part of this waste is collected

and reused by cooperatives and large recycling and infrastructure companies. Another part, thrown into the environment, becomes a supplication for needy communities, who live near dumps and landfills. Within this context, the difficulty in disposing of tires at the end of their useful life becomes a humanitarian issue. The improper disposal of waste tires has great impacts on nature, in addition to harming human health.

In Brazil, there are laws that require tire manufacturers and importers to be obliged to collect and dispose of waste tires in an environmentally appropriate manner, this measure demonstrates the danger of indiscriminate disposal of this waste. Due to their difficult

compaction, collection and disposal, the tires take up a lot of physical space. The large deposits occupy extensive areas and are subject to accidental or provoked burning, causing losses in the air quality, due to the release of smoke containing a high content of sulfur dioxide among other toxic substances. (CAMILO, 2010) The construction of the tire is basically done with a mixture of natural rubber and elastomers, also called 'synthetic rubbers', adding carbon black, giving the rubber properties of mechanical resistance and the action of ultraviolet rays, durability and performance, this composition favors the creation of tiles, mainly due to its characteristics of mechanical resistance and the action of ultraviolet rays. The roof of scrap tires can be included among the material options available for civil construction, with the consequence of attracting investments, creating demand for new products, generating jobs and development. (NAIME & SILVA, 2010)

To develop a tile from waste generated by unused tires, it is necessary to evaluate the tile manufacturing processes, their environmental impacts, and the application of a construction process in a more economical and sustainable way in residential buildings. According to Naime & Silva (2010), the use of waste tire rubber in several construction stages, allows a way to increase the life cycle of this material and provide architectural, aesthetic, constructive, environmental, and financial qualities. Therefore, the proposal is to apply tire rubber in the construction of an ecological roof, aiming through the tire tiles to minimize environmental problems, collaborate with sustainable development and benefit the community with a quality and low-cost product. This project proposes to analyze the feasibility of recycling waste tires, with the purpose of designing and building a new type of roof that meets the needs of comfort, structural and thermal insulation of a residence. For this, extensive bibliographic research was carried out to clarify the current state of tire recycling in Brazil and to establish technical and constructive parameters that favor its use in the country.

II. LITERATURE REVIEW

2.1. Scrap tires

The environment has become the focus of society's concerns on a global scale, the future depends on current global actions. Sustainable development is a process of change in which the exploitation of resources, an investment orientation, the directions of environmental development and an institutional change must consider the needs of the next presentations. (SOUZA & DELPUPO 2012). The National Association of the Pneumatic Industry, an ANIP was created in 1960 and represents a tire

and inner tube industry installed in Brazil, comprising 12 companies and 20 factories around the country. In 2007, ANIP created or Recycled which has the function of collecting and disposing of waste tires in a country, being one of the main initiatives in the post-consumption area of the Brazilian industry, having 1053 collection points around Brazil. In 1999, the national tire collection and disposal program started with a collection of manufacturers, more than 5.3 million tons of waste tires that were collected (that is, equivalent to 1.04 billion passenger tires) and used until the end of 2019. (ANIP, 2020).

According to Gomes et al. (2010), waste tires left to the environment are very harmful, as they not only contaminate the air, soil and groundwater in tropical countries like Brazil, they increase the spread of fatal diseases like dengue, Zika and Chikungunya. A 2003 study carried out by the Ministry of Health revealed that in 1140 municipalities surveyed, tires were in 25% of them the main focus of the mosquito (284 municipalities), and the second in 43% (491 municipalities) and the third in 41% (465 municipalities).

The accumulation of tires is one of the most serious environmental problems due to the difficulty of collection and the high production of it. The tires can be easily turned into tiles, using cutting instruments and a wooden structure, where the tires will be fastened with nails according to figure 1. The industry already produces a large quantity and its useful life is short after the use, it can be easily adapted for this purpose, thus being a cheap and lasting alternative, taking into account the way in which they are manufactured.

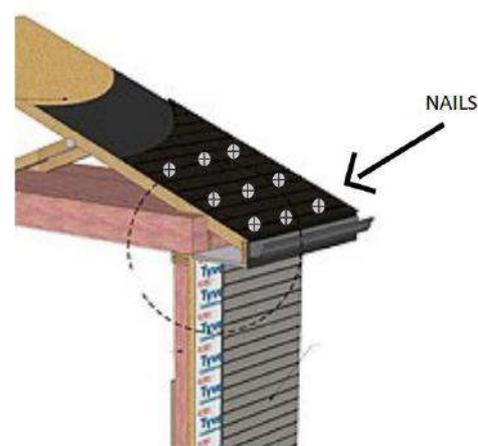


Fig.1: Timber and roof fixing

Source: EuroShield Roofing, adapted (2020).

2.2. Conventional proposals for the solution of the problem

The business commitment to recycling, Cempre, is a non-profit association, dedicated to encouraging recycling within the concept of integrated waste management. Founded in 1992, it is maintained by private companies from different sectors and its function is to raise awareness among the population about the importance of reducing, reusing, and recycling waste through seminars, research, and databases. (Cempre, 2020).

Also according to Cempre, (2020), waste tires can be ground and applied to the asphalt composition of greater elasticity and durability, contribute to soil compaction, create other rubber products such as soles, tubes, carpets, floors or even fuel - thanks to its calorific value that surpasses the burning of fuel oil and coal. In Brazil, the tire retreading rate is high, thus prolonging its useful life, especially that for buses and trucks, which is refurbished about twice, however, part of them ends up in landfills and along rivers and roads.

It is possible to generate energy by burning old tires in controlled, whole, or perforated furnaces. Each tire contains the energy of 9.4 liters of oil. In Brazil, the use as fuel, between 1999 and 2004, destroyed 150 thousand tons of tires, about 30 million used car tires, providing savings of 720 thousand tons of oil. Petrobras' plant in São Mateus do Sul in Paraná incorporates crushed tires in the bituminous shale extraction process, which guarantee lower viscosity to the mineral and an optimization of the process. (SEBRAE, 2017). In civil engineering, rubber from tires can be decomposed into grains that are used in the construction of materials for building bridges, viaducts, and rainwater retention basins so that they are lighter than using common materials. The drainage, anti-mold, anti-vibration, thermal insulation properties and the low weight of the materials derived from tire recycling, make its use increasingly advantageous in these applications. (FLORIOS, 2015).

2.3. An alternative method: tire roof

Thinking about the environmental issue and the appropriate destination for this material, aiming to reduce even more the impacts that are caused in nature, a tire roof can be used as another means of taking advantage of useless tires, so that its use, due to its properties physical and chemical properties, are very valid in the construction of roofs, given its thermal and acoustic insulation capacity, as well as the ease of its execution, as it is a lightweight material and does not require some resources commonly used in conventional roofs, Figure 2 demonstrates a roof composed of 70% tire, finished and in use.



Fig.2: Composite roof of 70% tire.

Source: Euro Shield Roofing (2020).

For Dias (2018), this type of tile can replace ceramic, fiber-cement, metallic tiles, among others. Each tire produces three tiles of approximately 53 cm. each and takes advantage of the tread with the sides, excluding the beads, being the tool used for cutting, the chainsaw or cutting machines. Figure 3 illustrates the composition of a tire.

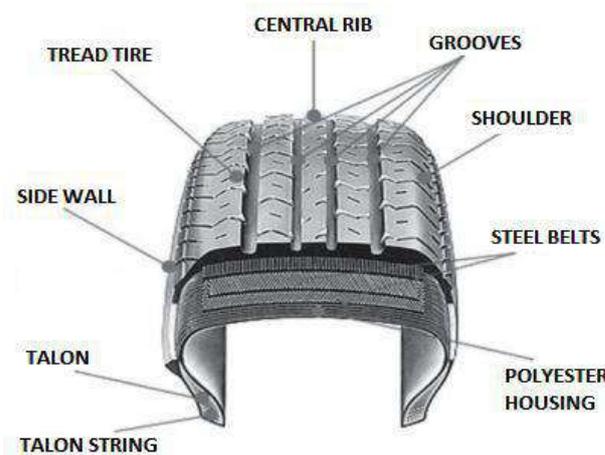


Fig.3: Composition of a tire

Source: Brazil Tires (2009) Apud Brazilian Association for the Prevention of Traffic Accidents (2013), adapted.

The wooden structure of the roof is the same as that used in ceramic tiles, however the tire tiles are fixed with nails. Rubber is a thermal insulator, which guarantees a good temperature inside the residence.

The manufacture of tire tiles allows buildings to be built in locations with trees that produce large fruit. With the characteristic of absorbing the tension due to the collision of the fruit with the roof, preventing it from coming to rupture. The tiles are extremely easy to transport, favoring the construction and maintenance of the roof.

The appearance of leaks is minimized due to its fixation by means of nails. The unit price of these tiles is relatively low when compared to more conventional tiles

because it is a material that has already been discarded for its original use. When comparing the cost of tiles and woodwork per square meter of ceramic, fiber-cement, and metal roofs, we have a significant reduction in the total value for the roof construction.

III. METHODOLOGY

First Stage: a bibliographic survey was made on several sources of research - periodical books and reliable sites regarding environmental preservation; sustainable development, generation and disposal of solid waste - in particular waste tires and the absorption of this issue by society and companies, the initiatives that have been adopted regarding recycling and reuse of waste tires.

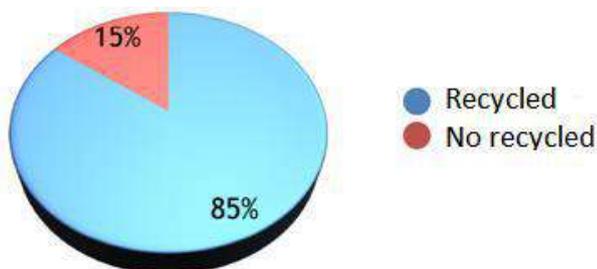
Second Stage: a study was carried out using data from the company Reciclanip, constituted by the National Association of the Pneumatic Industry (ANIP), based on the responsibilities imposed by Resolution No. 416, on September 30, 2009 at CONAMA - Conselho Nacional de Meio Environment, showing its importance for the environment.

Third stage: considerations were made regarding an alternative method for recycling tires with the creation of an ecological roof, surveying the recycling index in Brazil, comparing prices between the most common types of tiles and finally, collecting data from tensile test, to check the resistance.

IV. RESULTS AND DISCUSSIONS

In 2014 the tire recycling index in Brazil was 85% as shown in Graph 1, referring to the most recent survey carried out by Cempre, we have that 15% of all waste tires are still improperly disposed of in Brazil, having the roof use this space to contribute to the recycling of this material, seeking to further reduce environmental impacts.

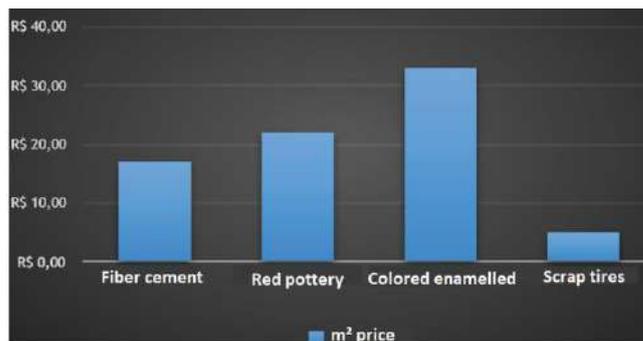
Graph 1: Tire recycling index in Brazil



Source: Cempre (2014), adapted.

As for the question of price in the use of waste tires in residential building roofs, we have a great differential according to Graph 2, as it is observed that the other types of tiles have expenses with lumber, transport and the price of the tile itself, which in the tire tile, we would only have the price of the cut and its transport and wood, that is to say also saving in the total value, since the tiles are made of a material that has already been discarded.

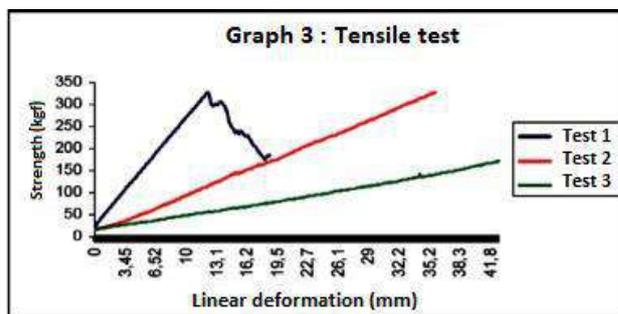
Graph 2: Types of tiles and their price differences.



Source: authors.

According to Graph 3, we have the minimum load that a tire tile can withstand is 122.5 kg. With this data, this product can easily withstand an average human load of 80kg. In test number 1, a maximum load was used until the specimen collapse was determined and the linear deformation obtained at rupture was measured. In the second and third tests, the parts were forced with applications of different magnitudes and measured the deformations of the part, making it clear that when the rupture does not reach, the deformations are quite close, regardless of the applied loads.

Graph 3: Tensile test



Source: Naime & Silva (2010), adapted.

The main purpose of the development of this tile is to further reduce environmental impacts and revolutionize the tile production market, generating jobs and a new material option, since the research that has been done, shows their superiority over other materials. as for costs,

lightness, and resistance, having a possible barrier to its implementation, cultural issues, because in Brazil new construction methods tend to be resisted by builders and customers.

V. CONCLUSIONS

According to research carried out in the construction process, it is concluded that tires have different uses, in addition, there are projects and organizations that are geared towards the reuse of this material. The reinsertion of waste tires as cover for residential buildings is ecologically, socially, and economically viable. The main reason for choosing this element is the cost, as an expressive inferiority was observed when compared to the other more usual materials, which can consolidate this innovative and quality technique for roofing. However, one of the obstacles encountered is the lack of knowledge about the technique in Brazil, as well as prejudice against reused materials, both in relation to the contractor and to the end users of the product. It is evident, therefore, that the use of the tire to create roofs of high durability and totally recyclable, is feasible, thus creating a cheaper and easier to be manufactured product, being also a great commercial competitor, adding to the set of materials for building roofs existing residential properties.

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Ozone Therapy – Ozone Applicability in Various Dental Specialties

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Abstract— Ozone (O₃) is an allotropic oxygen compound, found in abundance in the stratosphere and which, due to its antimicrobial, disinfectant and healing properties, provide therapeutic applications for more than 260 different pathologies. Ozone therapy is a technique that uses this gas, in its gaseous, aqueous and oily forms as a disinfection treatment option, being considered a safe, minimally invasive and conservative modality. This study aimed to review the literature on ozone therapy applied to dentistry, aiming to clarify its benefits and care during use as complementary therapy. For that, searches were carried out in databases addressing the theme proposed between 2007 and 2020, in three languages: Portuguese, English and Russian. It is concluded that Ozone therapy can be used safely and efficiently in dentistry as a complementary disinfection practice, without contraindications. Although laboratory studies have emerged as a promising potential for ozone in dentistry, more in-depth studies with standardized methodologies are needed to, in short, obtain more information about its applicability.

Keywords— Ozone therapy, Dentistry, Application.

I. INTRODUCTION

Ozone (O₃), an allotropic oxygen compound (O₂) also known as triple oxygen or oxygen, is formed in the atmosphere through photochemical analyzes, that is, after generating an electrical discharge in the oxygen molecule, the same breakdown releasing atoms and binding to another oxygen molecule, forming O₃. It contains a half-life of approximately 40 min at 20 ° C (AZARPAZHOOH, LIMEBACK, 2008). It is a dynamically unstable and oxidizing structure, being easily created and destroyed in O₂ molecules (BOCCI, et al., 2011).

Found in the stratosphere at a concentration of 1 to 10 ppm, ozone is important due to its ability to filter out ultraviolet (UV) rays emitted by the sun. On the other hand, ozone in the atmosphere is considered toxic to the lung, since it is produced by chemicals that involve sunlight, car exhaust and oxygen, while the atmosphere can be caused by the action of ultraviolet rays or artificially with the aid of a generator (OLIVEIRA, MENDES, 2009).

It was discovered in 1785 by Martin Van Marum and substantiated in 1840 by the German researcher Christian Friedrich Schonbein, who already worked with water electrolysis when he included ozone in one of his experiments. According to or researcher, after performing an electric discharge in the water in a glass hood using oxygen, the use of gas that had a bluish color and a strong

odor, calls it "Ozon", which derives from the Greek oil and means "what it smells." He considers ozone to be a potent disinfectant (FERREIRA, 2011).

During the First World War, the use of ozone was reported for the first time in the German physician Albert Wolf, whose main objective was to treat post-traumatic ulcerations, infected wounds, burns and fistulas in German soldiers, obtaining satisfactory results that, soon after, created a technique for exporting blood directly to the gas mixture composed of oxygen-ozone (NOGALES, 2011).

In Dentistry, its first use was in the form of ozonized water by Dr. Edward A. Fisch (1899–1966) during a surgery on the German Dr. Erwin Payr (1871-1946), being the main objective in employment in the technical era for promote hemostasis, inhibiting the proliferation of bacteria and, thus, improving the local oxygen supply. Fisch was fascinated by the technique and went on to research deeply. In 1935, he published the work "On Ozone Treatment in Surgery" at the 59th Congress of the German Surgical Society in Berlin and then started Ozone therapy as it is known today. (FERREIRA, 2011).

Ozone therapy is a complementary technique that uses ozone (O₃), in its gaseous, aqueous and oily forms, as a therapeutic option in the treatment of various pathologies, due to its biocompatibility generated by its bacteriological and immunostimulating power. In Brazil, a practice that

started in 1975 and gained more followers in the 1980s, due to the interest of some universities. In March 2018, the Unified Health System (SUS) included the use of ten new complementary practices, one of which is ozone therapy (NESI, 2018).

Nesi (2018) relates that Ozone therapy can be performed in several dental practices, for example: Periodontics (prevention and treatment of infectious/inflammatory conditions); Surgery (assist in tissue repair); Temporomandibular joint pain and dysfunction (reduction of symptoms); Jaw necrosis (osteoradionecrosis, drug-induced necrosis and osteomyelitis); Stomatology (accelerated healing of ulcers, cold sores and other gum infections); Caries treatment; Endodontics (intensifying an antiseptic phase of the root canal system, acute and chronic infections); Biosafety (acting as a technique in the sterilization of dental materials).

Therefore, this objective work reviews the literature on the use of ozone in several dental specialties, helps to clarify its benefits and care when using complementary therapy.

II. MATERIALS AND METHODS

The type of study addressed was a literature review, whose bibliographic survey was guided by the question: Is there evidence of benefit from ozone therapy in dentistry? To ensure the relevance of the information contained in this work, searches were carried out on the PubMed electronic portals using the Health Sciences Descriptors (DeCS) "Ozone therapy" and "Dentistry" and "Application"; and Google Scholar searching for "Ozonioterapia na Odontologia". In the crossing of the adopted words, the expression of Boolean logic "AND" was used. As inclusion criteria, it was determined: articles available in the aforementioned databases that reported on the therapeutic use of ozone in dental specialties. All studies that did not address the proposed theme and also those that presented duality were excluded.

Initially, to check if there was a relationship with the theme of the present study, the articles were previously selected from reading the titles and abstracts. After a more in-depth analysis of the research content, publications that were in agreement with the guided question and with the pre-defined inclusion and exclusion criteria were inserted in this bibliographic review. Thus, a total of 30 articles were included in this literature review and presented in three languages: English (22), Portuguese (08) and Russian (01).

III. RESULTS AND DISCUSSION

Ozone therapy is proposed in dentistry due to its biocompatibility, curative properties, oxidizing, antimicrobial, fungicidal and bactericidal action (LONCAR, et al., 2009; OLIVEIRA, MENDES, 2009; LYNCH, 2009; SAINI, 2011; NOGALES, 2011; FERREIRA, et al., 2013). The gas has been applied to enhance the healing of epithelial wounds, such as ulcerations and herpetic lesions; promote remineralization; and sterilize cavities, root canals and periodontal pockets (AZARPAZHOOH, LIMEBACK, 2008). Thus, Loncar, et al., (2009) state that, despite being frequently used in other dental specialties and proving effective for them, ozone in gaseous form is more used in Dentistry and Endodontics.

Ozonized oil is the most stable form obtained which, in addition to stimulating enzyme systems of oxide reduction, also has excellent antimicrobial and antibacterial action (NESI, 2018; ANZOLIN, BERTOL, 2018). According to Oliveira, Mendes (2009) and Abreu, et al., (2015), topical applications of Oil ozonized have been frequent both in prosthetic stomatitis and alveolitis and, according to Ferreira (2011), in fistula.

If compared to oxygen, ozone is 10 times more soluble in water (LONCAR, 2009; OLIVEIRA, MENDES, 2009; SAINI, 2011; FERREIRA, 2011; NOGALES, 2011). In the study by Loncar, et al., (2009), ozonized water decontaminated the root surface of loose teeth without causing damage to periodontal cells and proved to be useful for endodontic treatment. Azarpazhoo, Limeback (2008), Lynch (2009) and Nogales (2011) show that it is effective against oral microorganisms. Ferreira (2011) states that ozone in aqueous form did not show resistance to drugs, has low toxicity, is more biocompatible than other antimicrobials and is cheaper than other antiseptics. Ferreira, et al., (2013) add that the use of ozonized water as an antiseptic in oral surgeries improves tissue oxygenation, enhancing the repair process.

There is no agreement on the time of application and the ideal concentration of the therapeutic levels of ozone, as they vary according to each objective (OLIVEIRA, 2007). Loncar, et al., (2009) point out that the duration of the application varies from 10 to 80 seconds, however, according to Oliveira, Mendes (2009), it is 2 to 3 minutes. Makeeva, et al., (2017) observed that in less invasive procedures, such as in white spot lesions, for example, the gas mixture was used for 24 seconds under the element in question, while in EAR lesions, Al-Omiri, et al., (2016) claim that exposure to ozone gas lasted 60 seconds. Ferreira, et al. (2013) explain that, in the third molar ostectomy, ozonized water was administered as an

irrigating agent throughout the procedure and, Oliveira, et al., (2018) add that, in the context of GUN, the ozonized oil was applied without a specific time interval. Regarding the concentration, it is known that the maximum allowed for the clinical application of the ozone-oxygen gas mixture is 5% or 100 µg / ml of ozone, where 1 µg / ml means that it contains 0.05% O₃, and 100 µg / ml contains 5% (FERREIRA, 2011; NOGALES, 2011).

Nesi (2018) guarantees that Ozone therapy contributes to periodontics in both acute and chronic periodontal processes. Oil and ozonized water significantly reduced the bacterial count and the depth of the periodontal pockets (OLIVEIRA, 2018; OLIVEIRA, MENDES, 2009). Oliveira (2018) also states that, regardless of obtaining statistical improvements in periodontal parameters, ozonized water cannot replace RAR. Ozonized oil, while not the most widely used form, is an effective and safe therapeutic alternative for the treatment of necrotizing ulcerative gingivitis, promoting the reduction of inflammatory symptoms (URAZ, et al., 2019). The application of the gas was not associated with significant changes in periodontal recovery in cases of generalized chronic periodontitis and aggressive periodontitis (URAZ, et al., 2019; TASDEMIR, et al., 2019; DENGIZEK, et al., 2019).

Ozone acts fully in surgery and in infectious conditions, because, in addition to reducing painful symptoms, it can even induce a cure (OLIVEIRA, MENDES, 2009). Both gas, water and ozonized oil have shown promise in reducing complications and postoperative discomfort (AZARPAZHOOH, LIMEBACK, 2008; OLIVEIRA, MENDES, 2009; FERREIRA, et al., 2013; ABREU, et al., 2015; SIVALINGAM, et al., 2017). Additionally, Isler, et al., (2018) and Nesi (2018) report that, due to the scarcity of adverse effects, ozonized oil can serve as a substitute for systemic antibiotics.

After the application of the gas, lesions such as aphthous ulcerations, cold sores and oral candidiasis had their signs and symptoms ceased (AL-OMIRI, et al, 2016; AMIN, 2018; OLIVEIRA, et al., 2018). Amin (2018) states that this is due to the fact that ozone is an excellent fungicidal agent and serves as a warning to the immune system. Oliveira, Mendes (2009) explain that ozonized oil proved to be more effective than the antifungal Nystatin in the treatment of prosthetic stomatitis and, in cases of herpetic gingivostomatitis, it also contributed to the improvement of the infectious process.

Studies show that surgical procedures combined with ozone therapy are beneficial to patients who use

bisphosphonates (OLIVEIRA, MENDES, 2009). Anzolin, Bertol, (2018) claim that application of the gas under the wounds, in addition to enhancing healing and reducing genotoxic damage, in agreement with Nesi (2018), is also capable of stabilizing frames of osteonecrotic lesions induced by bisphosphonates and minimizing the painful symptoms in individuals with TMD. However, Celakil et al., (2019) claim that the occlusal plaque is the best therapeutic option to treat TMD. Anzolin, Bertol, (2018) state that ozonized water reduced the painful symptoms of osteoarthritis and, in accordance with Oliveira (2018), partially or totally improved TMD.

Loncar, et al., (2008) and Makeeva, et al., (2017) recognize that, in restorative dentistry, gas acts as a disinfectant, is an excellent therapeutic option for primary caries injuries and enhances remineralization. Kronic, et al., (2018) add that it is biocompatible, provides a good antimicrobial effect and can reduce children's anxiety in dental treatment. Ozonized water can have a lethal effect on *S. mutans* and *L. acidophilus*, proving its effectiveness in eliminating cariogenic microflora (AYKUT-YETKINER, et al., 2013). Within the dentinal tubules, it proves its high inhibitory power of biofilm accumulation and growth of gram-positive and gram-negative microorganisms (ALMAZ, SONMEZ, 2015). On the other hand, Durmus et al., (2019), emphasize that O₃ is not a disinfectant as effective as 2% chlorhexidine.

In endodontics, Oliveira, Mendes (2009) did not notice a significant difference in the antimicrobial effect of O₃ when compared to other chemical agents such as, for example, MTA and 3% NaOCl. For Loncar et al., (2009), Lynch (2009) and Nogales (2011), ozone (in gaseous and aqueous forms) does not eliminate microorganisms such as *E. faecalis* and *S. mutans*, and have antimicrobial activity similar to NaOCl 2,5% to 5% and CHX 2%. In contrast, for Noites, et al., (2014), the association of 2% chlorhexidine with ozone gas for 24 seconds, completely eliminates *Candida albicans* and *Enterococcus faecalis*. Ferreira (2011) believes that gas is more effective than ozonized water. Silva, et al., (2019) concluded that, for microbial reduction, ozonized water cannot replace or complement NaOCl, as it is less effective than conventional therapy. While Ferreira (2011) shows that patients who received ozonized oil as an intracanal medication had their recovery enhanced, Nogales (2011) states that there was no significant difference between him, calcium hydroxide associated with camphorated paramonochlorophenol and glycerin. The author adds that, in situations where NaOCl cannot be used in high concentrations, ozone in gaseous form can be an equivalent substitute.

Table.1: Summary of the main articles found

Dental Specialty	Author / Title / Year	Study Objectives	Research Method	Results and Conclusions
Periodontics	Oliveira, <i>et al.</i> Ozone therapy and Dentistry: new perspectives. 2018. Dengizek, <i>et al.</i> Evaluating clinical and laboratory effects of ozone in non-surgical periodontal treatment: a randomized controlled trial. 2019.	- Assess the permeability of oral microorganisms and dental plaques after using ozonized water as a subgingival irrigant; - To evaluate the clinical, biochemical and microbiological efficacy of Ozone therapy associated with RAR in patients with generalized chronic periodontitis.	Systematic review Data base: PubMed Randomized Controlled Study Data base: PubMed	- Efficacy proven in three studies; - In three studies it did not generate an additional effect to the periodontal parameters.
Surgery	Oliveira, Mendes. Clinical applications of ozone in dentistry. 2009. Sivalingam, <i>et al.</i> Does topical ozone therapy improve patient comfort after surgical removal of impacted mandibular third molar? A randomized controlled trial. 2017.	- Treatment of osteomyelitis and alveolitis; - Assess the influence of ozone therapy on patient comfort after extraction of the third molar.	Systematic review Data base:: Academic Google Randomized Controlled Study Data base: PubMed	- - In all studies, it accelerated healing and also reduced the amount of microorganisms, postoperative infectious complications, trismus, swelling and painful symptoms.
TMD and Jaw Necrosis	Anzolin, Bertol. Ozone therapy as an integrating therapeutic in osteoarthritis treatment: a systematic review. 2018; Celakil, <i>et al.</i> Management of pain in TMD patients: Bio-oxidative ozone therapy versus occlusal splints. 2019	- Evaluate the current evidence of Ozone therapy in the treatment of osteoarthritis; - To test the bio-oxidative effect of ozone in the treatment of symptomatic TMD compared to the treatment with occlusal plaque.	Systematic review Data base: PubMed Randomized double-blind clinical study Data base: PubMed	- In four studies, there was total or partial cure of the cases and reduction of painful symptoms; - In one study it did not obtain significant results, concluding that the occlusal plaque is the best treatment option.
Stomatology	Al-Omiri, <i>et al.</i> Ozone treatment of recurrent aphthous stomatitis: a double blinded study. 2016; Amin. Biological assessment of ozone therapy on	- Treatment of recurrent aphthous stomatitis; - Check if oral candidiasis may be	Double-blind study Data base: PubMed Randomized	- Signs and symptoms ceased, improvement in healing and even healing.

	experimental oral candidiasis in immunosuppressed rats. 2018	associated with impaired defense mechanisms generated by immunosuppressive drugs.	Clinical Trial Data base: PubMed	
Dentistry	Krunic, <i>et al.</i> Clinical antibacterial effectiveness and biocompatibility of gaseous ozone after incomplete caries removal. 2018; Durmus, <i>et al.</i> Effectiveness of the ozone application in two-visit indirect pulp therapy of permanent molars with deep carious lesion: a randomized clinical trial. 2019.	- Analyze the antimicrobial effect and the biocompatibility of ozone after incomplete caries removal; - Evaluate and compare the clinical and microbiological aspects of ozone therapy with other cavity disinfectants in indirect pulp therapy.	Randomized Controlled Study Data base: PubMed Randomized Controlled Study Data base: PubMed	- Seven studies showed that there was remineralization, little caries progression and a decrease in cariogenic microorganisms; - A study stated that CHX is the best cavity disinfectant;
Endodontics	Loncar, <i>et al.</i> Ozone Application in Dentistry. 2009. Ferreira. Effect on ozone therapy periapical bone repair as an adjunct to endodontic treatment: a radiographic clinical study. 2011.	- Evaluate in vitro the effects of ozone therapy and other root canal disinfectants infected with <i>Enterococcus faecalis</i> . - Examine the effect of ozone as an intracanal medication.	Systematic review Data base: PubMed Clinical and radiographic study Data base:: Academic Google	- In the other studies, it did not show significant results; - In three studies, ozone combined with other media completely inhibited pathogens and enhanced recovery.

IV. CONCLUSION

Ozone therapy is consolidated as a promising, safe and low cost complementary treatment option, generating benefits, especially for low-income patients. It is a widely known and used therapeutic modality due to the large number of bacteria and infectious diseases being sensitive to ozone.

Although laboratory studies advocate that ozone therapy is biologically effective and atraumatic for dental practices, there is still a discrepancy in the concentrations of therapeutic ozone levels, requiring more randomized, double-blind clinical trials with well-designed sample sizes and that present standardized measurement and analysis methods, in order to clarify the ideal concentrations and periods of ozone administration.

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Incendies: Trauma and the Gray Zone in Denis Villeneuve Film

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Abstract— Based on the homonymous play by the Lebanese Wadji Mouawad, the film *Incendies* (2009) has as premise the search of a twin couple, Jeanne and Simon, for the life, and death, story of their mother Nawal - after she goes into a catatonic state. Against the backdrop of Denis Villeneuve's film, our proposal, in this article is to deal with the effects of trauma for both Nawal and her children Jeanne, Simon and Abou Tarek / Nihad in the two places he occupies: son and father of his brothers. We will start with the definition of trauma proposed by Sigmund Freud, in which he defines trauma as a stimulus that exceeds our capacity for assimilation and, based on this definition, we will deal with the ideas about trauma attributed to the psychoanalyst Sándor Ferenczi, in which he divides it in two: the structuring trauma and the destructuring or invalidating trauma. It will be on the basis of these divisions that we will build a justification for the catatonic state of Nawal and the reason that she would have to include her children (all of them) in its history full of "fires".

Keywords— Denial, *Incendies*, Gray Zone, Trauma.

I. INTRODUCTION

Is one plus one equal to one? In the universe of Denis Villeneuve's film, in a stunning update of Sophocles' Oedipus, this question is answered in the affirmative, as much astonishment it causes. In this sense, mathematical language is called upon to support a solution to one of the most striking enigmas of humanity: parricide and incest. The use of mathematical principles to shed light on existential dramas is notorious.

The film begins in an oracular tone with the presence of a notary public who seems to be the embodiment of the figure of Tiresias who, when reading the testament, makes an enunciation: he delivers two letters and tells the dead woman's twins children that they must be delivered to their brother and father respectively. Difficult situation regarding the discovery of the existence of a living father and brother, especially at the moment when the mother who could speak is dead.

The oracular sentence that determines the delivery of said letters to their addressees is a sine qua non condition for the completion of the funeral ritual with the placement of a headstone, since the mother leaves one of her promises to her children: find her first child. And if the promise is not paid, a tombstone cannot be placed in her grave; the mother was buried without prayers, naked and with her

face turned to the ground, because she was indebted to this unfulfilled promise in life.

The destiny traced due to the delivery of the letters generates a conflict between the twins: the sister is willing to carry out the mother's request and the brother refuses. In a way, this sentence puts the two of them on a route that when traveling they make important discoveries: unveil the mother's past through a history marked by mishaps, pain, violence, suffering and torture, to finally arrive at the whereabouts of the brother who is also their father.

One of the lines of the movie of the character Jeanne who embarked on the paths of mathematics is quite illuminating in this respect: "will be discussed Insoluble problems that will always lead you to other equally insoluble problems". It was the endeavor to unravel the enigmas of their mother's life story that the two characters, Simon and Jeanne, were faced with horror against an unbearable knowledge to be known, even though they were warned by a school janitor that "sometimes it's better not to know everything".

At this point, the stories of the mother and the twins come together in a meeting marked by trauma, since this mother was silent after discovering that the son she seeks to find was her torturer and father of her two children. Here is very strong evidence that had an immediate traumatic

effect: erase the ability to transmit the revelation that Nawal faced. Certainly, that would be a finding that would impose on their children to walk on dark paths, gather filigree of knowledge and finally, in an instant of seeing, witness the shock suffered by the father/brother at the moment when he faced these certainties.

It was in the waters that the mystery was revealed to Nawal. This, a middle-aged woman, inside a community pool observes the feet of people on the outside edge of the pool. Among several feet, she sees the unmistakable mark tattooed on her son's right heel on the day of his birth, which crossed time as a mark of memory. Mother and son were separated at the moment he was born, and now they were reunited due to this uneven look. Upon leaving the pool and getting close to her son, Nawal recognizes another person in his countenance as well: her torturer and rapist during the period she spent in a prison in the Middle East. With this information the woman cannot elaborate in her psyche the cruel Discovery, that is, she cannot create a sense of what she is seeing and what is being unveiled at that very moment through the processing of the gaze. Faced with such impotence before the evidences verified, Nawal entered a catatonic and silence state until the moment of her death.

But David Villeneuve's film doesn't start there. Based on the homonymous play by Lebanese Canada-based Wadji Mouawad, the film *Incendies* (2009) has as premise the search of the twin couple, Jeanne and Simon, for the story of life, and death, of their mother Nawal. This, after her precocious and unexpected death leaves the responsibility of her executor to entrust his children with two functions: locate from her hometown - some unspecified place in the Middle East, most likely Lebanon - their unknown father, who they believed to be dead, and a brother they did not know existed.

To understand the relationship between the functions left by their mother, through the will, and her death, the twins must begin through her past. From a fragmented story, between scenes from their mother's past and the twins' present, they discover that Nawal, due to her own traumas, hid most of her life and the lives of her own children. Counting that Nawal's past was full of traumatic experiences, it was to be expected that she would struggle with all her strength to get away from that world geographically and subjectively.

Nawal, from a Christian family, born in a country divided by ethnic-religious conflict, unnamed nation in the Middle East, becomes pregnant by a Muslim refugee, the latter, killed by Nawal brothers when they learned about the romance. The child, who is born in secret thanks to the

interference of the great-grandmother, is taken to an orphanage, not without first receiving a distinctive mark, three points tattooed vertically on the heel, to one day be recognized, perhaps by the mother. Nawal, in fact, finds him again.

Our proposal, in this article, is to deal with the effects of traumas for both Nawal and her children Jeanne, Simon and Abou Tarek / Nihad in the two places he occupies: son and father of his brothers. These traumas are gradually unveiled over the course of the film's history by the discoveries of the twins. We will start with the definition of trauma proposed by Sigmund Freud, in which he defines trauma as a stimulus that exceeds our capacity for assimilation, or, in his own terms, "An experience that brings to mind, in a short period of time, an increase in stimulus too big to be absorbed" (FREUD, [1917]1976, p. 335). From this definition we will deal with the ideas about trauma attributed to the psychoanalyst Sándor Ferenczi, in which he divides it in two (PINHEIRO, 1995): structuring trauma and destructuring or invalidating trauma. It will be based on these divisions that we will build a justification for the catatonic state of Nawal in the pool and the reason that she would have to include her children (all of them) in her history full of "fires" (incendies).

II. THE ISSUE OF TRAUMA

In psychoanalytic writings, since Freud, the traumatic event can present itself in different ways, including different types of aggressions, any serious event, "or even any harmful chronic situation" (DOIN, 2005, p.2). What matters to Freud is that these events go beyond the capacity for assimilation, that is, of psychic elaboration of the individuals who experience them. These traumas are not necessarily of a sexual nature. From the observation of Austrian soldiers returning from the First World War, who despite many tormenting memories were unable to talk about them, Freud identifies that experiences of war, social and political violence can also be seen as traumatic, as everyone who participates in it is invaded by stimuli that they cannot assimilate or represent.

In this sphere, the German philosopher and essayist Walter Benjamin (1892-1940) writes, in his well-known text *The narrator* (1936/1994), that the experience would be on the verge of extinction and, with that, the modern human being would be losing the ability to elaborate as a true experience (Erfahrung) what he lives. This is because the transformations - technological, ethical, aesthetic, perceptual, etc. - that occurred from Modernity would have caused a profound change in the structure of experience. We would no longer have the ability to integrate

perceptions with our individual and collective memories, that is, with the wisdom accumulated historically. It is this capacity for integrating memories that Benjamin calls the elaboration of experience in the traditional sense of the term. In this regard, he reports the return of soldiers from World War I:

At the end of the war, it was observed that the combatants returned mute from the battlefield not richer, but poorer in communicable experience. (...) There was nothing unusual about that. Because there have never been experiences more radically demoralized than the strategic experience of trench warfare, the economic experience by inflation, the experience of the body through the material war and the ethical experience by the government. A generation that still went to school on a horse-drawn tram found itself outdoors in a landscape where nothing had remained unchanged, except the clouds, and beneath them, in a force field of torrents and explosions, the fragile human body (BENJAMIN, [1936]1994, p. 198).

In this passage described above, Benjamin is using as an example the traumatic experience suffered by soldiers in the First World War. It was also an experience of shock that the soldiers, who returned from it, were unable to elaborate as a true experience. Like trauma, the shock experience "brings to mind, in a short period of time, an increase in stimulus too large to be absorbed" (FREUD, [1917]1976, p. 335). Indeed, it is the notion of trauma in Freud that Benjamin will derive his conception of the shocks experienced in Modernity. Just as soldiers received more stimuli than they could handle, the inhabitants of large cities would be at all times having to deal with more stimuli than their psychic apparatus would be able to elaborate.

With this in mind, we can say that we suffer a trauma when we receive a greater amount of stimuli than our capacity to elaborate, to assimilate them. If the stimulus is excessive, we could not give a sense or produce a representation of what we experience, we could not integrate these stimuli into all of our past experiences. The traumatic is, therefore, the excessive for us. Excessive stimuli do not make us produce memories, but only images that are frozen and repeated indefinitely, images that require elaboration, as in a traumatic dream (FREUD, [1920]1976). Freud states that the traumatic dream is characterized by a compulsion to repeat; the dreamer compulsively repeats the traumatic scene trying to make it assimilated or elaborated by the psyche.

According to Freud, the excess resulting from traumas could be integrated into our memory if we went through an elaboration work (FREUD, [1914]1976). As the father of psychoanalysis said, elaboration is a work that the psychic apparatus does to control excitations and establish connections between ideas or representations, avoiding direct discharge of stimulations. In this sense, elaboration produces meanings and allows choices between a stimulus and the reaction to it, making a subject less dependent on the impulses or orders that come to him (FREUD, [1926]1977).

For Freud, the elaboration work consisted of reliving the trauma, talking about it and turning it into a memory like the others. Instead of repeating, recall. In this way, it would be possible to resume the normal functioning of memory and sensations, instead of living with frozen memories and anesthetized sensations.

This conception of trauma, capable of being elaborated, would be closer than the Hungarian psychoanalyst Sándor Ferenczi treated as a structuring trauma, as we will see later. These would be the traumas suffered by Nawal's children, Jeanne and Simon, throughout the movie. As the film shows us how the twins, little by little, discover the traumatic events of their mother's life and, from then on, they understand, more and more, why she left specific instructions for them. And gradually, climbing all the steps indicated by her in the testament letter, they could finally build her headstone, feeling that a certain route was fulfilled.

These steps, or purposes, left by Nawal, which they must follow, can be seen as potential ways of elaborating traumas that at first they did not even know existed and that they end up experiencing during their journey. That is, they discover one event at a time - such as the fact that they had a brother and he became a war soldier, the tragedies suffered by her mother while she lived in the Middle East and finally the reason that led her to enter catatonic state in that community pool. That way, they would not encounter any really excessive events, as everything would be done in small doses. Without having their capacity for elaboration invalidated, the twins could integrate their traumas into their individual and collective memories, that is, to the historically accumulated wisdom.

Ferenczi believes that every encounter between the subject and the world has a traumatic potential and traumas are one of the possibilities that open space for changes in the rhythm of life. "It is through disruptions in an established balance that living beings change. In that sense, trauma enhances life" (REIS, 2017, p. 182). Even when the twins discover the worst of secrets, that their brother is also

their mother's rapist and as a consequence his own father, when they find him and give him his mother's letters containing all the explanations, they are in the process of elaborating everything that happened. Structuring trauma contributes to development, even if it comes from suffering. Traumatic shock can produce an excess that, when elaborated, propels the subject forward, towards something new.

In this case, we understand as structuring trauma “an event or process that exceeds our capacity for assimilation at a certain moment, and that can, gradually, be integrated into the psyche and linked to other images and representations” (GONDAR, 2017, p. 90-91).

So far, we have seen that there are traumas that can be assimilated, allowing the subject to return to the normal functioning of his memory and sensations. But what about when the trauma cannot be assimilated, or rather, what happens when a trauma remains incommunicable, unrepresentable in the psyche as in the case of Nawal?

III. DESTRUCTURING TRAUMA AND THE GRAY ZONE

As we have seen, trauma according to Freud is very close to the notion of structuring trauma proposed by the first-generation Hungarian psychoanalyst Sándor Ferenczi (1873-1933). However, in addition to the structuring trauma, there is another type of trauma in Ferenczi's thought: the destructuring or invalidating trauma.

In order to exemplify a destructuring traumatic situation, Ferenczi (1933/1992) proposes a model for thinking a real violence scenario: an adult who sexually abuses a child, emphasizing the confusion of languages involved there, and another adult to whom the child confides what happened. In this situation, therefore, there are three characters and two moments (PINHEIRO, 1995). In the first moment the child plays with an adult and, while the child is in the language of tenderness - tenderness, here, is not opposed to sexuality, referring to a sexuality experienced from another parameter, not genital, ludic - fantasizing playfully in relation to the adult, the latter judges children's games as seductive advances of those who have already reached maturity. Because of this, the adult responds to playful seduction through another type of language: that of passion. He mistakes playful tenderness for genital seduction and ends up performing acts of sexual significance. This adult, out of guilt or fear, tells the victim that nothing has happened.

In the second moment, the child, without being able to elaborate psychically, that is, giving meaning to what

happened to her, seeks another adult of her trust so that he can help her with some explanation about the suffered violence. The second adult also denies what happened. It is through sexual violence and denial that the destructuring or invalidating traumatic scenario is constructed. The denial, here, is not just a matter of words, it is “the affections of a subject, his suffering, and himself as a subject that is being denied. The conjunction between the violence of the act and the victim's discredit, constitute, for Ferenczi, the invalidating trauma” (GONDAR, 2017, 91).

This model built by Ferenczi does not invalidate traumatic situations that occurred in different circumstances. He proposes this model as an organizing reference. However, in cases of extreme violence, invalidating trauma can occur without the violent act and denial taking place at two different times or containing three characters specifically.

Ferenczi validates what we are saying in *Reflections on trauma* (1934/1992, p. 110), a text in which he deals with psychic commotion as an immediate reaction to trauma: “A commotion can be purely physical, purely moral or physical and moral. Physical commotion is always also psychic; psychic commotion can, without any physical interference, engendering shock”. According to him, the shock would be equivalent to the annihilation of the feeling of self.

Thus, if the physical commotion is always also psychic, we can think about the possibility that physical violence psychically produces what corresponds to a denial generating the invalidating trauma. Gondar (2017) exposes two situations that can be considered similar to the sexual abuse scenario in the family, from the victim's psychological point of view: the experience of torture and the experience in the extermination camps. What will be important, in the three cases, is the experience of the annihilation of the Self and the importance of denial - located in what will be called the gray zone - for this to happen.

Who first wrote about the gray zone was Primo Levi (1919-1987), survivor of the Auschwitz extermination camp, in his book *The Drowned and the Saved* (2016). Levi writes that

the network of human relations within the Lager was not simple: it could not be reduced to two blocks, that of the victims and that of the oppressors. (...) [everyone] hoped to find a terrible but decipherable world, according to that simple model that we atavically bring with us, “we” inside and the enemy outside, separated by a clear, geographical boundary. On the contrary,

joining Lager was a shock because of the surprise it entailed. The world into which we plunged was certainly terrible, but also undecipherable: it did not conform to any model, the enemy was around but also inside, the “we” lost its limits, the contenders were not two, one border was not distinguished but many and confused, perhaps countless, separating each from the other (LEVI, 2016, p. 28).

Levi writes that the biggest shock within what he calls Lager (concentration camps) was the fact that the world inside could not be reduced into two blocks: the oppressors and the oppressed. The limits were not clear, because there was a hybrid class, a class of prisoners, who for different reasons, collaborated with the soldiers, that is, with the enemy. With that, it was no longer possible to organize a terrible, but decipherable, reality between friend and enemy. For once there, the subject suffered “a concentric aggression on the part of those in whom it was expected to find future allies” (LEVI, 2016, p. 28). The shock suffered was so great that it soon overturned the ability to resist and for many it was deadly, because “it is difficult to defend yourself from a blow for which you are not prepared” (LEVI, 2016, p. 29).

The fact of not being able to separate the world, inside, between friend and enemy was the biggest shock. Are these ill-defined outlines inside the Auschwitz death camp, this impossibility of making a division between victims and oppressors, between us and them - because often the we were inside them - that Levi called the gray zone.

Ferenczi (1934/1992) explains that the shock produces in subjectivity “the loss of its own form and the easy and without resistance of a granted form, like a bag of flour” (FERENCZI, 1992, p. 109), or, as has already been said, the shock is equivalent to the annihilation of the sense of self, of the ability to resist as oneself. Therefore, it is not difficult to see the relationship between what Ferenczi calls denial and what Levi is calling the gray zone. “In both situations, are being denied the values and world references that the subject has and on which your psyche is structured; it is the subject himself, therefore, who is being disallowed to exist as such” (GONDAR, 2017, p. 93). What interests us is that in both experiences the psychic effects will be similar. The lack of meaning and doubts about his own perception of reality are feelings experienced by the denied subject, and Levi situates what we are calling denial, or discredit, in that gray zone.

The relationship between the experience of torture and the gray zone is brought by the psychiatrist and essayist Frantz Fanon (1925-1961). Fanon, after graduating in

France, worked as director of the Psychiatric Hospital of Blida-Joinville in Algeria. His medical experience in that hospital, with the tortured Algerians, made it possible to verify that most of the victims of torture went through the same tactic by their torturers (FANON, 1979):

This tactic consisted of presenting itself to the victim in a contradictory manner, making the attitude, the voice and the behavior oscillate between two extremes. Thus, in some moments, the torturer screamed, raped and hurt the subject, while in others, he spoke sweetly to him, saying he was concerned about his pains and even treating his wounds. (GONDAR, 2017, p. 94)

Just as Jews who had just arrived in the extermination camp, as Primo Levi reported, had difficulties in organizing a reality between oppressor and oppressed, the victims of torture in Algeria, as Fanon identifies, were also unable to integrate the torturer only in the image of oppressor. The torturer placed himself in a gray zone where nothing made sense, further contributing to the annihilation.

Both in the extermination camp experience, in the torture experience described above, and in the experience of sexual abuse suffered by a child in a family environment, the values and references of life that are being denied are located in a gray zone. In the case of abuse by an adult who should protect that child, the denial already begins with the possibility of the act happening. For, once again, we can see the ill-defined contours for the psyche of this child in question. The child cannot identify her abuser only as an enemy or oppressor, “but as someone who also has tender feelings for her, who also takes care of her, someone who cannot be situated in them, and who is part of us, in order to guarantee the self” (GONDAR, 2017, p. 94). In this case, the violator adult presents himself to the child in an ill-defined place, or rather, in a gray zone.

We can affirm that Nawal suffered a destructuring trauma, because, when leaving that community pool and recognizing in her lost son's face her torturer, and rapist, she also collided with a place of ill-defined contours, a gray zone. The shock experienced by Nawal was so great that it overturned her ability to resist. “An unexpected shock, unprepared and overwhelming, acts so to speak as an anesthetic. (...) By suspending all kinds of psychic activity, added to the establishment of a state of passivity devoid of any and all resistance” (FERENCZI, 1934/1992, p. 113). Her catatonic state, according to Ferenczi (1934/1992), also includes the suspension of perception and the suspension of thought. As a consequence, the personality is deprived of any protection.

There is no way to defend yourself from a blow that you didn't expect to hit. Her world values and the structuring of her psyche were denied within a gray zone. For her the destructuring trauma, or disabling, it ended up being deadly. Even though Nawal went through all the traumas that marked her existence - murder of her fiancé, loss of child, imprisonment, torture and rape -, all of which are potential destructuring traumas, and still keep moving forward, despite all the suffering, realizing that her lost son was actually the father of her twin children, she fails to create a representation of what she is witnessing and succumbs to a catatonic state.

Before recognizing that three vertical dots tattoo on her son's heel, even though she went through countless traumas as already mentioned, her world, as terrible as it was, made sense. She could tell the friend from the enemy, the aggressor from the oppressed, the torturer from the tortured victim. But the moment she leaves that pool and recognizes in the same person both a victim of her actions - we will deal with Abou Tarek's traumas below - and the enemy, or rather, her aggressor, her world is denied and everything that used to make sense to her from one moment to the next does not.

In the case of Abou Tarek, or Nihad his name at birth, his traumas already begin at the time of his birth. Separated from his mother and sent to an orphanage, Tarek was also a victim of the ethnic-religious war in the Middle East. After having his orphanage destroyed, Abou Tarek is recruited for the holy war in which he becomes an accomplished soldier. Having known only violence, he grows up and becomes the cruelest torturer of a female prison, a prison that would be the same as Nawal would stay for a while. The film does not follow the life story of Abou/Nihad, what we know about him is information obtained through reports from other people that in one way or another would be related to the story. What is shown to us, onlookers, is that when the twins manage to find their father, and brother, they give him two letters from Nawal. The first is addressed to Nihad, explaining that she was his mother and that she never stopped looking for and loving him; the second is aimed at Abou Tarek, her torturer, rapist and father of her twins.

When delivering the letters to their father/brother the twins leave, and, as we said earlier, they would be in the process of traumatic elaboration because of everything they discovered about their mother's story and their own story. It now remains for Abou Tarek / Nihad to deal with his own traumas, old and new, after all his discoveries through the letters delivered by Jeanne and Simon. The film does not show us what happens psychically to him after reading the letters, however it is not impossible to think due to

everything that he went through in his life, and on top of the new information about him having committed incest, his own perception of reality has ill-defined borders, that is, that he is in a gray zone.

The scene of the delivery of letters is quite emblematic, first by the fact that evidence, in a comprehensive way, Simon's finding that one plus one equals one, giving a very complex outline to the enigma of the film that brings together, at the same time, the arguments of mathematics in the solution of existential dramas. Once the solution of mathematical operation completely escapes the field of concrete held, the argument used in the film, both by the author of the play and by the director, touches on an insoluble solution about the origin of the twins: they are fruits of the violation of incest and for that reason condemned to have a father who is at the same time a brother, thus bonding two lineages of descent.

IV. FINAL CONSIDERATIONS

In this way the film combines two nuances of the human condition, as we can infer from an excerpt from one of the letters: "My loves, where does your story begin? At your birth? Then it starts in horror. At your father's birth? So, it starts in a love story".

The traumatic story of the origin of Nawal's three children begins in love and comes to hate. From love to horror, there are four lives marked by the footsteps of destiny with traumas that will never be cured and boundaries that will never be defined. The outcome produced by the living letters of the letters gives new meaning to the life of the twins and ensnares the brother/father in a cage of despair from which only death will free him, as happened with Nawal. Ultimately it is trauma and finally death that unites Nawal, Abou Tarek, Simon and Jeanne forever.

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The importance of Pap smear for the prevention of Cervical Uterine Cancer

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Abstract—It is a slow-developing malignant neoplasm with a high cure rate when diagnosed early. The most important risk factor is the Human Papilloma Virus (HPV) infection, with sexual intercourse as the main form of contagion. Contribute to women's awareness about the importance of performing the preventive examination in the early diagnosis of Cervical Cancer. The expected results are to clarify the risks of cervical cancer (CC) in women's health and inform the women about the importance of periodic pap smear in the prevention of uterine cancer. This is a descriptive analysis study regarding the importance of performing the Pap smear as early diagnosis and prevention of uterine cancer, description of the cervix, its lesions, and HPV virus infection. It is concluded that the lack of knowledge about the method of prevention of CC is relatively large, with this should occur a better orientation, greater dissemination, and more qualified professionals, thus increasing the adherence of women performing the examination periodically.

Keywords—Cervical Cancer, Preventive Examination, HPV, Prevention, Vaccine.

I. INTRODUCTION

Cervical cancer also called cervical cancer is a malignant neoplasm that affects the cells of the cervix. It consists of the growth of a disordered form of the lining epithelium of the organ and may invade organs near or far from the anomaly. It is a slow-developing disease with

high chances of cure when diagnosed early. It is the third most common malignancy in the female population, second only to breast and rectal cancer, being the fourth leading cause of death of women from cancer in Brazil [1]. The most important risk factor and present in virtually all cases confirmed with this malignant neoplasm is human papillomavirus (HPV) infection, also having as other risk

factors smoking, early sexual relations, several partners, prolonged use of contraceptives, unprotected sex, multiparity among others [2].

The primary and most effective method consists mainly of the use of condoms during sexual intercourse, HPV vaccination provided only for girls from 9 to 13 years of age and periodic performance of the preventive examination Pap smear, this test is considered the most effective method for control and early diagnosis of this type of cancer [3, 4]. Given the extent of the problem, there is a need to disseminate and raise awareness of the importance of performing the Pap smear in the prevention and early diagnosis of cervical cancer to increase information and adherence to it and thus avoid or minimize possible injuries arising from the non-performance of the preventive examination.

II. PROPOSED METHODOLOGY

In this study, a descriptive analysis was performed regarding the importance of performing the Cytopathological Pap smear as early diagnosis and prevention of uterine cancer, description of the cervix, its lesions, and HPV virus infection. He followed an approach on cervical injuries, in articles, monographs, dissertations, theses, books, and periodicals, published between 2000 and 2016. The observation unit of the study were the subjects that had as descriptors: Pap smear, prevention, uterine cancer, HPV.

III. LITERATURE REVIEW

1.1. Uterine cervix cancer

Cervical cancer is a disordered replication of the lining epithelium of the uterus that is located at the bottom of the vagina, harming the underlying tissue (stroma), thus invading near or distant organs. It is mainly caused by the HPV virus, and maybe asymptomatic and usually takes 10 to 20 years to develop its diagnosis is made through the examination called Pap smear. Two main types of cervical cancer vary according to the origin of the compromised epithelium: squamous cell carcinoma (represents about 80% of cases) and adenocarcinoma, the rarest type that affects the glandular epithelium (10% of cases) [3].

1.2. Risk factors

Uterine cervical cancer is related to several risk factors, including HPV infection being considered the most important, early onset of sexual intercourse, multiplicity of partners, unprotected sex, as they increase the spread of HPV virus, history of the sexually transmitted disease

(STD), prolonged use of oral contraceptives, multiparity, smoking, nutritional deficiency and fear of the patient to perform the preventive test due to fear, shame or difficulty in accessing health services [2, 5].

1.3. Prevention and treatment

The primary prevention method consists mainly of the use of condoms during sexual intercourse, both male and female, performing the preventive pap smear, where it is considered the most successful method in the control of uterine cancer, and currently we have the bivalent and quadrivalent vaccine against HPV where it is distributed by the Unified Health System (UHS) [4, 6, 7].

Among the most common treatments, they consist of destroying the lesions caused by the virus, being with surgery or radiotherapy. Some factors should be taken into account for choosing the method to be used, including age, location, lesion extensions, tumor size, symptoms, and patient mood (desire to have children) [4].

1.4. Pap smear

It was discovered in 1940 by Dr. George Nicholas Papanicolaou (1886-1962) during studies on hormonal cytology. This method aims to detect changes in squamous cells and early diagnosis of diseases and the risks of women developing this type of cancer, also allows observing the presence of warts, vaginal infections, lesions in the female reproductive system, such as possible HPV infection, tumors in the vagina and cervix, sexually transmitted disease (STD) and conditions of hormone levels. The earlier these changes are discovered, the greater the chance of cure, and the less laborious treatment, thus reducing the mortality rate from cervical cancer [8].

The Pap smear should be performed periodically by all women who have or have had sex. Initially, the examination should be performed annually, after two tests in a row, and with normal results, the preventive examination can be performed every three years. It is a painless examination, simple and fast, and can cause little discomfort at the time of collection due to the discomfort of the woman. To perform the examination, the woman must avoid having sex (even with a condom), 48 hours before the collection, avoid the use of showers, vaginal medications, and local contraceptives in the next 48 hours before collection. The patient mustn't be menstruating, pregnant women can also perform the examination [1].

The collection is performed in such a way: The patient is placed in a gynecological position on a stretcher where with the aid of the fingers shoes by procedure gloves moves away from the walls of the vagina, later an instrument called a speculum is

introduced into the vaginal canal until it obtains complete visualization of the cervix, then the professional causes a small scraping of exfoliative cells of cervical and vaginal secretions, through the ectocervical material (external) performed with the Ayre spatula and the endocervical (internal) performed with a brush adapted exclusively for this type of procedure. The collected cells are spread vertically on a microscopy lamina by the Ayre spatula and horizontally by the brush evenly, soon after it should be fixed by a cytopathological fixator to avoid desiccation and deformation of the cells, the material must be identified with the patient's name, age, and the collection unit. After all these procedures you will be referred to a clinical analysis laboratory specialized in cytopathology [1, 9–11].

After the examination, the patient should return to the place where the collection was performed on the scheduled date to receive the result and forward it to the doctor. As important as the performance of the examination is the receipt of the result presented to the doctor [10].

1.5. HPV x Uterine cancer

The Human Papilloma Virus (HPV) is the virus responsible for cervical cancer, where it is estimated that about 10 to 50% of people who have a sexually active life are infected with at least one type of HPV virus. Currently, about 150 different types of HPV are recognized, where 40 of these types dominate in the genital organs. Viruses are classified as causing benign tumors causing common warts, papilloma, and condylomas. It is responsible for being the most common STD in the world, transmitted by contact of any cell of the skin or mucous membranes, vulva, anus, oropharynx, mouth, feet, vagina and cervix, being sexual intercourse the main form of contamination, thus causing malignant or benign tumors. In males, the most common clinical exposure of the virus is genital and anal warts. In females, she also has warts, but, moreover, she is responsible for most degrees of neoplasms in the cervix [12].

Among the 40 different types of HPV viruses, there are low-risk and high-risk oncogenic ones. Low-risk ones are associated with benign lesions including viral types 6, 11, 26, 42, 44, 54, 70, and 73 cause simple warts, papilloma, and condylomas. The high risk is 16, 18, 31, 33, 35, 39, 45, 51, 55, 56, 58, 59, 66 and 68, are related to the different degrees of intraepithelial squamous lesions of the cervix, vulva, penis, vagina; cervical carcinomas, head, and neck, oral cavity, larynx, oropharynx. Types 16 and 18 are the ones with the highest incidence of cervical cancer present in 70% of the cases already confirmed and

the 6 and 11 as low risks are found in 90% of genital condylomas and papilloma [13].

1.6. HPV Vaccine as a prevention device

To combat the proliferation of the virus and HPV lesions, a vaccine against the HPV virus was developed, this vaccine is based on contact with virus-like particles, preventing viral DNA from acting against host cells [14].

In Brazil, two prophylactic vaccines were approved, the bivalent one where it protects against CC caused by HPV types 16 and 18 and the quadrivalent vaccine, where it protects against HPV types 6, 11, 16 and 18, avoiding cervical, vaginal, vulvar and anal cancer, in addition to the genital wart. It is estimated that both vaccines in addition to preventing CC, also prevent other types of cancer caused by the HPV virus, with moderate to high efficacy. HPV infection in sexually active women can occur in any age group, although the highest degree of getting some HPV-related disease is soon after the onset of sexual life [15].

The Food and Drug Administration (FDA) approved quadrivalent vaccination for women aged 9 to 26 years, where vaccination is advised to occur in girls aged 11 to 12 years, and can be extended by 9 to 26 years, but has more efficacy in girls who do not yet have an active sex life. The Society of Oncology Gynecology of the United States indicates that regardless of whether the woman has abnormal Pap smear, genital warts, and positive viral presence, the vaccine can be performed in the same way, as it will be effective against the other types of HPV present in the vaccine and that the patient has not yet acquired [16].

The ministry of health began offering the HPV vaccine to boys aged 12 to 13 from January 2017, where it will be extended, progressively until 2020 serving boys aged 9 to 13 years. The vaccine available is the quadrivalent, where it confers protection against subtypes 6, 11, 16, 18 of the HPV viruses. The immunization of the HPV vaccine aims to protect patients against penile, anus, and throat cancers and diseases directly related to the HPV virus. Having as greater effective protection before the beginning of sexual life, that is, before contact with the HPV virus [17].

It is noteworthy that the HPV vaccine, although highly effective, does not replace other methods of prevention against cervical uterine cancer [18].

1.7. The importance and knowledge of cervical cancer prevention

Cervical cancer is a problem that affects women of all ages, regardless of their sex life, occurs worldwide and is still responsible for much of the number of deaths.

Numerous factors lead to the onset of the disease, among them lack of knowledge by the target audience, embarrassment due to the fact of exposing the body, discomfort, shame, fear of patients in which the examination is performed by a male professional, not having any apparent gynecological disease, level of education and, difficulty in accessing health units. The prevention and health incentive measures should develop methods that value the information and dissemination of knowledge of the theme, enabling more and more women to become aware of what it is, how it is performed and the importance of the examination for the early prevention of cervical cancer and thereby increase the adherence of women in the performance of the same [19–21].

1.8. Cervical cancer prevention program

Since 1940, in Brazil, pioneering initiatives have been made to control uterine cancer by professionals who brought cytology and colposcopy to our country. In 1956 Juscelino Kubitschek sponsored the construction of the Luíza Gomes de Lemos Research Center, currently integrated with RCCI – treating cases of breast cancer and female genital tract. This was the first initiative of institutional dimensions aimed at the control of CC in Brazil. Between 1972 and 1975 the Ministry of Health developed and implemented the National Cancer Control Program, aimed at tackling cancer in general. In 1984, IWHCP (Integrated Women's Health Care Program) was implemented, where basic health services offered women activities to prevent CC. The main contribution of this Program was to stimulate the collection for the Pap smear as a routine procedure in gynecological consultation.

In 1986, the Oncology Program (PRO-ONCO) was constituted, where he elaborated on the project for the expansion of uterine cancer prevention and control. After the creation of the STD, in 1988 the INCA became the body responsible for the elaboration of the national policy for the prevention of CC, incorporating PRO-ONCO. Due to the high rate of death due to CC, in 1996 the Ministry of Health developed a pilot project called "Live woman", intended for women whose age group is 35 to 49 years. Protocols were elaborated for the collection of material and the segment and conduct in the face of each alteration related to the test result, also introducing high-frequency surgery for the treatment of preinvasive cancer lesions. Due to being a pilot project, the action was restricted only to Curitiba, Recife, Federal District, Rio de Janeiro, Belém and, Sergipe, but in 1998 this action was expanded throughout Brazil.

In 2011, the Brazilian guidelines for cervical cancer screening were also published by INCA. In 2014, the

National Immunization Program (NIP), began the vaccination campaign against the HPV virus for adolescent girls. The function of primary care is to organize actions for the prevention of CC through health education actions, group vaccination, and early detection of cancer through screening. Secondary and Tertiary Care has the function of confirming the diagnosis and treating ambulatory the precursor lesions of the CC with the performance of colposcopies, biopsies, and excision. The Pap smear performed periodically remains the most used technique in the screening of CC. Reaching a high number of target audiences is the priority in primary care, to significantly reduce the number of deaths from this neoplasm. Cervical cancer has a long period of lesions, and may be asymptomatic or not, curable in most cases where they are diagnosed early and when treated appropriately [17].

Valent et al., (2009) [22] in a study conducted with 1035 female night high school students in public schools in the city of Uberaba/MA to identify knowledge about the Pap smear test found that 38.4% of the women interviewed had an erroneous knowledge about this exam. In a study developed in the city of São José de Mipibu/RN, from March to September 2007, where 267 women were interviewed, aged between 15 and 69 years and who had already started sexual activities, it was observed that 98.1% of the women have heard about the procedure, but only 46.1% know what the preventive examination serves [23]. Corroborating the research conducted in a Basic Health Unit of the Northern State of Paraná where they interviewed 54 women, between 17 and 46 years old, reported that some women claim to know about the existence of uterine cancer, but did not know that the preventive examination Pap smear was the test in which they diagnosed cancer early [24].

In descriptive research with a quantitative approach, developed in a Unified Health System (UHS) of the Southern District of the City of Natal, capital of the State of Rio Grande do Norte, in the Northeast region of Brazil, some women reported that they did not perform the preventive test due to shame, fear at the time of performance and difficulty in making an appointment and receiving the results, where 41.7% are afraid of being diagnosed with the disease, thus generating one of the main reasons for not returning to the unit in search of results, and 33.3% do not perform it due to the delay in delivery of results and difficulty in scheduling, causing them to return several times to the health center [25]. An exploratory descriptive study, conducted in a Unified Health System (UHS) of a municipality in the north of Paraná, interviewed 54 women, between 17 and 46 years

old, emphasizing that the preventive exam is impaired due to the majority of women feeling ashamed at the time of collection and afraid to discover they have cancer. The rudeness of some professionals at the time of collection makes access to basic health services difficult [24]. In a study conducted by Brenna (2001) [26], where he interviewed 138 women, among them 80% were demotivated and ashamed to perform the test, 60% reported that the doctors did not examine and 50% complained about the waiting time for the consultation and the delay in scheduling.

IV. FINAL CONSIDERATIONS

Due to the facts mentioned, it is concluded that, given the lack of knowledge about the method of prevention of CC, public policies should be organized for the dissemination and training of health professionals so that they can guide and encourage, clearly transmitting the information that points out the importance of performing the Pap smear periodically, it should also be reported how the examination is performed, highlighting its advantages. With everything, the teams of professionals in this area must possess the knowledge and adapt to the reality of their community, to provide strategies and objectives to obtain better results in the prevention of this disease.

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Analytic Hierarchy Process in Production Engineering: A Bibliometry Analysis

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Abstract— AHP (Analytic Hierarchy Process) tool stands out for its reliability and effectiveness, therefore, the objective of this research was to identify the scientific productions found in the electronic databases chosen by the author on the AHP tool. The date of publication covered by the survey comprises the periods from April 1992 to January 2018. The electronic bases used for the research were Scopus, Web of Science and Scielo, which after filtering only articles that mentioned the method in the title or abstract totaled in 178 articles. The year 2013 was the most productive with 24 articles (13.48%) published. Eight researchers appeared to be more productive because they had more than one published article. The International Journal of Production Research was the most productive periodical (5.62%), China the country with the largest number of publications (34.26%) and four universities had the largest number of articles published (6.74%) and the words that more appeared in article were process, hierarchy, analytic, fuzzy and production. It is concluded that the AHP tool still has great relevance in decision support methods even after 46 years of its creation, and that its potential continues to be promising for the analysis and solution of problems.

Keywords— AHP, bibliometry, AMD, Multicriteria Decision Support.

Analytic Hierarchy Process na Engenharia De Produção: Uma Análise Bibliométrica

Resumo— A ferramenta AHP (Analytic Hierarchy Process) se destaca por sua confiabilidade e efetividade assim, o objetivo deste trabalho foi identificar as produções científicas encontradas nas bases de dados eletrônicas escolhidas pelo autor sobre a ferramenta AHP. A data de publicação abordada pela pesquisa compreende os períodos de abril de 1992 até janeiro de 2018. As bases eletrônicas usadas para a pesquisa foram a Scopus, Web of Science e Scielo, que após filtragem por apenas artigos que mencionassem o método no título ou resumo totalizou-se em 178 artigos. O ano de 2013 foi o mais produtivo com 24 artigos (13,48%) publicados. Oito pesquisadores figuraram como mais produtivos por terem mais de um artigo publicado. O International Journal of Production Research foi o periódico mais produtivo (5,62%), a China o país com maior número de publicações (34,26%) e quatro universidades tiveram o maior número de artigos publicados (total: 6,74%) e as palavras-chave com maior frequência no artigo foram process, hierarchy, analytic, fuzzy e production. Conclui-se que a ferramenta AHP ainda possui grande relevância

nos métodos de apoio à tomada de decisão mesmo depois de 46 anos de sua criação, e que seu potencial continua sendo promissor para a análise e solução de problemas.

Palavras-chave— AHP, bibliometria, AMD, Apoio Multicritério à Decisão.

I. INTRODUCTION

The market is in increasing need for quality information, which makes decision support tools a pivotal force for choices involving large risks in companies.

The available tools are the most versatile, providing rational procedures to model problems and represent and quantify variables, taking into account the criteria and weights proposed by the decision makers. Currently, the AHP (Analytic Hierarchy Process) method stands out for its traditionality and reliability.

On the other hand, with the significant increase in the publications, works that classify and / or synthesize the knowledge produced become more relevant. Bibliometric, scientometric and web-based studies, as well as systematic reviews, stand out in this line. In this way the reader will have access to a quality material, which describes aspects predominantly quantitative of the state of the art of a certain theme.

When comparing the scientific production of bibliometrics in the Scopus site in 2006 and 2017, which had 205 and 1172 publications respectively, the 471.71% increase in publications empirically affirms the growing relevance of the theme in the academic community.

The present study aims to identify the scientific production about the AHP method pertinent to the Multicriteria Decision Support.

II. ANALYTIC HIERARCHY PROCESS (AHP)

Multicriteria Decision Support (AMD) consists of a set of methods and techniques to assist or support individuals and organizations in making decisions, when having multiplicity of criteria (GOMES *et al.* 2002).

Another important step is the choice of the method to be used, which should depend more on its adequacy to the preference structure of decision makers than on the analyst's preference for particular models and methods.

The multi-criteria decision analysis process can be presented with the following steps (GOMES *et al.* 2004):

- 1) Identification of decision-makers and their objectives;
- 2) Definition of alternatives;

3) Definition of criteria relevant to the decision problem;

4) Evaluation of alternatives to criteria;

5) Determination of relative importance of criteria;

6) Overall assessment of each alternative;

7) Sensitivity analysis;

8) Recommendation of courses of action;

9) Implementation.

It should also be noted that a family of criteria, that is, the set of criteria used in a given decision situation, must satisfy three conditions (Roy's axioms) to be a coherent family of criteria (ROY; BOUYSSOU, 1993; MELLO *et al.* 2003): exhaustiveness (it imposes the need to describe the problem taking into account all relevant aspects); cohesion (requires the correct analysis of which are the criteria of maximization and which of the minimization criteria); and non-redundancy (it obliges to exclude criteria that are evaluating characteristics already evaluated by another criterion).

The AHP (Analytic Hierarchy Process) method was developed by Tomas L. Saaty and his first record is dated 1972 in the article An eigenvalue allocation model for prioritization and planning. It is the most widely used and well-known multicriteria method in support of decision-making in negotiated dispute resolution, in problems with multiple criteria (MARINS, SOUZA, BARROS – 2009).

Ishizaka and Labib (2011) affirm that the structural basis used in the method is inspired by past findings, such as peer comparison rather than weight allocation (Thurstone, 1927; Yokoyama, 1921), the hierarchical formulation of the criteria (Miller, 1966), scale 1-9 based on observational psychology (Fechner, 1860; Stevens, 1957) and the number of items in each level (Miller, 1956).

According to Costa (2002, p. 16-17) this method is based on three stages of analytical thinking:

1 – Hierarchical Construction: Because problems usually have complex resolutions, their structure is made hierarchically to facilitate their understanding. The first level corresponds to the general purpose of the problem, the second level the criteria and the third the alternatives.

2 – Prioritize: In order to define such importance, the following steps must be followed:

- Joint Judgments: We judge the elements of a hierarchy level in comparison of each element in

connection with a higher level, establishing the judgment matrices A, using the scales presented in the table 1. (TREVIZANO E FREITAS, 2005);

Table 1 - Saaty Number Scale

Number Escala	Verbal Scale	Explanation
1	The two elements have the same importance	The two elements contribute property equally
3	Moderate importance of one element over another	Experience and opinion favor one element over the other
5	Strong importance of one element over the other	An element is strongly favored
7	Very strong importance of one element over the other	One element is very strongly favored over the other
9	Extreme importance of one element over the other	An element is favored by at least one order of magnitude of difference
2, 4, 6, 8	Intermediate values between opinions	Consensus values

Source: Roche (2004, p.6)

The number of judgments required to construct a generic judgments matrix A is $n(n-1)/2$, where n is the number of elements belonging to this matrix. The elements of A are defined by the conditions :

$$A = \begin{bmatrix} 1 & a_{12} & \dots & a_{1n} \\ 1/a_{21} & 1 & \dots & a_{2n} \\ \vdots & \vdots & \dots & \vdots \\ 1/a_{n1} & 1/a_{n2} & \dots & 1 \end{bmatrix}, \text{ onde}$$

$$a_{ij} > 0 \Rightarrow \text{positive}$$

$$a_{ij} = 1 \therefore a_{ji} = 1$$

$$a_{ij} = 1/a_{ji} \Rightarrow \text{reciprocal}$$

$$a_{ik} = a_{ij} \cdot a_{jk} \Rightarrow \text{consistency}$$

- Normalization of the matrices of judgment: obtaining normalized tables by adding the elements of each column of the matrices of judgment and later division of each element of these matrices by the sum of the values of the respective column;

- Calculation of local average priorities: These are the averages of the lines of the standard tables;

- Calculation of global priorities: in this step we wish to identify a global priority vector (PG), which stores the priority associated with each alternative in relation to the main focus.

According to Vaidya and Kumar (2006), one of the main advantages of the AHP method is its flexibility,

allowing integration with other techniques for problem solving, such as Quality Function Deployment, Fuzzy Logic and Linear Programming. This enables the decision-maker to derive the benefits of all the combined methods, helping to achieve the desired results optimally.

Tam and Tummala (2001) describe the AHP as being very useful for reaching a consensus when it involves several decision makers with different conflicting objectives.

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According to Silva and Hamacher (2008), one difficulty that persists in problems structured with the AHP method is the quantification of project quality assessments.

Grandzol (2005) says that improper application of the method in unfavorable environments is perceived as oversimplification or as a waste of time.

Although the fault is not blamed on the tool's structure, most decision makers are unaware of the successive improvements that have been developed over time to specific thematic problems (ISHIZAKA, LABIB, 2011).

Vaidya and Kumar (2006) find in their review of the main developments of the method, articles in the most diverse areas, including: manufacturing, engineering,

education, industrial, government, sports, administration, etc. In order to measure the classification of the areas of application of AHP, the authors classify in three groups: (a) applications based on themes, (b) specific applications and (c) applications combined with other methodologies.

The themes encompassed by the first group are selection, evaluation, cost-benefit analysis, planning and development, priorities and ranking, and decision making. The second group is focused on specific applications in meteorology and medicine related areas, while the third group has AHP problems integrated with the Quality Function Deployment (QFD) tool.

It is also interesting to highlight some works that made use of the method. Kengpol and O'brien (2001) present a decision-making tool for selection of advanced technology, integrating as criteria cost-benefit analysis, an effective decision-making model and a common criteria model for a choice of Time Compression Technologies (TCT).

III. BIBLIOMETRY

Tarapanoff et al. (1995) establish bibliometrics as the study of quantitative aspects of scientific production, sharing and use of information recorded, from mathematical models, to the decision-making process.

According to Lopes et al. (2012), bibliometrics is a quantitative and statistical method to measure indicators of production and dissemination of knowledge, as well as observing the development of several scientific areas and the patterns of authorship, publication and use of research results. The evaluation of the scientific production, important for the analysis of the researchers in the scientific community, is made through the application of several bibliometric indicators, which are divided into indicators of scientific quality, importance and impact.

Bibliometry has laws that use statistical and mathematical techniques that determine the principles of research and ordering in scientific analysis, such as the laws of Lotka, Bradford and Zipf (GUEDES AND BORSCHIEVER, 2005).

According to Urbizagastegui (2008), Lotka's Law states that the number of authors who make n contributions in a given scientific field is approximately $\frac{1}{n^2}$ of those making a single contribution, and that the proportion of those making a single contribution is about 60 percent.

According to Bradford (1934), there is a conception of core formation of journals that address a specific subject. The author states that with the advent of

initial articles on a particular topic, they will go through the selective process of journals to which they submitted, and if accepted, will promote the scientific production of articles on the same theme, creating a nucleus of more productive journals followed by areas of less dedication to the theme.

Zipf's Law is based on the principle of least effort: it accounts for the frequency of words in an article. According to Amaral et al. (2004), the law states that if the words appearing in an article are counted and sorted in descending order of number of occurrences, the multiplication of the number of occurrences by the ranking position for each word is a constant.

IV. METHODOLOGICAL PROCEDURES

The article analyzed three electronic databases for this study. Two reference bases (Scopus and Web of Science) and one textual (SciELO). The first two databases are not open to the public, and access has been granted through the partnership established between Brazilian universities and databases, the third being open to the public.

We use the term "Multicriteria Decision Support Tools" OR "AHP" OR "Analytic Hierarchy Process" AND "Production Engineering" in three databases: Scopus, Web of Science and SciELO. All articles that used the AHP method to solve problems were counted for research done in April 2018, the oldest article being dated from April 1992 until the most recent one published, dated January 2018.

Then, the data were exported to the Microsoft Excel 2013 software and stratified into the following items: author, H index, co-authors, year, university, country, journal, CAPES qualis, impact factor, title, keywords, and digital base.

CAPES classifies the production from the quality of journals by the Qualis system, in a ranking by levels A1, A2, B1, B2, B3, B4, B5 and C and can be found on the Sucupira Platform (online). Its importance is determined through the note, which takes into account the quality and number of published works (BARATA, 2016). The area of Engineering III was chosen for the research. The impact factor of journals can be found in the publications' own databases, which take into account the number of citations received by articles published in the journal in the two years prior to the evaluation, divided by the number of articles published in the period.

The H index of researchers was also found in databases, which take into account the largest "h" number

of articles of a researcher who has the same "h" number of citations each.

For the quantification of the indicators of years with the highest scientific production, the articles were ordered and counted per year of publication. The same method was used (ordering the appropriate variables for each index) to create the index of the most productive researchers, journals with more articles published on the topic, countries with more publications, more productive universities and keywords.

For the Cluster Word image, the keywords were placed on the website www.wordclouds.com, which generates clouds of words showing more prominently the words more frequently in the text.

V. RESULTS

The search terms resulted in 115 (one hundred and fifteen) articles from the Scopus database, of which 8 (eight) were withdrawn for not mentioning the method in the title of the paper or abstract. The Web of Science database returned 92 (ninety-two) articles, of which 21 (twenty-one) were excluded for not mentioning the method. And finally, the textual base Scielo, returned 0 (zero) articles. Unlike the previous databases that have articles in English, the Scielo database has many articles in Portuguese. An attempt was made to translate the term using "Multicriteria Decision Support Tools" OR "AHP" OR "Hierarchical Analysis Process" AND "Production Engineering" to search, but the result of the search again was 0 (zero).

Table 2 - Ten years that have had more articles published on the AHP.

Year	Number of articles
2017	8
2015	10
2014	15
2013	24
2012	11
2011	9
2010	13
2009	17
2008	11

2007	8
TOTAL	126

Source: The author, 2018.

Table 2 shows the 10 years that most had articles published. Starting with 2007, which had 8 articles published, 2008 with 11 articles, followed by 2009 with 17, with 13 articles, 11 articles with 11 articles, 11 with 11 articles, eleven) articles, 2013 with 24 (twenty four) articles, 2014 with 15 (fifteen) articles, 2015 with 10 (ten) articles and 2017 with 8 (eight) published articles, totaling 126 one hundred and twenty six articles.

The year 2013 was the most productive year of the study, with twenty-four (n = 24) total publications, contrasting with eight (n = 8) publications in 2007. Of the 27 years of publications found, the last 10 (except 2016, which had 7 publications), correspond to 70.78% of the total research. This shows that the growth of scientific production in recent decades has boosted bibliometrics as well as the generation of indicators to measure the results of scientific and technological activities (FILIPPO; FERNANDEZ, 2002).

Table 3 – Authors who have had two or more publications on the AHP tool

Authors	Number of publications	Index H
Chan, F.T.S.	3	49
Kodali, R.	2	23
Sharma, S.	2	13
Korpela, J.	2	10
Bascetin, A	2	8
Chen, X.-L.	2	1
Li, Z.	2	1

Fonte: Dados da pesquisa, 2018.

Table 3 shows the eight (n = 8) authors who had more than one publication in the research and its respective H index (according to the electronic database in which the file was found). Chan, FTS is the author with more publications, totaling 3 (three articles) and with an H index of 49 (forty-nine) points, being the author with the highest H index among the most productive authors.

Table 4 – Journal with two or more publications on the AHP tool

Journal's name	Quantity	Qualis	Impact Factor
International Journal of Production Research	10	A2	2,40
Advanced Materials Research	8	C	0,23
International Journal of Production Economics	7	A1	4,34
Expert Systems with Applications	5	A1	4,68
Environmental Progress and Sustainable Energy	4	-	1,46
International Journal of Advanced Manufacturing Technology	4	B1	2,15
Computer Integrated Manufacturing Systems	4	-	0,37
Journal of Manufacturing Systems	4	C	3,2
Production Planning and Control	4	-	1,54
Applied Mechanics and Materials	3	C	0,16
Process Safety and Environmental Protection	3	A2	2,57
CIRP Annals - Manufacturing Technology	2	-	3,62
Journal of Cleaner Production	2	A1	5,84
Production Engineering	2	B3	0,78
Management and Production Engineering Review	2	-	1,28

Source: The author, (2018)

Table 4 shows the 15 journals that had more than one article published in the survey, totaling 64 articles counted and representing 35.96% of the 178 articles. It was not possible to find the qualis of the journals Computer Integrated Manufacturing Systems, Environmental Progress and Sustainable Energy, Production Planning and Control, CIRP Annals - Manufacturing Technology and Management and Production Engineering Review. The journal with the most publications was the International Journal of Production Research (IJPR), with 10 articles published and above the average of 4.26% of articles published by this journal.

IJPR is a well-established and highly successful journal reporting production and manufacturing

research. It is published monthly and includes articles on manufacturing technology and the fundamental behavior of production resources, as well as the complex and interdisciplinary analysis and control problems that arise in combining these features in the design of production systems. The strategy of manufacturing, formulation and evaluation of policies and the contribution of technological innovation are the main concerns of the journal. Techniques developed in computational and mathematical sciences used in design, measurement or operation of production systems are also considered.

Although five publications were made in Brazil, no Brazilian journal appeared in this research (Table 5).

Table 5 – Countries with more articles published on the AHP tool

Country	Number of articles
China	61
Turkey	17
Iran	14
USA	14
India	9

Brazil	5
United Kingdom	5
South Korea	4
Finland	4
Italy	4

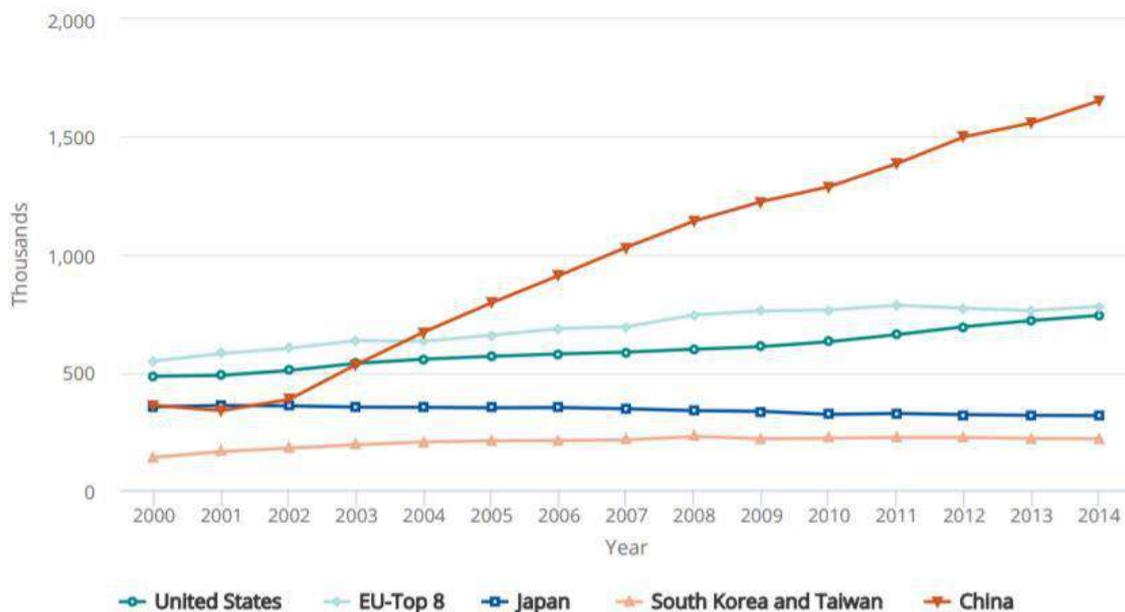
Source: The author, 2018

Table 5 shows the ten countries that had the most publications on the AHP tool. The sum of the publications of these countries corresponds to 76.97% (137 articles) of the total of articles of the research.

China was the country with most publications, leading the ranking with 61 (sixty one) articles and a very significant difference of 44 articles for the second place, Turkey, with 17 (seventeen) publications. This is an interesting number for discussion, as it reiterates data from the 2018 edition of the journal Science & Engineering Indicators, which states that China surpassed

the United States in the absolute number of articles produced, the country with the most published articles of the world.

Unlike the US that spends about \$ 500 billion in research and technology but with near-frozen spending in recent years, China has been steadily increasing its investment in the area, currently spending \$ 408 billion a year. In 2006, the country had approximately 190,000 published articles, and in 2016 reached the top position in the world leadership with more than 426,000, a substantial growth around 124%.



EU = European Union.

Fig.1 – Bachelor's graduates in the fields of Science and Engineering, from 2000 to 2014

Source: Science & Engineering Indicators, 2018.

One of the consequences of China's large research investment can be measured by the number of bachelors graduated in the field of Science and Engineering in the country, which from 2003 to 2014 more than tripled, with a remarkable increase of 240%.

For comparative purposes, Brazil in the period from 2006 to 2016 had a 89% increase in the

number of publications, but this increase is far behind the emerging economies. This situation is further weakened by the decrease in the budget for investments in the area in 2018, which is about 19% lower than the previous year (SMAILI, 2018).

Table 6 - Institutions with the largest number of publications on the AHP tool

Institutions	Number of articles
Islamic Azad University	3
Istanbul Technical University	3
Lappeenranta University of Technology	3
University of Tehran	3
Amir Kabir University of Technology	2
Beihang University	2
Beijing University of Chemical Technology	2
Engineering of Guangzhou University	2
Department of Mechanical Engineering	2
Indian Institute of Technology	2

Source: The author, 2018

There were four universities with more published articles tied with three articles, Islamic Azad University and University of Tehran, both from Iran, Istanbul Technical University, and Lappeenranta University of Technology, Turkey and Finland, respectively. The final table of universities that had two more publications adds up to 19 universities, which together have 42 publications representing 23.59% of the 178 articles.

Originally from Iran, Islamic Azad University began operations in 1982 and now has facilities in the United Kingdom, United Arab Emirates and Lebanon. The university has courses aimed at the most diverse areas, which include: Engineering, Agriculture and Veterinary, Humanities, Arts and Medicine. The Engineering areas correspond to about 42% of the students of the university, which has an investment of US \$ 140.9 million for research and maintenance of the facilities.

The University of Tehran opened its doors in 1934 and is considered the Center of Excellence by the Iranian Ministry of Science and Technology in the areas of

Sustainable Urban Planning and Development, Architectural Technology, High Performance Materials, Planning and Rural Studies among 11 other categories. With a funding of \$ 199.7 million, the university publishes more than 50 scientific journals and encourages teaching by giving full scholarships to students with the best marks in college entrance exams.

Istanbul Technical University is the oldest of the four, dating from 1773. With more than 20 institutes and research centers, the university was voted by QS World University Rankings as one of the 500 best university in the world and the best university in Istanbul in the field of Engineering and Technology.

Finally, Lappeenranta University of Technology began its activities in the year 1969. The university is known for awarding the Viipuri Prize, which boasts outstanding achievements in the field of strategic research.

Brazil had no prominent university in the subject, despite having 5 published articles, corresponding to 2.81% of the total articles found in the research.

this fact, the work had a more directed nature and found similar examples.

It is suggested for future research that the thematic area should be broader, not limited to Production Engineering but to other Engineering, or even open research. It would be interesting also to make a bibliometric comparison between other methods of support to decision making, coming from a distinction between date of creation or even schools of thought.

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Factor analysis as a tool for building the sustainable development index of river basins in Rondônia, Western Amazon

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Abstract— *Objective: to build a sustainable development index for the river basins of Rondônia, using factor analysis as an analytical model. Method: factor analysis was used as a tool for building environmental, economic, social and institutional performance indexes. The classification scale of Hair et al [16] adapted was adopted to express the results achieved by each hydrographic basin. Results: The set of sustainable performance indexes for the river basins of the Mamoré river (0.527) was considered a regular index; the Madeira River (0.388, a bad index); the Guaporé River (0.287, a bad index); the Machado river (0.256, bad index) and the Roosevelt river (0.177, terrible index). In addition, there was a drop in the indexes 10 years after the initial year of the survey, showing that, in terms of sustainable development, there was no improvement in Rondônia in the geographical context of the river basins. Conclusions: the factor analysis demonstrated efficiency as a multivariate statistical method in the construction of sustainable development indexes for the river basins of Rondônia. River basin management is still very ineffective, despite being regulated by state law. It is highly recommended to institutionalize regional public policies in the form of a River Basin Master Plan for Rondônia.*

Keywords— *Hydrographic basins. Factor analysis. Sustainable development. Rondônia. Western Amazon.*

I. INTRODUCTION

The world development process has brought about a cultural and economic change on a global level and that such change, in general, has contributed, to a greater or lesser degree, to the worsening of the planet's environmental conditions [1]. However, it took some time for humanity to realize that the actions carried out in one particular territory ended up aggravating the environmental situation in another, resulting in a socio-environmental and economic burden to the detriment of the prosperity bonuses achieved by the territories originating from predatory actions that, normally, exercised the hegemonic role of industrial control.

From the political-institutional point of view, results of international agreements, the situation began to be formally discussed, among the stakes holders, when the first World Conference on Environment and Development (CMMAD), held in Sweden, in the city Stockholm in 1972. However, the world, even so, still did not know how to solve, in practice, the equilibrium equation between “environment and development”, thus increasing the degree of complexity to carry out concrete actions in search of a model alternative development.

The Brundtland report, the main guiding document of the II CMMAD, which took place in Rio de Janeiro, in 1992, brought the famous definition of what would be this new model called “sustainable development”, which, in fact, would be very close to the concept of “ecodevelopment” brought by Maurice Strong a year after I CMMAD, leading authors like Ignacy Sachs to recognize them as synonyms [2]. However, one of the major issues that emerge regarding the sustainable development paradigm, in the field of praxis, concerns its viability. This practical dilemma still persists today. And in this temporal trajectory, the self-reinforcing characteristics end up dictating the rules of the game in society, within a conception of space and power relationship, and, thus, influencing institutional performances, based on their historical constraints, as pointed out in the institutionalist theory of Douglass North [3].

Thus, this work is part of a contribution to the discussion on methodologies applied to studies from the perspective of environmental management, in order to serve as a practical instrument of analysis, with the objective of assisting decision making and, with that, planning, under the regional focus, however, within the concept of endogenous development, mainly in peripheral regions such as the Western Amazon.

In view of the above, the spatial cut at the level of hydrographic basins in the State of Rondônia was adopted

as a central element of analysis, due to its role of importance for strategic planning and environmental management. In this context, the objective of the study was to build a sustainable development index for river basins in Rondônia, using factor analysis as an analytical model.

II. THE QUESTION OF WATERS AND THE RONDÔNIA HYDROGRAPHIC BASINS

The growing demand for water has aggravated water problems in many parts of the world. As a consequence, it is observed, more frequently, the increase in the statistics of completely dry rivers and / or streams and other sources totally unsuitable for human consumption, be they superficial or underground. Therefore, much of the water extracted for human activities, from whatever source, has been used in a very ineffective way [4].

Decree No. 24,643 of 1934 (Water Code) already regulated the use of water in Brazilian territory. Although it is recognized that the Water Code established a very advanced policy for the time, its regulation was limited to aspects related to the development of the electricity sector, leaving aside multiple uses and protection of water quality [5].

In the 1980s, with the institution of the National Environment Policy (PNMA), Brazil started to have a legal framework for dealing with environmental issues, which contributed to boost the formulation of new rules related to water management [6].

The Federal Constitution of Brazil, promulgated in 1988, played an important role in the management of water resources, because it defined waters as goods of common use and changed the dominance of the waters of the national territory, previously defined by the Water Code of 1934 [7]. Article 21, item XIX of the Federal Constitution of Brazil gives the Union the competence to institute a National Water Resources Management System and define criteria for granting the right to use it.

According to Setti et al [4], water resource management, in a broad sense, is the way in which it is intended to equate and resolve issues of relative scarcity of water resources, as well as to make the appropriate use, aiming at the optimization of resources for the benefit of society. Lanna [8] conceptualizes Water Resources Management as an analytical and creative activity focused on the formulation of principles, the preparation of normative documents, the structuring of management systems and decision-making, the ultimate goal of which is to promote the inventory, use, control and protection of water resources.

Law no. 9,433, of January 8, 1997, instituted in Brazil the National Water Resources Policy (PNRH) and the National Water Resources Management System, which, according to article 1º, presents the following grounds: a) the management of water resources must always provide for the multiple use of water; b) the hydrographic basin is the territorial unit for implementing the National Water Resources Policy and performance of the National Water Resources Management System; c) the management of water resources must be decentralized and count on the participation of the Government, users and communities.

One of PNRH's guidelines is to adapt water resources management to the physical, biotic, demographic, economic, social and cultural diversity of the different regions of the country, the integration of water resource management with environmental management, and the articulation of water resources planning with that of the user sectors and with regional, state and national planning.

In the context of the State of Rondônia, Complementary Law No. 255, of January 25, 2002, is in effect, which “institutes the State Policy for Water Resources of the State of Rondônia and creates the Management System and the Water Resources Fund for the State of Rondônia and other measures”.

By CNRH Resolution No. 32, of October 15, 2003, the Brazilian territory was divided into 12 Hydrographic Regions, as follows: Amazon, Western Northeast Atlantic, Eastern Northeast Atlantic, Parnaíba, Tocantins-Araguaia, São Francisco, East Atlantic, Southeast Atlantic, South Atlantic, Paraná, Uruguay, Paraguay. With regard to Rondônia, the State is inserted in the Amazon Hydrographic Region, with its territory divided into 7 hydrographic basins, which are those of the Guaporé River, Mamoré River, the Abunã River, the Madeira River, the Jamari River, the Machado River and the Roosevelt River.

Considering a hydrographic basin as a planning unit for the implementation and / or management of water resources requires addressing all elements of its landscape and not just water, in addition to adopting an approach that integrates environmental, social, economic and political aspects and the inclusion of environmental quality objectives for obtaining an increase in production potential with the minimum of environmental impacts and risks [9]; [10].

Santos [11] states that water management, from hydrographic basins, denotes:

“The close links between waters, other natural resources and human activities. In general, integrated management and river basin management plans aimed at resources

associated with water, are broader and more effective when they add measures for soil conservation, vegetation and fauna remnants and with the control of rural and urban activities”.

The hydrographic basin as a planning unit, therefore, is already accepted worldwide, since it constitutes a natural system well delimited geographically, where phenomena and interactions can be integrated a priori by input and output, thus hydrographic basins can be treated as geographical units, where natural resources are integrated. It also constitutes a spatial unit that is easy to recognize and characterize, considering that there is no land area, however small, that does not integrate with a hydrographic basin and, when the central problem is water, the solution must be closely linked its handling and maintenance [11]; [12].

In this sense Guerra [13] reports that the hydrographic basins integrate a joint view of the behavior of the natural conditions and of the human activities developed in them, since significant changes in any part of the basin can generate changes, effects and / or impacts downstream and in the outgoing energy flows (discharge, solid and dissolved charges), among other consequences.

From the point of view of planning and managing regional development, river basins are presented as objects of study with an integrated and unified view of planning, enabling approaches and studies from the most diverse perspectives [14].

For Magalhães Jr [15] the hydrographic basin as a management and planning unit, results from the complex interaction between the parts and the whole. The adoption of the hydrographic basin as a delimitation of the system to be managed has advantages and disadvantages. The advantage is that the drainage network of a basin consists of a preferential path in most of the cause-effect relationships, especially when dealing with the water environment. The disadvantages are that the municipal and state limits do not always respect the basin's dividers.

According to Guerra [13], river basin management plans in Brazil have mostly addressed only the aspect of the use of water resources (irrigation or sanitation or energy generation), causing problems of a social, environmental, economic nature, political and cultural. This is because these plans are not always related to sustainable development, since the environmental capacity to support development always has a limit, from which all other aspects will inevitably be affected.

It is, therefore, within this focus that the present work was structured, using instruments of multifactorial

analysis, to contribute to the discussions on the necessary means for decision-making in watershed areas in Brazil and, more specifically, in the Amazon.

III. PROPOSAL FOR AN ANALYTICAL MODEL

The proposal under study aims to establish a parameter for quantitative analysis involving issues inherent to environmental, economic, social, political-institutional parameters, capable of generating the index of sustainable development in river basins. For this purpose, factor analysis was used as a mechanism for building performance indices for each parameter studied.

Factor analysis is a generic name given to a class of multivariate statistical methods whose main purpose is to define the underlying structure in a data matrix. In general terms, factor analysis addresses the problem of analyzing the structure of the interrelations (correlations) between a large number of variables, defining a set of common latent dimensions, called factors. With factor analysis, the researcher can first identify the separate dimensions of the structure and then determine the degree to which each variable is explained by each dimension. Once these dimensions and the explanation of each variable are determined, the two main uses of factor analysis - summary and data reduction - can be achieved. When summarizing the data, factor analysis obtains latent dimensions that, when interpreted and understood, describe the data in a much smaller number of concepts than the original individual variables. Data reduction can be achieved by calculating scores for each latent dimension and replacing the original variables with the same ones [16]. Santana [17]; Santana [18]; Santana [19]; Santana [20] and Cavalcante [21] are other important works that corroborate with Hair et al [16].

For the analysis of such parameters, the municipalities were grouped by hydrographic basins, based on the distribution adopted by SEDAM - Rondônia State Secretariat for Environmental Development [22], as shown in table 1. It is also noteworthy that the Abunã River basin was not included in this work, since there are no municipalities in its coverage area.

Table 1: Distribution of river basins by municipalities in Rondônia.

Watersheds	Counties
Guaporé River	Costa Marques, São Francisco do Guaporé, Seringueiras, São Miguel do Guaporé, Alta Floresta d'Oeste, Alto Alegre de Parecis, Corumbiara, Cerejeira,

	Cabixi, Colorado do Oeste, Pimenteiras do Oeste
Mamoré River	Guajará-Mirim
Madeira River	Nova Mamoré, Porto Velho
Jamari River	Candeias do Jamari, Itapuã do Oeste, Alto Paraíso, Rio Crespo, Ariquemes, Monte Negro, Buritis, Campo Novo de Rondônia, Cacaupônia
Machado River	Cujubim, Machadinho do Oeste, Vale do Anari, Theobroma, Ouro Preto do Oeste, Governador Jorge Teixeira, Vale do Paraíso, Jarú, Teixeirópolis, Ji-Paraná, Nova União, Mirante da Serra, Urupá, Presidente Médici, Alvorada do Oeste, Cacoal, Castanheira, Espigão do Oeste, Pimenta Bueno, Chupinguaia, São Felipe do Oeste, Vilhena, Primavera de Rondônia, Rolim de Moura, Novo Horizonte do Oeste, Parecis, Nova Brasilândia, Santa Luzia D'Oeste
Roosevelt River	Ministro Andreazza

Source: Own elaboration, based on data from SEDAM.

3.1 Analytical model

A model of factor analysis can be presented in the matrix form as in Dillon; Goldstein [23]:

$$X = \alpha F + \varepsilon \quad (1)$$

Then,

X = is the p-dimensional vector transposed from observable variables, denoted by $X = (x_1, x_2, \dots, x_p)$;

F = is the q-dimensional vector transposed from non-observable variables or latent variables called common factors, denoted by $F = (f_1, f_2, \dots, f_q)$, where $q < p$;

ε = is the p-dimensional vector transposed from random variables or unique factors, denoted by $\varepsilon = (\varepsilon_1, \varepsilon_2, \dots, \varepsilon_p)$;

α = is the array (p, q) of unknown constants, called factorial loads.

According to Gama et al [24]; Santana [20], in the factorial analysis model it is assumed that specific factors are orthogonal, among themselves, with all common factors. Normally, $E(\varepsilon) = E(F) = 0$ and $Cov(\varepsilon, F) = 0$.

According to the authors, the initial structure used to determine the array of factorials loads, in general, may not provide a significant pattern of variable loads, so it is not definitive. This initial structure can be done by several methods of rotation of the factors, as Dillon and Goldstein [23]; Johnson and Wichern [25]. It was used the VARIMAX method of orthogonal rotation of the factors for this study.

The VARIMAX method is a process where the reference axes of the factors are rotated around the source until some other position is reached. The objective is to redistribute the variance of the first factors to others and to achieve a simpler and more theoretically significant factorial [16]; [18]; [20]; [24]; [26].

The choice of factors was carried out through the technique of latent root. So, the array of factorials loads, which measures the correlation between the common factors and observable variables, is determined by means of the correlation matrix, as Dillon and Goldstein [23].

For the determination of sustainable development indexes, the matrix of factor scores estimated by the factorial basis orthogonal rotation process was adopted, as pointed out by Santana [19]. The factor score, by definition, places each observation in the space of common factors. For each factor f_j , the i -th factor score extracted factorial score is defined by FI_j , expressed as follows [23]:

$$F_{ij} = b_1 x_{i1} + b_2 x_{i2} + b_p x_{ip} \quad (2)$$

Then:

b_i = are the estimated regression coefficients for the n Common factorials scores;

x_{ij} = Are the n Observations of p Observable variables.

$$i = 1, 2, \dots, n.$$

$$j = 1, 2, \dots, p.$$

To arrive at the equation that represents the Performance Index, Gama et al [24]; Santana [20], show the evolutionary sequence of formulas from the previous equation. It turns out that even if the variable FI_j is not observable it can be estimated through the factorial analysis techniques, using the matrix of observations of the vector x of observable variables. In factorial notation, equation 2 becomes:

$$F_{(n,q)} = X_{(n,q)} b_{(p,q)} \quad (3)$$

In Equation 3, F is the matrix of the estimated regression from the n Factorials scores and it can be affected by both the magnitude and the measurement units of the variables x . To work around this kind of problem,

replace the variable x by the standard variable w , given the ratio of the deviation around the average and the standard deviation of x , as follows:

$$\frac{x_i - \bar{x}}{S_x}$$

With these values, Equation 3 is modified making equation 4 possible, then:

$$F_{(n,q)} = w_{(n,q)} \beta_{(p,q)} \quad (4)$$

Based on equation 4, the beta weights matrix (β) with q standardized regression coefficients, replaces b , given that the variables are standardized on both sides of the equation. Pre-multiplying both sides of equation 4 by the value $\frac{1}{n} w'$, in which n is the number of observations and W is the transposed matrix of w' , it makes it possible to reach the following equation:

$$\frac{1}{n} w'_{(p,n)} F_{(n,q)} = \frac{1}{n} w'_{(p,n)} w_{(n,p)} \beta_{(p,q)} = R_{(p,p)} \beta_{(p,q)} \quad (5)$$

The Matrix $\frac{1}{n} w' w$, therefore is the matrix of intercorrelated variables or correlation matrix among the observations of the matrix x , designated by R . The Matrix $\frac{1}{k} w' F$ It represents the correlation between the factorials scores and the factors themselves, denoted by Λ . With this, rewriting the equation 5, one must:

$$\Lambda_{(p,q)} = R_{(p,p)} \beta_{(p,q)} \quad (6)$$

If the matrix R is non-singular, one can pre-multiply both sides of equation 6 by the inverse of R , obtaining:

$$\beta = R^{-1} \Lambda \quad (7)$$

Substituting the β vector into equation 4, we obtain the factorial score associated with each observation, as follows:

$$F_{(n,q)} = w_{(n,p)} R_{(p,p)}^{-1} \Lambda_{(p,q)} \quad (8)$$

In this way, the main formula of the Performance Index (I.D.) is arrived at, where the ID is defined as a linear combination of these factor scores and the proportion of the variance explained by each factor in relation to the common variance. The mathematical expression is now represented by the following formula:

$$ID_i = \sum_{j=1}^q \left(\frac{\lambda_j}{\sum_j \lambda_j} F P_{ij} \right) \quad (9)$$

Then:

$i = 1, 2, \dots, n$.

λ = is the variance explained by each factor;

$\sum \lambda$ = is the total sum of the variance explained by the set of common factors.

The factorial score was standardized (FP) to obtain positive values from the original scores and allow the hierarchy of the municipalities since the values of the performance index are between zero and one. The formula that allows this hierarchy can be seen by the following equation:

$$FP_i = \left(\frac{F_i - F_{min}}{F_{max} - F_{min}} \right)$$

It can be seen that F_{min} e F_{max} are the maximum and minimum values observed for the factor scores associated with the parameters observed by municipalities in Rondônia, framed in the level of hydrographic basins, for a period of 10 years. Thus, it is based on this understanding that it was possible to determine the performance indices adopted by this research.

3.2 Tests of adequacy of the factorial method to the mass of data

According to Gama et al [24]; Santana [20], the two main tests with the objective of assessing the adequacy of the method to the mass concern, first, the Bartlett sphericity test, which has the property of evaluating the general significance of the correlation matrix, that is, it tests the null hypothesis that the correlation matrix is an identity matrix. In addition to the Bartlett test, the Kaiser-Meyer-Olkin (KMO) test is also widely used and is based on the principle that the inverse of the correlation matrix approaches the diagonal matrix, in this case, it seeks to compare the correlations between the observable variables. Thus, both methods were used by this research as techniques for assessing the adequacy of the method to the surveyed database.

According to Dillon; Goldstein [23]; Reis [26]; Mingoti [27]; Gama et al [24]; Santana [20] the mathematical formulas of these tests can be seen by the following equations:

$$KMO = \frac{\sum_i \sum_j r_{ij}^2}{\sum_i \sum_j r_{ij}^2 + \sum_i \sum_j a_{ij}^2} \quad (10)$$

Like this,

r_{ij} = is the sample correlation coefficient between variables xi and xj;

a_{ij} = is the partial correlation coefficient between the same variables that is simultaneously an estimate of the correlations between the factors, eliminating the effect of the other variables.

According to Hair et al [16], the a_{ij} should assume values close to zero, since it is assumed that the factors are orthogonal to each other. Thus, according to this same author, values of this test below 0.50 are unacceptable.

Bartlett's sphericity test tests the null hypothesis that the variables are independent, against the alternative hypothesis that the variables are correlated with each other. That is, $H_0: R = 1$ or $H_0: \lambda_1 = \lambda_2 = \dots = \lambda_p$, which allows us to arrive at the following mathematical formula:

$$X^2 = - \left[n - 1 - \frac{1}{6}(2p + 5) \right] \ln |\mathbf{R}| \quad (11)$$

$$X^2 = - \left[n - 1 - \frac{1}{6}(2p + 5) \right] \cdot \sum_{j=1}^p \ln \lambda$$

Where,

$|\mathbf{R}|$ = is the determinant of the sample correlation matrix;

λ = is the variance explained by each factor;

n = is the number of observations;

p = is the number of variables.

The statistic has an asymptomatic distribution of χ^2 with $[0,5 p(p-1)]$ degrees of freedom. The Bartlett test is the most common method applied to test the homogeneity of variances [28].

3.3 Analysis tool

The SPSS program, version 17, was used as an analysis tool, which enabled the application of mathematical knowledge and allowed the construction of performance indices based on each parameter analyzed: environmental, economic, social and political-institutional.

3.4 Levels of scale

The classification adopted by the research to express the results achieved by the river basins in Rondônia is described in table 2.

Table 2: Scale of analysis adopted by the research.

Scale	Description	Color representation
0.000 a 0.200	Terrible	
0.201 a 0.400	Bad	
0.401 a 0.600	Regular	
0.601 a 0.800	Good	
0.801 a 1.000	Great	

Source: Own elaboration based on the classification model of Hair et al [16].

3.5 Indicators raised by the survey

The model was built based on the following indices: environmental, economic, social and political institutional. The combination of these four indexes resulted in the sustainable development index, as indicated in the methodology (methodological script). The indicators raised and the respective research sources, which were part of the analysis of this work, are listed in tables 3, 4, 5 and 6, below.

Table 3: Environmental Index Indicators

Indicators	Source
Deforestation	INPE http://www.dpi.inpe.br/prodesdigital/prodesmunicipal.php
Percentage of the area of the municipality occupied by Conservation Units	ICMBio SEDAM
Percentage of the area of the municipality occupied by Indigenous Lands	SEDAM

Source: Own elaboration.

Table 4: Economic Index Indicators

Indicators	Source
Gross domestic product per capita	IBGE (Demographic census)
Number of cattle	IBGE (Municipal Livestock Research)
Rice production (% in relation to the State)	IBGE (Municipal agricultural production)
Coffee production (% in relation to the State)	IBGE (Municipal agricultural production)

Value of Pará nut production (R\$ thousand)	IBGE (Production of plant extraction and forestry)
Value of non-processed wood production (R\$ thousand)	IBGE (Production of plant extraction and forestry)
Cocoa production (% in relation to the State)	IBGE (Municipal agricultural production)

Source: Own elaboration.

Table 5: Social Index Indicators

Indicators	Source
Households with access to water (%)	IBGE (Demographic census)
Households with access to sewage (%)	IBGE (Demographic census)
Households with access to electricity (%)	IBGE (Demographic census)
Number of Health Units (per thousand inhabitants)	DATASUS
No. of hospital beds (per thousand inhabitants)	DATASUS
No. of doctors (per thousand inhabitants)	Atlas of Human Development in Brazil DATASUS
Illiteracy rate	IBGE (Demographic census)
Average household income per capita	IBGE (Demographic census)
Gini index of household income per capita	IBGE (Demographic census)
Proportion of people with low income	IBGE (Demographic census)
• % population with income <1/2 MW	IBGE (Demographic census)
•% population with income <1/4 MW	IBGE (Demographic census)
Proportion of children in a low income household situation	IBGE (Demographic census)
•% children income gift <1/2 SM	IBGE (Demographic census)
•% children income gift <1/4 SM	IBGE (Demographic census)
Unemployment rate 16a and +	IBGE (Demographic)

	census)
Child labor rate	IBGE (Demographic census)

Source: Own elaboration.

Table 6: Institutional Political Index Indicators

Indicators	Source
Collection capacity	
• Per capita budget revenue	Own preparation based on data from IPEADATA, STN / FINBRA
• % own revenue	Own preparation based on data from IPEADATA, STN / FINBRA
Investment capacity	
• investment expense per capita	Own preparation based on data from IPEADATA, STN / FINBRA
• investment expense over realized expense	Own preparation based on data from IPEADATA, STN / FINBRA
Per capita expenses by function (R\$)	
• Education and culture	Own preparation based on data from IPEADATA, STN / FINBRA
• Health and sanitation	Own preparation based on data from IPEADATA, STN / FINBRA
No. of municipal councils	IBGE (Profile of Brazilian municipalities)

Source: Own elaboration.

3.6 Methodological roadmap

Next, the steps taken in this work will be described, which were considered essential for the consolidation of the process of construction of sustainable development indexes due to the object of the present study.

Table 7: Methodological Roadmap

Phases	Description
1	Classification of municipalities in the State of Rondônia by hydrographic basins.
2	Survey of official data for each municipality

	framed by hydrographic basins.
3	Preparation of an Excel spreadsheet with the available data according to the structure recommended by steps 1 and 2.
4	Use the SPSS tool, through factor analysis, based on the Varimax method.
5	Observe the data adequacy criteria for factor analysis.
6	Determine the performance indexes by municipalities aggregated by river basins.
7	Using the average performance indexes of the municipalities, determine the indexes for each parameter for each hydrographic basin.
8	Using the average of the parameters, determine the index of sustainable development by hydrographic basins.

Source: Own elaboration.

IV. ANALYSIS OF THE SUSTAINABLE DEVELOPMENT INDEX AT HYDROGRAPHIC BASIN LEVELS IN THE STATE OF RONDÔNIA

Next, the results achieved by the present study will be presented, aiming to demonstrate the scope of the model and the possibilities of analysis, due to the proposed methodological instrument, as a suggestion of a scientific criterion for decision making involving the theme of environmental management, at hydrographic basins.

Figures 1A and 1B below show the environmental management indexes for river basins in Rondônia. Based on this parameter, the hydrographic basin of the Mamoré River was the one that presented the best results, reaching the maximum level of performance (performance index of 1,000 in the base year of the survey and 1,000, ten years later, according to the scale adopted). This hydrographic basin concentrates the highest percentages and areas of environmental preservation in Rondônia.

The opposite, however, was observed in the watershed of the Roosevelt River (index 0.000 in the first year and 0.000, ten years later). The hydrographic basin of the Madeira River (performance indexes 0.411 and 0.288, respectively in the first survey and ten years later) had a 19.9% drop in performance from the base year to a decade later, in the same way as the hydrographic basins of the Guaporé River (index of 0.291 and 0.206, respectively, in the first year and ten years later) fell by 29.2%, in the Machado River (index of 0.411 and 0.288, respectively),

with a drop of 26.4% and in the Jamari River (index of 0.126 and 0.071, respectively in the first year and ten years later), with a drop in performance of 43.65%.

The environmental performance index of the first stage of the survey showed the following results: Mamoré river basin (1,000 considered an great index), Guaporé river basin 0.291 (bad index), Madeira river basin 0.411 (regular index), river basin Machado 0.125 (terrible index), Jamari river basin 0.126 (terrible index) and Roosevelt river basin 0.000 (terrible index).

Ten years later, the environmental performance index showed the following results: Mamoré river basin (1,000 considered an great index), Guaporé river basin 0.206 (bad index), Madeira river basin 0.288 (bad index), Machado river basin 0.092 (terrible index), Jamari River Basin 0.071 (terrible index) and Roosevelt River Basin 0.000 (terrible index). (Table 8).

Table 8: Environmental Management Index by river basins in Rondônia.

Hydrographic basin	Index (Reference year)	Index 10 years later
Guaporé River	0.291	0.206
Mamoré River	1.000	1.000
Madeira River	0.411	0.288
Jamari River	0.126	0.071
Machado River	0.125	0.092
Roosevelt River	0.000	0.000

Source: Own elaboration.

In the first phase of the survey, rates of economic performance were very low, without exception. The indices appear in the following decreasing order and classified according to the scale adopted in the research. Madeira River Basin 0.288 (bad index), Rio Machado Basin 0.256 (bad index), Rio Guaporé Basin 0.241 (bad index), Rio Jamari Basin 0.193 (terrible index), Rio Roosevelt Basin 0.182 (terrible index) and Mamoré River Basin with 0.163 (terrible index) completes the scenario of the economic performance conditions of the river basins of Rondônia.

Ten years later, the situation for economic performance index rates is as follows: Rio Mamoré Basin 0.437 (regular index), Rio Madeira Basin 0.333 (bad index), Rio Guaporé Basin 0.246 (bad index), Rio Basin Jamari 0.222 (bad index), Roosevelt River Basin 0.189 (terrible index) and Machado River Basin 0.183 (terrible index).

As for the economic aspect (figures 2A and 2B), the hydrographic basin of the Mamoré River presented the

highest growth in the analyzed period (168.1%), reaching the highest index (0.437), followed by the hydrographic basins of the Madeira River (0.333), of Guaporé River (0.246), the Jamari River (0.223) and the Roosevelt River (0.189). It is inferred, therefore, that the Free Trade Area legally established in the municipality of Guajará-Mirim, located in the referred hydrographic basin, contributed to this index. Despite this, there has been no consolidation of a local development process in the region.

The municipality of Guajará-Mirim is projected as a strategic collection point for the State, which places it as an important economic zone in Rondônia. However, with reservations about the current management model implemented to consolidate the sector, which prevents the resources from the tax incentives in the free trade zone of Guajará-Mirim from returning in full as investments for the region (figures 2A and 2B).

In the same way, it can be inferred that the performance achieved by the hydrographic basin of the Madeira River has been influenced by the major infrastructure works in progress in the region, for example, the Hydroelectric Plants (UHE's) of Jirau and Santo Antônio, both located on the Madeira River. In addition, the strong process of "cattle raising" in the municipalities within the aforementioned hydrographic basin also demonstrates an influence on the performance of the economic index. (Table 9).

Table 9: Economic index by hydrographic basins in Rondônia.

Hydrographic basin	Index (Reference year)	Index 10 years later
Guaporé River	0.241	0.246
Mamoré River	0.163	0.437
Madeira River	0.288	0.333
Jamari River	0.193	0.223
Machado River	0.256	0.183
Roosevelt River	0.182	0.189

Source: Own elaboration.

The social performance indexes in the first stage of the research were as follows: Mamoré River Basin 0.706 (good index), Madeira River Basin 0.561 (regular index), Machado River Basin 0.476 (regular index), Guaporé River Basin 0.457 (regular index), Jamari River Basin 0.439 (regular index) and Roosevelt River Basin 0.329 (bad index). Ten years later, the social performance indexes were: Madeira River Basin 0.502 (regular index), Mamoré River Basin 0.489 (regular index), Machado River Basin 0.381 (bad index), Jamari River Basin 0.367 (bad index),

Guaporé River Basin 0.338 (bad index) and Roosevelt River Basin 0.295 (bad index).

With regard to the social parameter (figures 3A and 3B), it was found that all the studied hydrographic basins presented negative performances in the analyzed period, with emphasis on the Mamoré River which reached a decrease of -30.73%, followed by the Guaporé river (-26.04%), Machado River (-19.96%), Jamari River (-16.40%), Madeira River (-10.52%) and Roosevelt River (-10.33%).

The results demonstrate that, in general, the trajectory of public policies did not result in improvements in the quality of life of the population, which, in a way, reveals that Rondônia presented rates of economic growth in the period, however, without due monitoring in social performance, thereby affecting one of the main accounting mechanisms for “development”, that is, indicating that the State has grown, but has not developed to the same degree from the perspective of river basins. (Table 10).

Table 10: Social index by river basins in Rondônia.

Hydrographic basin	Index (Reference year)	Index 10 years later
Guaporé River	0.457	0.338
Mamoré River	0.706	0.489
Madeira River	0.561	0.502
Jamari River	0.439	0.367
Machado River	0.476	0.381
Roosevelt River	0.329	0.295

Source: Own elaboration.

The indices of institutional political performance in the first stage of the research do not differ much from the other performance indices. The Jamari River Basin had a 0.415 index (regular index), followed by the Machado River Basin 0.423 (regular index), the Roosevelt River Basin 0.424 (regular index), the Guaporé River Basin 0.398 (bad index), the Madeira River Basin 0.339 (bad index) and Mamoré River Basin 0.319 (bad index).

Ten years later, the institutional political performance indexes were: Madeira River Basin 0.502 (regular index), Jamari River Basin 0.364 (bad index), Guaporé River Basin 0.311 (bad index), Machado River Basin 0.334 (bad index), Roosevelt River Basin 0.263 (bad index), Madeira River Basin 0.229 (bad index) and Mamoré River Basin 0.184 (terrible index).

The political-institutional parameter (figures 4A and 4B), the last one observed by the research, revealed a

Table 12: Index of sustainable development by river basins in Rondônia.

situation that is also worrying. From the perspective of hydrographic basin analysis, the political-institutional aspects did not bring the necessary strength capable of leveraging a level of identity of public policies linked to the local reality, in Rondônia. The absence of this characteristic ends up weakening the aspects inherent to governance and weakening local power, the main armor for the consolidation of a trajectory of economic prosperity, as pointed out by Putnam [29]. In Rondônia, it is considered to be the root cause of regional inequality [30]; [31]; [32].

Thus, according to figure 4, the largest losses were, in decreasing order, verified in the basin of the river Mamoré with -42.32%, followed by the basins of the rivers Roosevelt (-37.97%), Madeira (-32.45 %), Machado (-22.69%), Jamari (-12.29%) and Guaporé (-9.29%). (Tabela 11).

Table 11: Political-institutional index by river basins in Rondônia.

Hydrographic basin	Index (Reference year)	Index 10 years later
Guaporé River	0.398	0.361
Mamoré River	0.319	0.184
Madeira River	0.339	0.229
Jamari River	0.415	0.364
Machado River	0.432	0.334
Roosevelt River	0.424	0.263

Source: Own elaboration.

In this way, the sustainable development index of the hydrographic basins of Rondônia is reached (figure 5A and 5B). It was verified that the hydrographic basins reached the following indices: basin of the river Mamoré (index 0.527), river Madeira (index 0.388), river Guaporé (index 0.287), river Jamari (index 0.256), River Machado (0.256) and river Roosevelt (index 0.177). All of them showed a decrease in the performance index in the analyzed period, in the following proportions -3.65%, -15.5%, -17.29%, -12.63%, -23.29% and 20.08%, respectively. (Table 12).

Therefore, it was evident that in terms of sustainable development there was no improvement in Rondônia within the geographic context of river basins, which confirms the research carried out by Cavalcante [21]; Cavalcante; Góes [30]; [31]; Cavalcante; Alves [32]; Cavalcante; Góes [33]; Cavalcante; Silva [34] on the “conservation and development” trade-off in Rondônia.

Hydrographic basin	Index (Reference year)	Index 10 years later
Guaporé River	0.347	0.287
Mamoré River	0.547	0.527
Madeira River	0.400	0.338
Jamari River	0.293	0.256
Machado River	0.322	0.247
Roosevelt River	0.234	0.187

Source: Own elaboration.

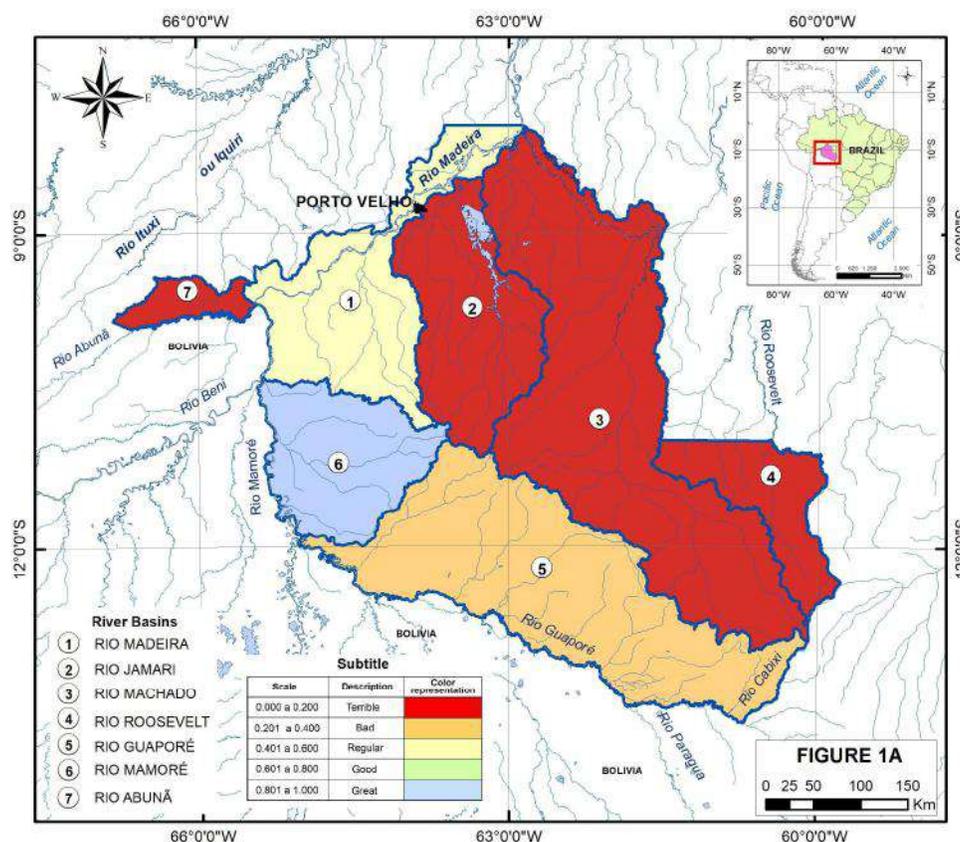


Fig. 1A: environmental management index for river basins in rondônia, in the reference year.

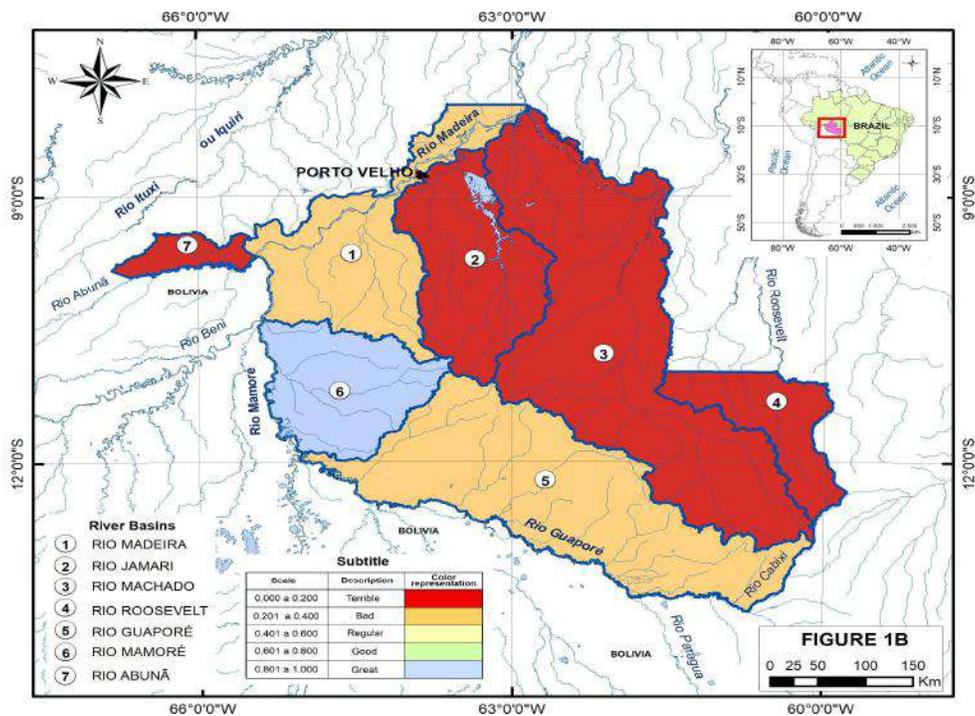


Fig.1B: Environmental management index for the hydrographic basins of rondônia, 10 years later.

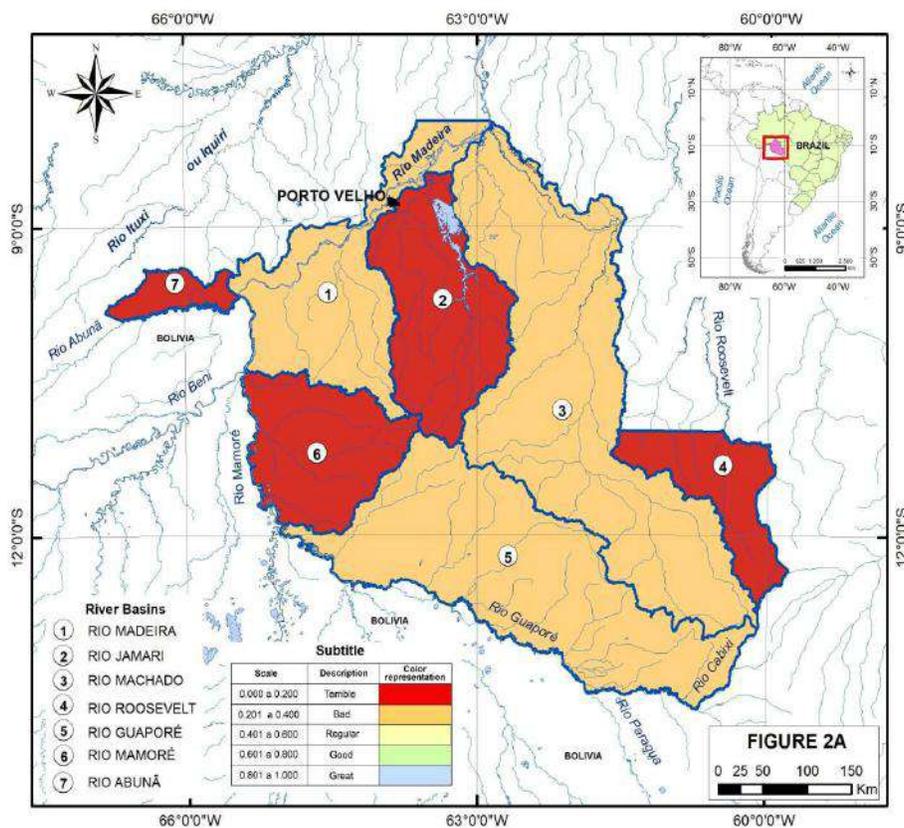


Fig.2A: Economic index of river basins in rondônia, in the reference year.

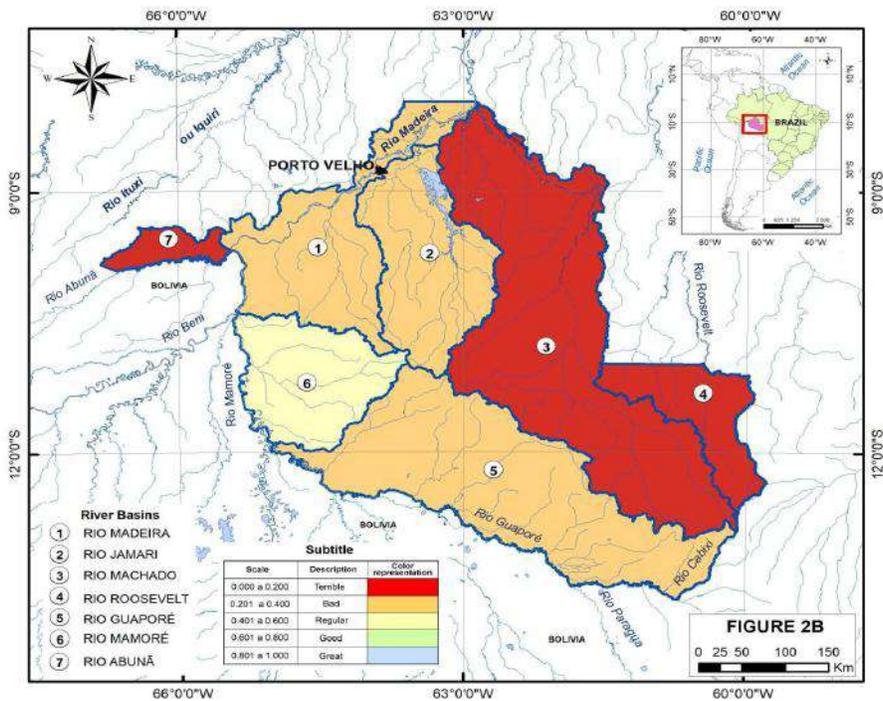


Fig.2A: Economic index by hydrographic basins in rondônia, 10 years later.

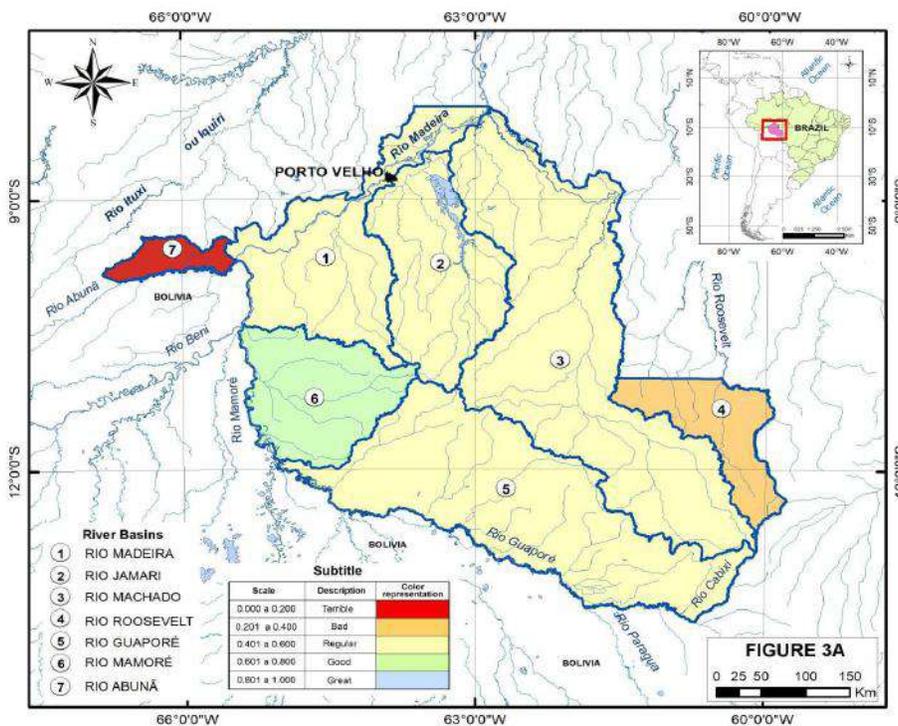


Fig.3A: Social index by hydrographic basins in rondônia, in the reference year.

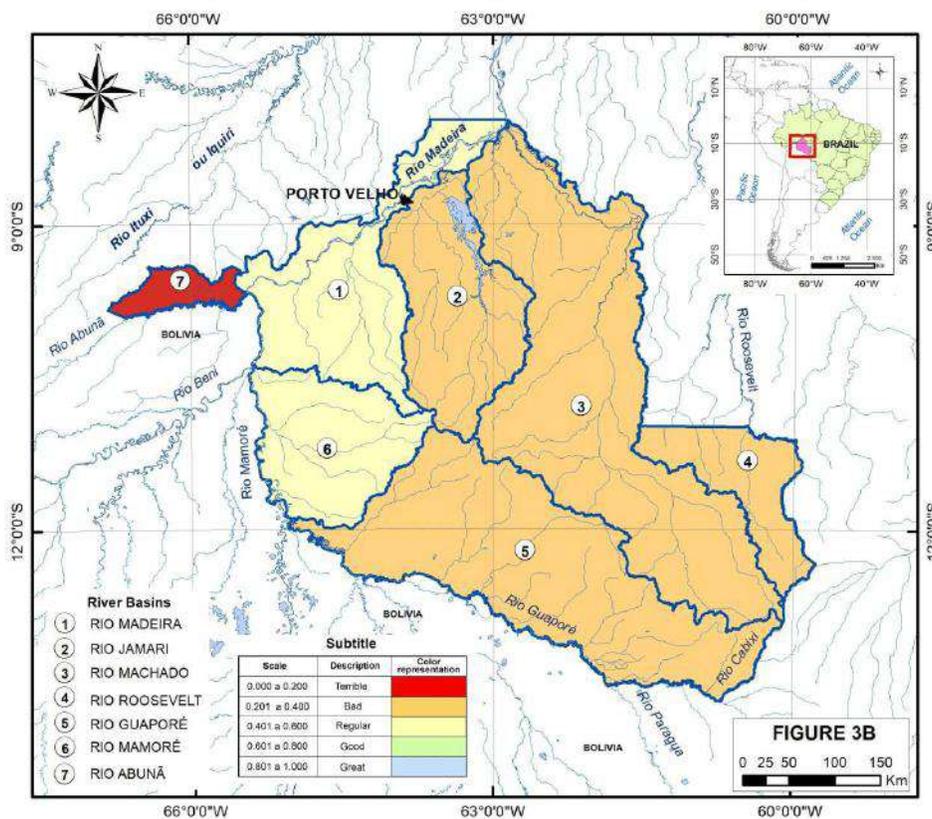


Fig.3B: Social index by hydrographic basins in rondônia, 10 years later.

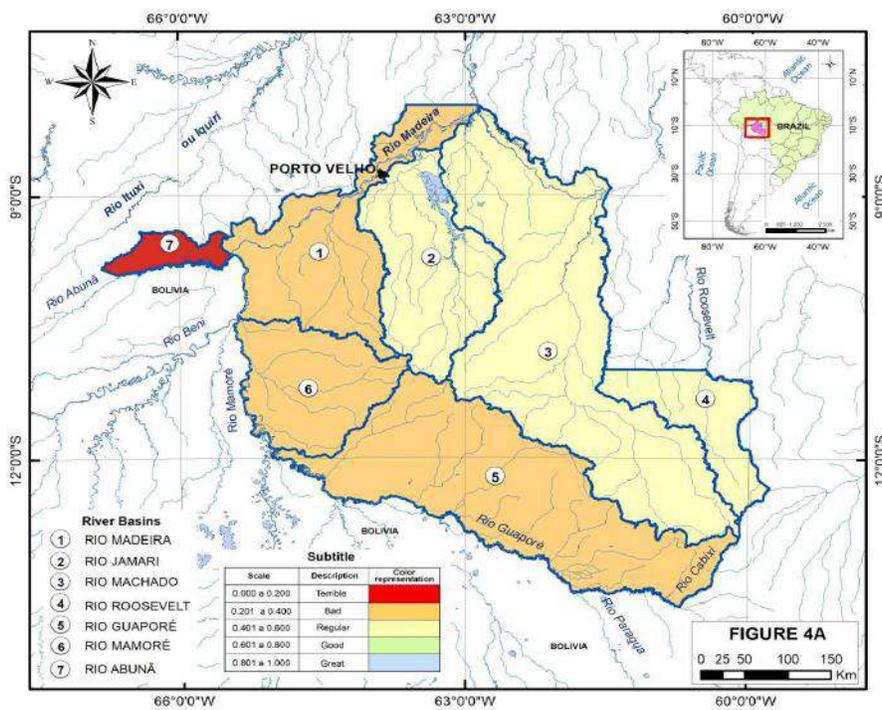


Fig.4A: Political and institutional index by basins in Rondônia, in the reference Year.

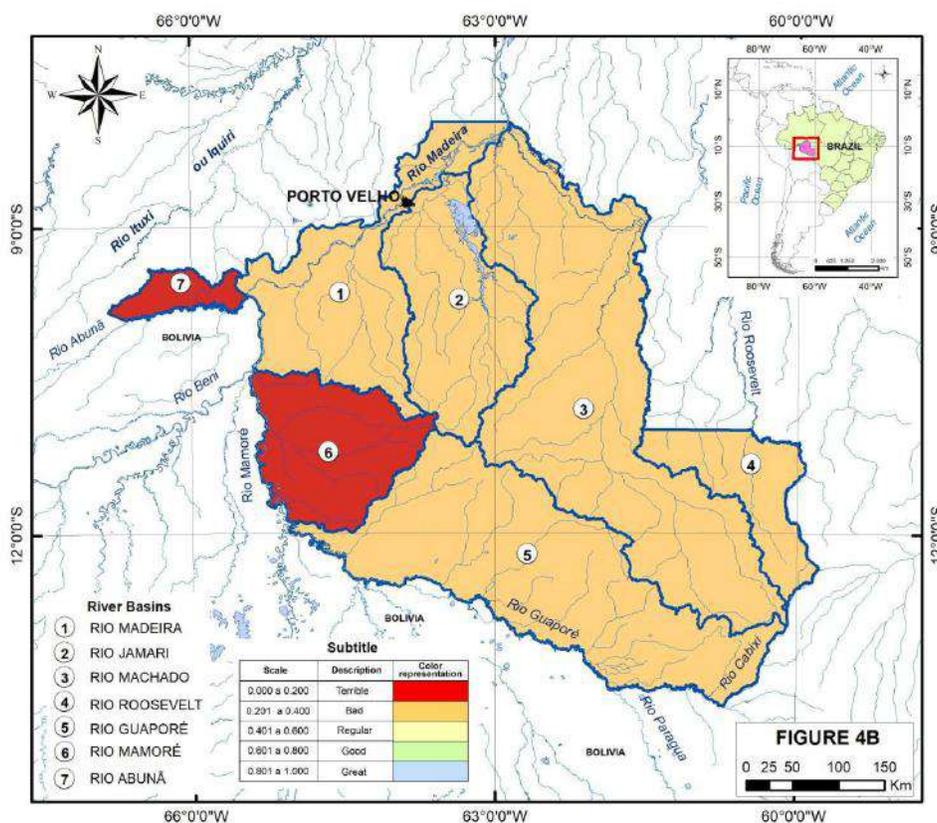


Fig.4B: Political and institutional index by basins in rondônia, 10 years later.

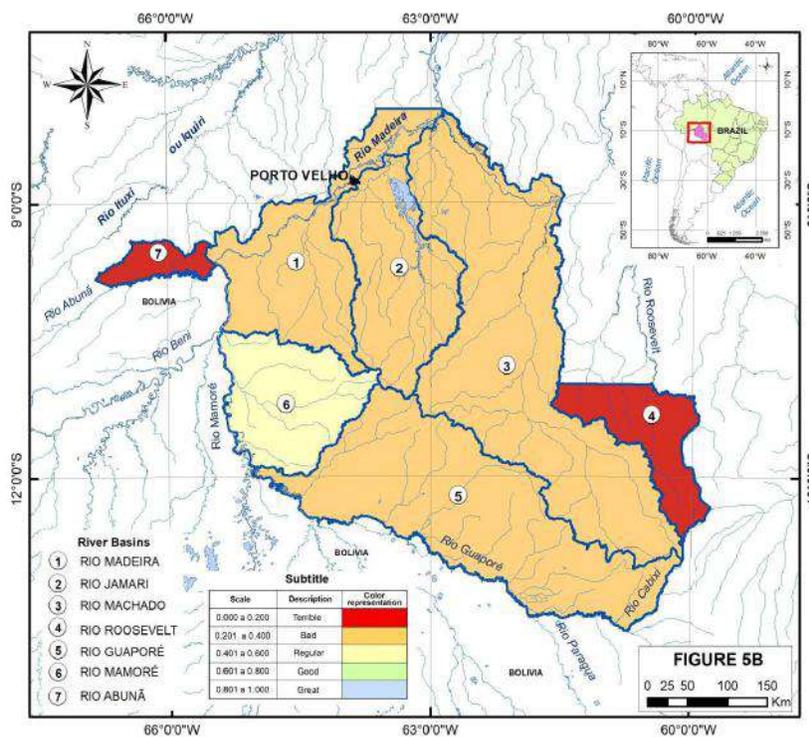


Fig.5A: Sustainable development index for rondônia hydrographic basins, in the reference year.

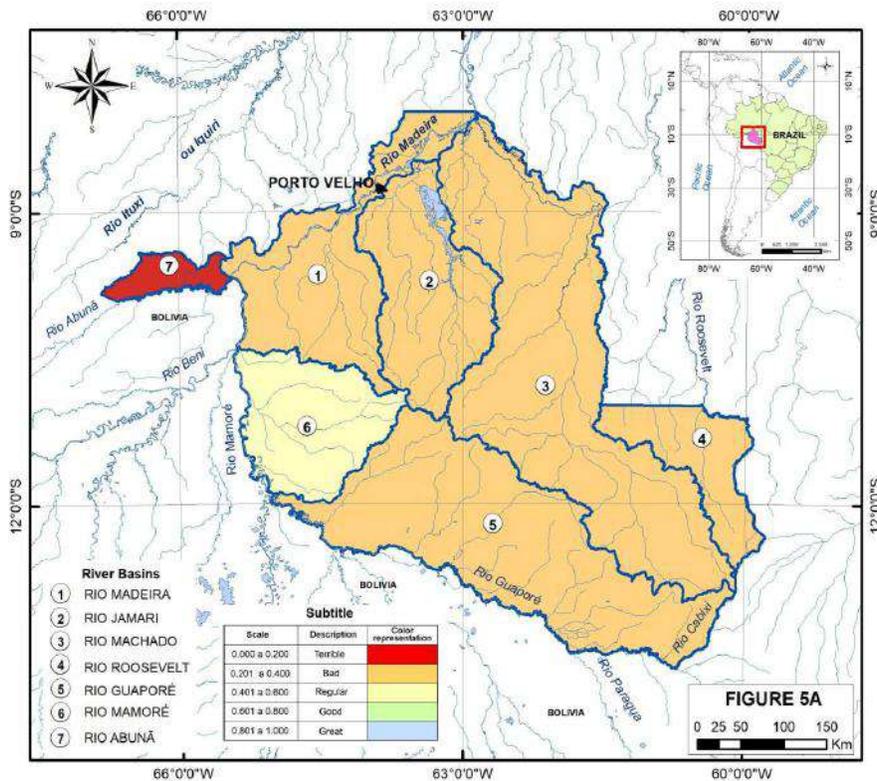


Fig.5B: Sustainable development index for rondônia hydrographic basins, 10 years later.

V. CONCLUSIONS

With the development of this methodology, it was possible to reach the following conclusions: The hydrographic basin of the Mamoré River presented a better index of sustainable development (0.527), however, this index only indicated a “regular” situation, according to the scale adopted, which together with the “poor” performance of the other hydrographic basins, points to a worrying situation in the state of Rondônia.

It was also found that the incipient public policy of strengthening the paradigm of sustainable development at the level of river basins in Rondônia, has contributed to the advance of deforestation in Rondônia.

The generalized decline in social indices, in all studied hydrographic basins, reflects that the current hegemonic model of regional development is not, in fact, bringing an improvement in the quality of life in the respective geographical regions of the hydrographic basins, which, with this, would trigger, among other aspects, the social weakening and the collective effort of local power, thus reducing the criteria for strengthening endogenous social capital.

It is necessary to recognize that the “conservation and development” trade-off is latent in Rondônia and that regional development policies are not being sufficient to solve the problems of regional inequality in the State of Rondônia. It is evident, therefore, with this work that even with the Water Resources Law of the State of Rondônia, approved in the beginning of the 2000s, the results presented demonstrate that the management of hydrographic basins in an effective and full way has not yet been effected.

This is because there are other factors that make it difficult, such as the geopolitical logic established in Rondônia, where a region is practically all preserved to the detriment of economic development even though it is considered a productive region. Thus, it appears that the trade-off “conservation and development” is the biggest challenge to environmental management in Rondônia, as pointed out by Cavalcante [21], Cavalcante; Silva [33], Cavalcante and Góes [30]; [31]; [33], a fact aggravated in the context of river basin areas, where the complexity of interests reaches an even greater dimension.

The factor analysis demonstrated efficiency as a multivariate statistical method in the construction of sustainable development indexes for the river basins of Rondônia.

Finally, it is highly recommended to institutionalize regional public policies in the form of a River Basin Master Plan for Rondônia as a planning and management mechanism for the respective areas, in the perspective of sustainable, integrated and inseparable development of their local communities.

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Remote labs in high school: a case study in physics teaching

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Abstract— This document explored remote laboratories (LR) and their potential for practical activities in Physics in high school. LRs are devices that can support experimental activities, which are one of the key aspects of science teaching and learning processes. The research, with a qualitative approach, used a case study as a strategy. Participated in the research, carried out in 2017, 2 teachers, and 454 students, from 13 classes, from a public school in Uberlândia/MG. The collection was carried out through two questionnaires, one directed to the students, composed of 25 items, distributed in the subscales: usability, learning perception, satisfaction, and usefulness. The second, composed of two open questions, was applied to teachers who participated in the research. The average Likert score for the 25 items was 3.94 and the Cronbach's alpha coefficient found was 0.85. The interpretation of the data showed that the perception, on the part of students and teachers, that the remote laboratories showed benefits to the study of Physics. Making it possible to harmonize theory with practice, mainly due to the lack of laboratory infrastructure in public schools. Participants also highlighted the possibility of carrying out practices at any place and time.

Keywords— Educational Technology, High School, Physics Teaching, Remote Laboratories.

I. INTRODUCTION

Scientific training, in the opinion of many experts, is a requirement that has been demonstrating its strategic role in the development of people and peoples. Scientific training or culture must be acquired from the first years of schooling and, especially, before dropping out, as in many countries, such as Brazil, there are high rates of dismissal before the completion of high school.

According to data released by INEP [1], failure and/or dropout rates were 6.0%, 12.9%, and 16.9%, respectively for elementary, middle, and high school. Since the 9th grade had a dropout rate of 7.7%. Significant percentages if it is taking into account that in 2017 Brazil had over 35 million students enrolled in elementary, middle, and high school.

In addition to the indexes presented, account should also be taken of the dropout in the transition from the last year of middle school to the first year of high school. There are several causes that cause evasion, and will not be addressed in this document, however, meaning, flexibility, and perception of importance also represent factors that contribute to this. Many adolescents and young people

have the feeling that the school is not adequate to their reality and vision of the future and start to consider it “as a waste of time and end up preferring to dedicate themselves to other things” (Meaning). They do not perceive the school as dynamic or innovative if they engage less in school activities (Flexibility). The perception of importance, on the other hand, emphasizes that education and school must not only teach relevant topics but also motivate students and show that what the object of study is or will be useful for their life, that is, presenting education as a value.

It is observed that the deficit in science education goes far beyond the fact of learning or not learning scientific content. This deficit will also condition the full exercise of that person's citizenship. Another face for the same problem is in a scientific education that no longer arouses interest, pleasure, and motivation for learning science. If this situation persists, students will lose their attraction to scientific and technological careers.

This context reinforces the need for more attractive environments for teaching and learning, redesigning education, creating new and interesting teaching and

learning opportunities. That is, to provide compatible, non-antagonistic environments, with the way, especially children, adolescents, and young people learn. For example, using the Internet, mobile devices, and virtual and remote laboratories in the educational context.

Experimental activity is one of the key aspects of science teaching and learning processes, both for the theoretical foundation that can contribute to students and for the development of certain skills for which experimental work is fundamental. There are arguments in favor of laboratory practices, in terms of their value for improving objectives related to conceptual and procedural knowledge. Aspects related to scientific methodology, to the promotion of reasoning skills, specifically to critical and creative thinking, and to the development of attitudes of open mind and objectivity and distrust of those judgments that lack the necessary evidence [2].

Laboratory work favors and promotes science learning, as it allows students to question their knowledge and confront them with reality. Besides, the student puts previous knowledge into practice and verifies it through practices. The experimental activity should not be seen only as a knowledge tool, but as an instrument that promotes conceptual, procedural, and attitudinal objectives that must include any pedagogical device [3].

However, most Brazilian public schools do not have laboratories equipped to carry out experimental activities. According to the School Census of Basic Education MEC/INEP 2018, only 11% of schools in Brazil (8% public and 19% private) had science laboratories. Also, according to the MEC/INEP 2018 School Census, only 38% of schools (38% public; 37% private) had a Computer Laboratory and the average number of computers available for use by students in schools was 7.41 computers per school. for student use (6.7 public and 9.7 private).

These are shortcomings that have led to deficiencies in technological infrastructure in basic education schools. What hinders the integration of digital technologies in the educational context. And consequently, create opportunities for the creation of compatible environments, not antagonistic, with the way, mainly children and adolescents learn.

According to the CoSN Driving K–12 Innovation/2019 Tech Enablers report, the main technological tools with the potential to facilitate the path to broader opportunities and solutions in education for the next five years are Mobile devices; Analysis of learning and adaptive technologies; Blended Learning; Extended reality and Cloud computing infrastructure. And the estimate of adoption by schools worldwide, on a scale of 1 to 5 (1 = the most immediate

adoption; 5 = the most distant from adoption) was estimated as follows: 1.26: Mobile devices; 1.41: Blended Learning; 1.58: Cloud Infrastructure; 2.48: Extended Reality and 2.49: Adaptive Analysis and Technologies.

The CoSN Driving K–12 Innovation/2019 report highlights the emphasis on Internet-based technologies. Mobile devices, such as smartphones, allow access to information and creative activities anytime, anywhere. Mobile devices also support global connections, self-capture content, and personalized learning. Making it possible to extend not only the classroom but also the school. That is, not limiting the teaching and learning processes to the time and space of the classroom. In a concept of ubiquity [3] referring to a society that learns and absorbs data and information all the time and everywhere. It also has a direct effect on the way teaching and learning should be viewed in this context.

Data from the National Telecommunications Agency (Anatel) indicate that Brazil ended April 2019 with 228.6 million cell phones and density of 108.71 cell phones/100 inhab. Regarding the use of these devices, data from the Teleco portal, for 2017, identified the following profiles: Percentage of people in the age group who accessed the Internet in the last 90 days: 10 to 15 years old = 91% and 16 to 24 years old = 96%; Internet Users by Income Range: up to 1 SM = 60%, 1SM - 2SM = 72%, 2 SM - 3 SM = 79% and location used for access by Internet users: At home = 94%, at school = 19 %, workplace = 19% and someone else's home = 62%.

These data show opportunities for using mobile devices, especially smartphones, in an educational context. The expansion of the educational space allows students to see the school in very different places in their learning journeys. And that contemplates different needs, styles, interests, and preferences. The use of Internet-based resources. The Internet offers a large number of didactic alternatives that, with the necessary adaptations to the realities of each school scenario, can be used to promote the development of the cognitive process. These possibilities include, for example, videos, websites, interactive activities, content sharing tools, and online labs. Laboratories that have the potential to represent learning opportunities, and even fill gaps in infrastructure deficiencies.

The online labs include simulations (virtual labs), where it is possible to reproduce any type of experiment, without restrictions and real experiments (remote labs), whose interaction is intermediated by an ICT, where the student can manipulate real materials and equipment in a different place from found (Silva, 2018). In an online

laboratory, the investigation parameters can be manipulated and the effects of this manipulation are observed to obtain information about the relationship between variables in the conceptual model underlying the online laboratory [4].

Inspired by the contextualization and problematization presented, this research was designed, which is based on the following premises: there is a need for more attractive environments for teaching and learning, in basic education; the growing use of mobile devices and the Internet by children and adolescents; and the lack of technological and laboratory infrastructure, mainly in public primary schools.

Seeing this scenario as an opportunity, the use of remote laboratories (LR) in Basic Education was proposed. An LR is characterized by online access to a real experiment. [5]

This document presents research developed over the academic year 2017 and which contemplated the use of LR, in Physics classes, in high school, in public schools. Two professors of the Physics discipline participated in the research, who made the specification of the resources and produced the didactic contents to be made available in the virtual learning environment (AVA) and 454 of the high school. Technical support and provision of digital resources were provided by the Campus Araranguá Laboratory. The research subjects were students, who took the Physics disciplines, in classes of 1st and 2nd years of high school, in the public system. The research involved 8 classes from the 1st year, totaling 262 students and 5 classes from a total of 192 students.

Following are the methods and materials, the main results, discussion of the results and conclusions obtained from the research carried out.

II. MATERIALS AND METHODS

Qualitative research in education allows using many methods to collect data and information, through personal experience, interviews, texts on the subject to be investigated, among others. Case studies are a very important research method in the development of human and social sciences, and represent one of the natural ways in research-oriented from a qualitative perspective [6]. According to Stake [7], case studies are an adequate method for investigation when it is in harmony with the researcher's previous experience. And this facilitates the understanding of the phenomena in question through an in-depth view of one or more cases during a defined time, to understand aspects of social behavior and the factors that influence the researched situation [8].

The population object of this study was the students who used the digital resources available and the teachers who boosted the didactic experience in their subjects. To select the sample and define the units of analysis, the object of the study, the following criteria were applied:

- Schools that are part of the InTecEdu Program developed by at RExLab since the research is linked to the use of remote laboratories, in Physics subjects, at EB, in a public school;
- Active teachers, teaching Physics, in basic education in the public network.

Based on the prerequisites defined above, three steps were taken to continue the research, which is described below:

1. Identification of the EB school: contacts with the physics teachers of the school in which the proposed research was developed, to present the work proposal and obtain approval of the discipline's coordination and effective agreement by the school's management in its development;

2. Strategy: definition of the teaching strategy for the use of technological resources;

3. Selection and availability of remote laboratories: carrying out a study of the remote experiments available at UFSC's RExLab, to identify the most appropriate ones for use in research.

The tools used for data collection were two questionnaires called: "Questionnaire for the evaluation of the use of mobile remote experimentation" and "Questionnaire of teaching reports regarding the use of mobile remote experimentation". The "Questionnaire to assess the use of mobile remote experimentation" was applied online for students. This aimed to observe the perception of students involved in research regarding the use of resources offered by LR, in the discipline of Physics. This questionnaire was structured with 25 (twenty-five) items, and was based on questionnaires developed and used by Professor Euan David Lindsay [9], from Curtin University in Australia, published in the document "The Impact of Remote and Virtual Access to Hardware up on the Learning Outcomes of Undergraduate Engineering Laboratory Classes", as well as the study by Sergio López; Antonio Carpeño and Jesús Arriaga [10], from the Universidad Politécnica de Madrid, published in the document "Remote Lab eLab 3D: An immersive virtual world for electronic learning".

The 25 items are divided into four subscales: Usability (7 items), Perception of Learning (6 items), Satisfaction (6 items), and Utility (6 items), which seek to perceive the

degree of agreement of the students concerning the technology used. For the calculation of satisfaction scores, a 5-point Likert scale was used, formed by several elements in the form of statements, on which the degree of satisfaction must be expressed, and to perform the analysis, the following values were adopted in numbers: 1 totally disagree (DT), 2 partially disagree (DP), 3 without opinion (SO), 4 partially agree (CP), 5 totally agree (CT).

To estimate the reliability of the questionnaire applied in the research, Cronbach's alpha coefficient was used. This coefficient measures the correlation between responses in a questionnaire, by analyzing the profile of the responses given by the respondents. This is an average correlation between questions [11]. Cronbach's alpha coefficient is a commonly used measure of reliability (that is, the assessment of internal questionnaire consistency) for a set of two or more construct indicators [12]. Alpha values range from 0 to 1.0; the closer to 1, the greater the internal consistency of the items analyzed. The reliability of the scale must always be obtained with the data of each sample to guarantee the reliable measurement of the construct in the concrete sample of investigation.

The use of reliability measures, such as Cronbach's alpha, does not guarantee unidimensionality to the questionnaire but assumes that it exists [13]. As a general criterion, George and Mallery [14] recommend the following indications for assessing Cronbach's alpha coefficients:

- Alpha coefficient > .9 is excellent;
- Alpha coefficient > .8 is good;
- Alpha coefficient > .7 is acceptable;
- Alpha coefficient > .6 is questionable;
- Alpha coefficient > .5 is poor;
- Alpha coefficient < .5 is unacceptable.

The second questionnaire was applied to teachers who used the resources in their classes and comprised two open questions in which teachers were invited to indicate "strengths and weaknesses regarding the use of mobile remote experimentation in the science subjects taught".

III. RESULTS

The research was developed throughout the academic year 2017, in 13 classes of the subject of Physics, in classes of 1st and 2nd years of high school, in a public school in Uberlândia/MG. There were 8 classes from the 1st year, all from the morning period, with a total of 262 students and 5 from the 2nd year, all from the afternoon period, totaling 192 students. Therefore, the research had the participation

of 454 students. The classes participating in the research were chosen according to the work plan defined by the teachers, together with the integration of the remote laboratories available. However, the definition of remote laboratories was by the content covered in the classroom.

Based on the criteria determined in the methodology section and others explained above. Remote laboratories were selected: "Conversion of Light to Electric Energy", for the 1st year classes, to work on the study of "Light energy (Interaction of radiation with matter)". For the 2nd year classes, the LR "Heat conduction in metal bars" was selected, to work on the theme "Heat propagation by conduction in metal bars".

The remote experiment "Conversion of Light to Electric Energy" aims to show the transformation of light energy into electrical energy, "using an automotive filament lamp and a photovoltaic cell". Next to the structure, "a capacitor and a resistor were added, allowing tests of the capacitor's charge and discharge times according to the amount of energy produced". This experiment contains "a photovoltaic fixed on top of a servo motor, which allows the user to move the plate close to or away from the light, and with that, respectively generating more or less energy". This "power generation can be verified through a multimeter and an LED matrix, where the light intensity generated by this panel is directly proportional to the energy produced".

Figure 1 shows the user interface for the LR Conversion of Light Energy into Electric Energy.



Fig. 1: LR Conversion of Light to Electric Energy

The LR "Heat conduction in metal bars" consists of three heat sources, one for each metal bar and three horizontal metal bars (Aluminum, Copper, and Iron) of 12.70mm x 4.76mm ". "Each of the metal bars has three temperature sensors spaced every 10 cm and three displays, which provide a temperature reading on each sensor along the bars".

Figure 2 shows the LR user interface "Heat conduction in metal bars".



Fig. 2: LR Heat conduction in metal bars

The “Questionnaire to assess the use of mobile remote experimentation” was answered by 260 students, representing 57% of the total enrolled in the Physics discipline. To interpret the results obtained in the questionnaire, the Average Score (EMd) was made and defined for the answers acquired in the questionnaire, using the 5-point Likert scale. To find out, if attitudes were positive or negative, through EMd, the following conditions were imposed: values below 3 presented adverse attitudes and greater than 3, favorable, while value 3 was estimated “without opinion”. Thus, the EMd score for the 25 items was 3.94. Indicating a very favorable activity. The Cronbach's alpha coefficient found for all items in the questionnaire was 0.85. The Standard Deviation for the average of the items was 0.45 and the Coefficient of Variation was 11.51%.

Regarding the subscales, the average scores, on the Likert scale, were as follows:

- Usability: 3.68;
- Perception of Learning: 4.03;
- Satisfaction: 3.87;
- Usefulness: 4.26.

Figure 3 shows, graphically, the EMd values obtained for the subscales.



Fig. 3: Scores for the questionnaire subscales

Usability refers to the ease of use of LR. If there were no problems to perform the desired actions if the information on the screen contributed to handling the LR, and if the time available to execute and manipulate the experiment was sufficient to carry out the activities. The EMq obtained for the seven items was 3.68. About the statements, the lowest score was found in item 3 (“the internet connection made access to the remote laboratory difficult”, with 2.61 and the highest in item 5, with 4.20 (“the information contained in contributed to handling the experiment”).

The Perception of Learning sought to indicate whether the student, through the LR, perceived improvement in his learning, and whether the practice performed contributed to problem-solving if the concepts that were addressed during the use of the tool were understood, and these were related with the student's daily life. And, if “all the skills acquired were valuable for learning”. The EMq for Learning Perception for the six items was 4.03. Regarding the statements, the lowest score was found in items 9 and 12, with 3.92 (“remote experimentation helped to relate the concepts studied in the classroom with my daily life” and “the acquired skills were valuable for my learning”) and the largest, in item 10, with 4.16 (“ the remote experiment contributed to my learning”).

Satisfaction seeks to show how much the student “was convinced that he was carrying out a real and not remote experiment when manipulating the experiment, as well as if it is possible to achieve learning similar to that acquired in a classroom laboratory”. Besides, it sought to show whether the student's ability to access the LR, at any time and from any place, was useful to better plan study time, and whether the tool provided new ways of learning. The EMd calculated for the perception of satisfaction about the six items was 3.87. Regarding the statements, the lowest score was found in item 19 (“the remote experiment improved communication with my colleagues”) with 2.93 and the highest in item 18 with 4.51 (“I would like to use other remote experiments in the discipline of physics”).

The Utility subscale sought to show whether the student “was more motivated to learn after using the LR, as well as whether he was satisfied with the experience”. And, if “after using the LR, the student would advise other colleagues to use it as well, as well as if he would like to use other remote experiments”. The EMq of the perception of Utility for the six items was 4.26. Regarding the statements, the lowest score was found in item 20, with 3.89 (“I was convinced that I was carrying out a real and not remote experiment”) and the highest in item 25, with 4.60 (“the laboratory of remote experimentation can provide new ways of learning”).

The second questionnaire was applied to the two teachers who participated in the application of resources in their classes. These were the two open questions in which the teachers indicated the "strengths" and "weaknesses", perceived by the use of remote laboratories in their classes. The following are some responses from the teachers:

Regarding the strengths:

- "The experiment has real physical existence and that is why it allowed us to deal with real problems in its handling";

- "Makes experimental activities possible, even without the presence of a science laboratory in the school";

- "Resource that facilitates the student's visualization; helps the teacher to transmit the material".

As for the weaknesses:

- "The queue generated for the use of the experiment was the biggest obstacle".

- "I would quote the waiting line, but this can be circumvented with parallel activities. Another problem would be the connection to the internet, but it is also not a problem of experimentation, but unfortunately for the municipal and state public schools that lack this resource. So, I don't see any weaknesses";

- "A student's waiting time to experiment, the queue".

IV. CONCLUSION

This document aimed to present a case study on the use of remote laboratories, for practical activities in the discipline of Physics in High School, in a public school. The objective was fulfilled and the results obtained in the data collection instruments were favorable to the use of the resources provided by the LR to support the experimental activities. The LRs provided students with remote access to physical experiments and their handling, without restrictions on time and place. It is also worth remembering that this technology has provided new ways of learning outside the classroom. Also, the classes were more interactive, dynamic, and attractive, and this made the students more attached to the discipline - the usual classes were switched. For example, the Utility subscale had a mean score of 4.26. Added the options Totally Agree (CT) and Partially Agree (CP), these reached 82.34%, for a sum of 6.38% Totally Disagree (DT) and Partially Disagree. Since the item with the highest average score, with 4.60, was where the students expressed their agreement to the statement that "the remote experimentation laboratory can provide new ways of learning". In this item 93.53% of the students indicated (CP + CT) and only 2%, DT + DP.

Another subscale with a very significant mean index was "learning perception" with 4.03. Where 86.15% of students indicated (CP + CT) and only 6.14%, DT + DP. In this subscale, the item with the highest score, with 4.66, was where the students were asked if "the remote experiment contributed to my learning", where 94.53% of the students indicated CP + CT. These are results that allow us to reflect on the potential of digital technologies and their potential to contribute to education. However, the real potential of these technologies lies effectively in their integration into the teaching and learning processes. Integration that necessarily involves the role of the teacher when inserting them in their pedagogical practice. And providing a significant gain in the teaching and learning processes, and motivating students for new practical experiences in the classroom, bringing them closer to the real world.

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The impact of different kinematics on crack formation in root dentin after endodontic instrumentation

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Abstract— Endodontic instrumentation systems can cause dentinal cracks. These defects may propagate a vertical root fracture to the teeth and extraction will be necessary. The purpose of this study was to compare the formation of root crack caused by the rotatory and reciprocating system. Forty-five extracted human mandibular molars were selected for this study. The mesial roots have been removed and randomly divided into 3 groups according to instrumentation technique: GWG- waveOne Gold primary, GRP: reciproc Blue R25 and GPN – Protaper Next X2. The roots were standardized at 16mm in length and only the mesio buccal canals were prepared by the respective instruments. The mesio-lingual root canal served as control of the research. After root canal instrumentation the roots were the horizontally sectioned at 3, 6 and 9mm from the apex with low-speed saw under water-cooling. The slices were analyzed at X12 magnification with operative microscopy to determine the presence of dentinal cracks. The Friedman test was used to analyze the data. The control did not exhibit and dentinal defects however, all the evaluated systems promoted crack rates. There was no difference among the groups in crack frequency. According to he results, root canal instrumentation with rotatory or reciprocating files can result in some microcracks in root dentin.

Keywords— Cracks, dentinal defect, endodontics, reciprocation motion, rotary systems.

I. INTRODUCTION

Conventional endodontic treatment consists of several stages, but they are interconnected, and whose final objective is to clean, disinfect and effectively fill the root canal system, to promote the return of normality or the preservation of tissue health. apical and periapical, as well as returning function to the tooth in the dental arch [1, 2, 3, 4].

One of the extremely important stages that has undergone major technological advances is the chemical-mechanical preparation of the root canal system, since new

techniques and instruments have been used with different proposals, always aiming at more conservative treatments and with greater preservation of root dental structure [5, 6, 7, 8, 9].

Currently, with a crown-down preparation philosophy, there is the possibility of using automated techniques, which can be used under rotational or reciprocating kinematics, with nickel-titanium instruments with or without heat treatment, different tapers and specific motors [10, 11]. Such systems promote faster endodontic

treatments and, also, with improvements in the quality of the preparation [12, 13, 14, 15].

The possibility of formation of cracks in the dental structure is something important and must be taken into account in the case of the mechanical part of the endodontic preparation [6, 10, 12, 16, 17, 18]. The kinematics and other characteristics of automated instruments are still a recurring question in the works regarding their influence on the formation of apical cracks resulting from the preparation [4, 9].

Several current studies have been published in order to analyze the formation of root cracks in teeth after endodontic instrumentation, so it is always advisable to carry out comparison studies as new instruments are developed and commercialized [19, 20, 21, 22]. The aim of the present study was to evaluate the formation of dentinal cracks after preparation with different kinematics of endodontic instrumentation: WaveOne Gold and Reciproc Blue reciprocating systems and Protaper Next rotary system in curved mesial root canals of mandibular molars.

II. MATERIALS AND METHODS

The Human Research Ethics Committee of the Pontifical Catholic University of Campinas approved this study. This *ex vivo* experimental study was performed on 45 extracted human permanent mandibular molars. To select only moderately curved mesial roots, radiographs of each tooth were taken, digitalized and the angle of curvature were measured using Schneider's method. Only those roots with angles of curvature between 10° and 20° (moderate curvatures) were selected. All teeth were decoronated perpendicular to the long axis of the tooth, standardizing roots segments of 13 mm in length. An evaluation under microscopy to analyze possible existing cracks was performed.

Another analysis criterion observed was the need for two independent root canals in the mesial roots, and this was confirmed with K # 10 files and standardization of the apical foramen with a # 15 file.

All specimens were embedded in auto-polymerizing acrylic resin, and periodontal ligament simulation was performed using hydrophilic vinyl polysiloxane impression material (3M ESP, Seefeld, Germany) as described in the literature previously [6].

The samples were randomly divided into three experimental groups using a computer algorithm (www.random.org). Each group represented an endodontic instrumentation system:

Group GWG – a WaveOne gold primary file (25.07) was used in reciprocating motion in a crow-down technique. Three in-and-out movements (pecks) with a stroke amplitude of 3 mm were performed in each third of the canal (cervical, middle, and apical) until the working length was reached (1 mm short of the apical foramen).

Group GRB – an R25 blue (VDW, Ballaigues, Switzerland) file was used in a manner similar to that described for the RCB group.

Group GPN - An X1 (17.04) Protaper next file (Dentsply Maillefer, Ballaigues, Switzerland) was used in rotary motion (300 rpm, 2 N-cm). Three in-and-out movements (pecks), with stroke amplitude of 3 mm, were performed in each third of the canal (cervical, middle, and apical) until the working length was reached (1 mm short of the apical foramen). The exact same sequence was then followed with an X2 (25.06) instrument.

The same operator performed all preparations. Instrumentation of the respective experimental groups was performed with the aid of an X-Smart Plus motor (Dentsply Maillefer, Ballaigues, Switzerland), adjusted for each system. Regardless of system, each file was used only once, for the preparation of only one canal, and later discarded. The specimens were irrigated with 3 mL of double-distilled water per root third, through a 30G NaviTip needle (Ultradent Products Inc, South Jordan, UT) throughout instrumentation. In all groups, after each cycle of instrumentation and irrigation, foramen patency was controlled with a #10 K-file advanced 1 mm beyond the foramen. At the end of the instrumentation, a final irrigation with 1 mL of the same irrigant used throughout was performed, never exceeding the total amount of irrigant standardized for all specimens (10 mL). Canals were evacuated with the aid of capillary tips (Ultradent, South Jordan, UT) and further dried with the paper points provided with the respective systems.

Finished the preparation, all roots were removed from the resin apparatus and stored in distilled water for hydration.

Roots were horizontally sectioned at 3, 6 e 9mm from the radicular apex using a diamond-coated saw (Isomet 1000- Buehler, Lake Bluff, IL, USA) under a continuous water stream. The samples were then stained with 1% methylene blue and after inspected under an operator microscope at 16X for detection of dentinal cracks. Roots slices with any type of crack line were accounted.

Statistical tests were performed using SPSS (Version 9.0, SPSS Inc., Chicago, Ill, USA). The normality of data was tested with D'Agostino test and after Friedman test. The level of statistical significance was set as 5%.

III. RESULTS

It was found that, regardless of the instrument used and the analysis of the root third, structural cracks were observed in all groups (Fig. 1-3).

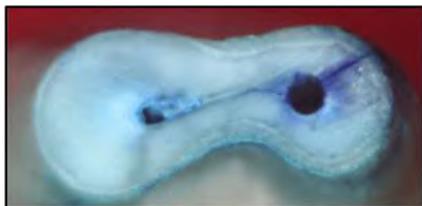


Fig. 1: Crack line observed in specimen of GWG



Fig. 2: Crack line observed in specimen of GRB



Fig. 3: Crack line observed in specimen of GPN

After microscopic evaluation, no cracks lines were observed in the mesio-lingual root canals considered as negative control.

No significant difference was noted among the groups ($P > .05$) (Table 1), independent of the root third evaluated (Table 2).

Table.1: Occurrence of dentinal cracks in different groups

	GWG	GRB	GPN	p-Value
Median (IQD)	0.00 (0.50) ^a	0.00 (0.50) ^a	0.00 (1.00) ^a	= 0.8187

Abbreviations: IQD, interquartile deviation.

Table.2: Occurrence of dentinal cracks in different thirds

Group	Data	3mm	6mm	9mm	p-Value
GWG	MD (IQD)	0.00 (0.00) ^a	0.00 (0.00) ^a	0.00 (0.00) ^a	=0.9512
	MA (SD)	0.13 (0.35) ^a	0.06 (0.25) ^a	0.06 (0.25) ^a	
GRB	MD (IQD)	0.00 (0.00) ^a	0.00 (0.00) ^a	0.00 (0.00) ^a	=0.9512
	MA (SD)	0.13 (0.35) ^a	0.06 (0.25) ^a	0.06 (0.25) ^a	
GPN	MD (IQD)	0.00 (0.00) ^a	0.00 (0.00) ^a	0.00 (0.00) ^a	=0.8607
	MA (SD)	0.20 (0.41) ^a	0.06 (0.25) ^a	0.13 (0.35) ^a	

Abbreviations: MD, Median; IQD, interquartile deviation; MA, Mean; SD, standard deviation.

IV. DISCUSSION

Many previous studies confirm micro cracks or some dentinal defects after root canal preparation with different endodontic files [13, 19, 20, 21, 23, 24]. The current study assessed the effect of endodontics files using different kinematic motions (rotatory and reciprocating movements) on the formation of dentinal cracks. The presence the defects like microcracks in dentinal root can compromise the success of endodontic treatment [9, 17, 20].

During root canal preparation, the root canal diameter is enlarged on account of the contact between dentin walls and endodontic file. A possible cause of dentinal micro cracks would be excessive dentin removal during instrumentation, and it is important to emphasize that resistance to tooth fracture is an important aim in endodontics as they may decrease the long-term survival rate [7, 25, 26].

In the present study, no dentinal defect was observed in the non-instrumented root canals of the same mesial root, which confirms a possible influence of endodontic instrumentation on the stress caused in the prepared roots [9]. The use of curved mesial root canals in the study aimed to simulate a condition similar to in vivo [24].

Studies reveal conflicting results on dentinal cracks after the use multifile (Protaper Next) or single files (WaveOne and Reciproc) systems [9, 14, 27, 28]. However

in the experimental groups it was observed that independent of the kinematics evaluated in the study, no significant difference was observed in the formation of root cracks.

Endodontics instruments with higher tapers tend to generate more stresses into the radicular dentine and promote an increase in the incidence of root cracks [15, 29, 30]. The instrument used in the present study in the Protaper Next system for the apical preparation was the X2 which has # 25 and taper .06. On the other hand, the WaveOne gold primary and Reciproc Blue R25 reciprocating instruments feature a taper of .07 and .08 respectively. However, this factor was also not relevant since all the instruments tested showed a similar index of root cracks in accordance with some studies [25, 30, 31, 32].

The cross-sectional design presents itself differently as the files tested, Reciproc exhibit a S-shaped with a double cutting edge while, WaveOne gold has an offset parallelogram-shaped cross-section and Protaper Next an off-centred rectangular cross section. As much as this difference could impact greater stress on dentin, this fact did not cause differences in the root crack index [30]. The staggered preparation by root thirds, regardless of the system employed, shaping the root canal in a more conservative way, probably allowing a lesser impact on dentin.

Regardless of the endodontic instrumentation system, the clinician or specialist must be aware of the importance of training prior to clinical use in order to obtain better efficiency and success in their endodontic treatments.

Further studies are needed to understand the effect of different root canals preparation systems on dentinal crack formation.

V. CONCLUSION

Under the limitation of this study, rotatory and reciprocating instrumentation can be associated with the microcracks formation in radicular dentine, regardless of the root third analyzed.

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Utilisation of agro-wastes as energy efficient building materials

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Abstract— In developing countries, housing has constituted a major challenge affecting development adversely. This is because of the inability of the government to provide adequate housing for the growing population and also because of the high rate of poverty hampering individuals from providing housing for themselves. This study took the form of a systematic literature review, and harnessed information from both the traditional and the internet sources which include journals, books, web pages, publications and relevant posts which are focused on the use of agro-waste materials as energy efficient building materials towards ensuring sustainable housing development in developing countries. This study has clearly enumerated selected agro-wastes that could be used as energy efficient building materials. With references to their various chemical and mechanical properties, coupled with their characteristics, it is evident that these agro-wastes could be deployed as energy efficient building materials.

Keywords— Agro-waste, Energy Efficient Building Materials, Sustainable Housing, Housing Development, Growing Population, Developing Countries.

I. INTRODUCTION

Developing countries have long been characterized by rapid population growth and urbanization. This has brought about issues relating to the difficulties in providing basic infrastructure such as adequate housing for the growing population. Housing is a major basic need of every human being and fundamental to the welfare, survival and health of man coupled with food and clothing (Fadamiro, Taiwo and Ajayi, 2004; Igwe, Okeke, Onwurah, Nwafor and Umeh, 2017). Hence, it has been noted as one of the major indices for standard of living and development among communities and countries (National Affordable Housing Association, 2006; The Social Protection Committee, 2014). In developing nations, housing has constituted major challenge affecting development because of the inability of the government to provide housing for the population and also because of the high rate of poverty prevalent in the third world nations (Ibimilua and Ibitoye, 2015; Igwe et al., 2017).

According to Igwe, Okeke, Onwurah, Nwafor and Umeh (2017); and Enoghase, Airahuobhor, Oladunjoye, Okwuoke, Orukpe, Ogunwusi and Bakare 2015, housing problem constitute a major issue in any third world nation. Igwe et al.

(2017) noted that in developing countries such as Nigeria, poor housing delivery has been attributed to inadequate mechanisms and systems for land allocation, funding, mortgage institutions and infrastructure. In addition, with approximately over 50% of its population living below acceptable basic standard of living (Kazeem, 2018), this makes the housing problem in Nigeria to be a more difficult problem that demands urgent attention. A major reason for housing problems in most of the third world countries is attributed to the high cost of building materials (Ananwa, 2006; Igwe et al. 2017). This is because most of these building materials are imported from other nations and because majority of the population are poor, owning a house has become exclusive accomplishment of very few people and a herculean project.

Okupe (2002); Aliyu and Amadu (2017) and Enisan (2017) affirmed that there is severe housing shortage due to the growing population and poverty. This has led to a high elasticity of social pressure on social services such as housing. Hence, housing shortage is growing worse day by day in developing countries because of the inadequate supply relative to the elastic demand of housing due to the high

increase in the population growth and increase rate of poverty (Olutuah, 2000; Igwe et al. 2017). Furthermore, apart from quantity deficiency to meet the increasing housing demand, another major challenge to the housing system in third world nations is the low quality of housing being delivered. According to Fakunle, Ogundare, Olayinka-Alli, Aridegbe, Bello, Elujulo, Olugbile and Saliu (2018), housing quality in third world nations is not as professionally exquisite as it is in developed nations and houses that are of high quality are few.

In addition, this situation is common in both urban and rural areas but are more severe in the urban areas due to the fact that most people live in houses that are of poor quality with unsatisfactory environment (Morenikeji, Umaru, Pai, Jiya, Idowu & Adeleye, 2017; Fakunle et al., 2018). Several factors have been noted to be used to describe housing quality in third world nations and these factors include internal facilities; major materials for roofing and materials for external walls; flooring; the type of toilet and bathroom facilities available and provision of stable power supply (Aderamo and Ayobolu, 2010).

Hence, poor quality and low quantity of housing are known to be the major problems affecting sustainable housing development in developing nations. Therefore, attention should be given to ensure the provision of quality housing towards sustainability of housing in developing nations. For example, the Nigerian government has introduced and established National Housing Policy which seeks to provide an institutional framework to ensure the provision of adequate housing both in quantity and quality (Adeshina and Idaeho, 2019). Despite these efforts, little or no achievement has been made to actually meet the housing demands of the growing Nigeria population (Jiboye, 2011; Emiedafe, 2015; Adeshina and Idaeho, 2019). To this end, Basorun and Fadairo (2012) categorized the Nigeria housing challenge into: administrative, institutional and management challenge; financial and economic challenge; physical challenge; and local participatory challenge.

With these elastic challenges affecting provision of sustainable housing in developing nations, and with the fact that Maslow (1943); Jiboye (2011); Emiedafe (2015) and Adeshina and Idaeho (2019) affirmed that quality housing is a basic human need hence, everyone has the right to this basic need. However, the reverse is the case as poor housing has been a normal phenomenon among many communities in developing nations. Nevertheless, the search for alternative means to increase sustainable housing provision,

affordability and at the same time to ensure housing quality has led to the discovery of the potentials of using agricultural wastes as building materials towards ensuring sustainable housing in Nigeria (Aimola, 2012). According to Nuffic and UNESCO/MOST (2002) and Omiunu (2012), local resources such as agro waste are important part of the lives of the poor. Examples of these include sisal (*Agave sisalane*) fibres, rice husk, cotton stalk, sugarcane (*Saccharum officinarum*) fibres, coconut (*coconut nucifera*) fibres, bamboo fibres, banana, kenaf, jute, oil palm, among others. Naveen, Jawaid, Amuthakkannan, and Chandrasekar (2019) noted that these agro wastes are abundantly available, cheap and possess superior mechanical properties that make them energy efficient building materials.

In third world nations and in the world at large, energy efficient building materials as construction materials have been attracting considerable attention. Currently most buildings have a high content of reinforced concrete - the high cost of building materials has been a problem to the average citizen. Steel is partially scarce and its cost is ever increasing and even when available, its quantity and quality fall below the average demand of users. These inadequacies therefore lead to the importation of steel from producers in other countries hence, this has led to the abandonment of projects at various levels of construction. In some cases storey buildings have had to be converted to bungalows or the number of storey of various buildings reduced to minimize cost to meet completion target.

Sequel to seeking for lowering costs of building, scientific and research attention have been shifted to the non-conventional building materials which could possess similar characteristics as those deployed and used in the traditional construction engineering system (Rabi, Santos, Tonoli, and Savastan, 2009). Hence, there is therefore the need for the development and use of locally available materials to implement low cost housing. Before the advent of modern technology, houses were built with traditionally and locally available building materials. The pursue for this traditional innovation and materials use for energy efficient building towards achieving sustainable development is hinged on two assumptions:

- (i) It could assist in reducing the dwelling deficits especially in developing countries because cheaper houses become economically feasible.
- (ii) It could be environmentally friendly as such agro wastes can be recycled or exploited towards ensuring sustainable

housing. Hence, there are numerous local materials and energy efficient materials that could be used as good alternatives in enhancing sustainable housing.

For example, the use of clay in building was widely adopted with palm fronds as roofing materials. Later clay itself was being reinforced with sticks, sisal and fibrous components to make it suitable for roofing. Rice husk ash has also been used as cement replacement additions and it consists of minerals in the form of fine powder derived from other production processes (Aciu and Cobirzan, 2013). Also, reed is another agro-waste material and due to its physical properties, it is a good building material that is light and stable. Reed is mechanically pressed and bound with galvanized metal wire which could make it better for building towards sustainability of housing development. Other types of agro-waste such as, cotton stalk, sugarcane (*Saccharum officinarum*) fibres, coconut (*coconut nucifera*) fibres, bamboo fibres, among others have also been affirmed to be good traditional materials to enhance housing development at the local level.

The use of agro-waste as building materials in the building industry is an efficient modality for implementing sustainable housing development in the construction industry. In addition, the use of agro-waste materials for energy efficient building guarantees the complete, relatively inexpensive, elimination of waste, under environmentally safe conditions, and also the avoidance of environmental pollution that such waste products constitute (Aciu and Cobirzan, 2013). Furthermore, Aciu and Cobirzan (2013) noted that this could also contribute to the conservation of natural resources and this could lead to the reduction of gas emissions often generated during the storage or burning of waste; the avoidance of the over-accumulation of waste products in various controlled waste dumps; and the improvement of the environmental image in third world countries with a very high level of environmental pollution. Therefore, the use of agro-waste materials as energy efficient building materials opens promising perspectives in ensuring energy efficient building hence, the need for this study. To this end, this study would among others, highlight selected types of agro-waste that are energy efficient building materials, their characteristics, mechanical properties, among other attributes.

II. METHODOLOGY

The study took the form of a systematic literature review, and harnessed information from both the traditional and the internet sources which includes journals, books, Web pages, among others. However, it was ensured that publications and relevant posts used in this study are focused on the use of agro-waste materials as energy efficient building materials towards ensuring sustainable housing development in third world nations. In addition, it was ensured that information obtained were arranged thematically and in addition, systematic review of relevant articles and information was done to establish relevant argument of the study in order to drive the course of this study towards affirming how agro-waste materials could be deployed and used as energy efficient building materials for ensuring sustainable housing development in developing nations.

III. CHARACTERISTICS OF ENERGY EFFICIENT BUILDING MATERIALS

According to Celly (2007) agro wastes are used as energy efficient building materials because of the following characteristics:

- i. Easy to manufacture
- ii. Faster and cheaper construction
- iii. Effective waste utilization
- iv. Energy efficient and environment friendly
- v. Environmental protection
- vi. Energy efficiency in manufacturing processes
- vii. Reducing poverty through employment generation
- viii. Modernization of manufacturing process of composite materials by recycling agro – industrial wastes
- ix. Technology transfer, capacity building and procurement of technical know-how and machines.
- x. Building up capacities at institutional and enterprise levels for productive employment, technology transfer and adoption.
- xi. Protecting environment by utilization of renewable resources rather than fast depleting non-renewable ones.
- xii. Promoting energy saving technologies, and thus, making very significant contribution to gaseous emissions, especially of carbon dioxide.
- xiii. Encouraging competitive enterprises to gain access to profitable markets, especially in the alternative materials sector.

IV. AGRO-WASTES USED AS ENERGY EFFICIENT BUILDING MATERIALS

Some agro-wastes as energy efficient building materials have been investigated, these are provided and discussed below:

a. Sisal (Agave sisalane) Fibres

This is the most extensively cultivated hard fibre in the world. It is a strong fibre and has rigid bright green leaves about 10cm wide and 150cm long. Figure 1 shows Sisal plant and fibre.

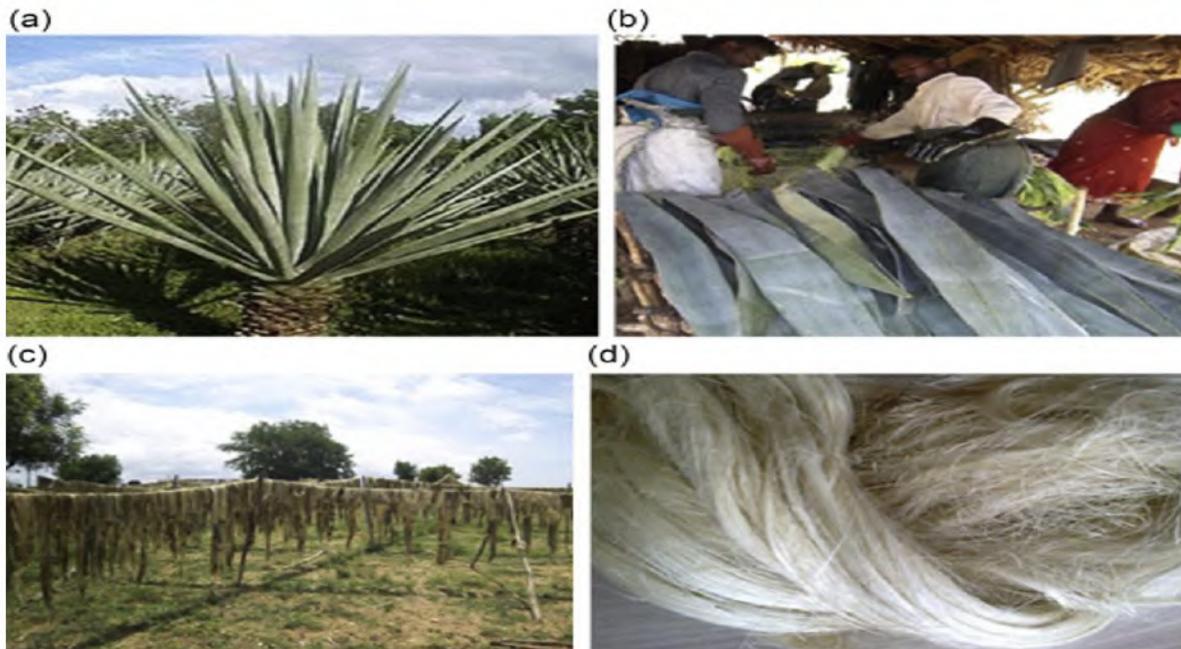


Fig.1: Sisal Plant and fibre

Source: Naveen, Jawaid, Amuthakkannan, and Chandrasekar (2019)

Figure 1 is the Sisal plant while Figure a, b, c and d are the Sisal fibre processed from the Sisal plants. Sisal has been successfully used as reinforcement in cement and concrete matrices (Filho, Joseph, Ghavami & England, 1999). Sisal fiber is a major promising reinforcements in polymer composites because it has higher tensile strength, modulus and impact strength (Naveen et al., 2019). Traditionally, sisal fibers were previously used to make ropes, fancy articles, and carpets, among others. Traditional innovative

development has led to its use for energy efficient building materials towards sustainable housing development.

b. Rice Husk

Rice husk ash is used in concrete construction as an alternative of cement. Ramasamy and Biswas (2008) made use of Rice Husk Ash (RHA) as a cement substitute material. Their end results signified that optimum amount of RHA boosts the mechanical properties of concrete.



Fig.2: Rice husk plant and fibre.

Figure a shows the rice husks and figures b and c show the processed rice husk ash into building materials, figure d shows a brick made from rice husk ash as provided by Arjun (2020). Nair, Fraaij, Klaassen and Kentgens (2008) and Habeeb and Mahmud (2010) also attested to the use of rice husk ash for energy efficient building materials. In addition, Memon, Shaikh and Akbar (2011) and Ling and Teo (2011) investigated the use of rice husk ash as viscosity transforming agent in Self Compacting Concrete (SCC) and observed that developing low cost Self Compacting Concrete from rice husk ash is feasibly viable. Rahman (1988) fabricated bricks from clay-sand mixes using varying percentages of rice husk ash and found that the use of rice husk ash contents increased the compressive strength of the bricks. Also, Chiang et al. (2009) and Shakir et al (2013) observed that adding up of rice husk ash below 15% wt. and sintered at 1100 °C created low density and relatively high

strength bricks which were compliant with appropriate Taiwan standards for lightweight bricks.

c. Cotton Stalk

Cotton stalk is residue of cotton left in the field following harvest and must be buried or burned to prevent it from serving as an overwintering site for insects such as the pink bollworm (PBW) (Al-Afif, Pfeifer and Pröll, 2019). In contrast to other agricultural crop residues, cotton stalk is comparable to the most common species of hardwood in respect of fibrous structure (Pandey and Shaikh, 1986) and hence are deployed and be used for the manufacture of particle boards, preparation of pulp and paper, hard boards, among others. Hence, its usage would not just only help in the enhancement of housing but also reduce the environmental pollution and disease producing tendency in the community (Al-Afif, Pfeifer and Pröll, 2019). Figure 3 shows cotton plant and stalks.



Fig.3: Cotton plant and stalks

Figure 3a shows a cotton plantation with cotton plants, figure 3b shows the cotton stalks which are remnants from harvesting cotton, Figure 3c shows the straws made from cotton stalks, while figure 3d shows boards produced from cotton stalks as provided by Kumar (2010). According to Chen, Wang, Chen & Lv (2014), cotton stalk fiber play a stronger role in the fiber reinforced cement and cotton straw cement-based blocks are not easy to crack or brake. Nkomo and Nkiwane (2017) showed that cotton stalk has better mechanical properties and tenacity especially those at the top and middle position that makes it possible for its use for building materials. Li, Yu, Zhao, Li & Li (2003) and Agwa, Omar, Tayeh & Abdulsalam (2020) noted that cotton stalks have fiber/gypsum composite that could effectively be used for self-compacting concrete to enhance sustainable housing.

d. Sugarcane (*Saccharum officinarum*) Fibres

There are two by-products from cane sugar processing, namely the straw and bagasse (cane fibres) (Yamane, 2020) and they can be used to enhance sustainable building materials. Sugarcane fibre is a waste material left over after

the extraction of the juice of sugarcane known as bagasse. Sugarcane is cultivated in most of South American sub-tropic zone, and also in Nigeria. Sugarcane fibres have been used in the production of 1.2cm² panels, which are either bonded with cement of up to 49% (Blackburn, 2000). Composite boards of sugar cane bagasse particles and recycled high-density polyethylene were manufactured by means of a flat press process under laboratory conditions using a partial factorial experimental design (2K-1) to determine the effects of the process variables press temperature, pressing time, bagasse/plastic content and pressure on bending properties, water absorption and thickness swelling (Wyk, 2005). Sand replacement and performance tests were carried out by Sales and Lima (2010) for preparing mortars and concretes with Sugar Cane Bagasse Ash (SCBA). Their results indicated that the SCBA samples show cased physical properties comparable to those of natural sand. They also found that the mortars produced with SCBA instead of sand presented enhanced mechanical results as opposed to the conventional mortar. Figure 4 shows sugarcane products and fibres.



Fig.4: Sugarcane products and fibres

From Figure 4, Figure 4a shows a Sugarcane plantation (Yamane, 2020), Figure 4b shows Sugarcane fibres, Figure 4c shows boards manufactured from Sugarcane fibres (Carvalho, Mendes, Cesar, da Flórez, Mori & Rabelo, 2015), while Figure 4d shows local bricks manufactured from Sugarcane fibres (Danso , Martinson, Ali and Williams, 2015). Hailu and Dinku (2012); Abbasi and Zargar (2013); Otoko (2014); Lathamaheswari, Kalaiyarasan and Mohankumar (2017); among others noted that sugarcane fibres are deployed in the building industry to enhance sustainable housing in developing countries. According to Kawade, Rathi and Vaishali (2013), partially replacement on concrete with bagasse has shown that the strength of concrete increased up to 15%. Other studies such as Dhengare, Raut, Bandwal and Khangan (2015) noted that the strength of concrete reported to have optimum of 15% replacement level. According to Núñez-Jaquez, Buelna-Rodríguez, Barrios-Durstewitz, Gaona-Tiburcio and Almeraya-Calderón (2012), with the corrosion rate of steel by polarization resistance method, embedded in concrete having cement

replaced with bagasse ash by 20% provides some profound beneficial effect on protection of steel rebar from corrosion. According to Amin (2011), the optimal replacement ratio of 20% of cement by Sugarcane fibres reduced the chloride diffusion by more than 50% without any adverse effects on other properties of the concrete.

e. Coconut (Coconut nucifera) Fibres

A mature coconut has an outer covering made of fibrous material. This covering called the 'husk' consists of a hard skin and large coconut fibres embedded in a soft material. The fibres otherwise known as Coir can be extracted simply by soaking the husk in water to decompose the soft material surrounding the fibres. The fibre is light, elastic, exceedingly high in resistance to mechanical wear and dampness, and it is highly sound insulating especially in sea water. However, it is less durable and rougher surfaced than other vegetable fibres. Nevertheless, the low production cost makes it quite compatible despite its limitation (Hasan, Sobuz, Sayed and Islam, 2012).



Fig.5: Coconut (*Coconut nucifera*) Fibres

Figure 5a shows a coconut (MyFarmbase Africa, 2019); figure 5b shows coconut fibre (Shutterstock, Inc., 2020); Figure 5c shows Boards made from coconut fibres (Pinoy-Entrepreneur, 2019), while Figure 5d shows coconut fibre used as insulator in blocks (Iwaro and Mwashu, 2019). Coconut fibres could be deployed and used for building materials to require care of a comfy indoor building environment in residential buildings (Pasic, Topalovic, and Kobas, 2010; Al-Rabghi and Akyurt 2004; Panyakaew and Fotios, 2008). Effective thermal insulation material is taken into consideration the foremost important component of building energy conservation building which can reduce the worth of cooling and energy consumption and thus the resulting pollution of the environment (Radhi, 2008). As such, thermal insulation materials like those obtained from coconut fibres are chosen for his or her physical properties, like low thermal conductivities, moisture protection, and mold and fire resistance (Oushabi, Sair, Abboud, Tanane, and El-Bouari, 2015).

f. Jute Fibres

Jute could also be a vegetable grown mainly in India, China and Thailand solely for creating ropes and bags to maneuver grains and other materials ranging from cement to sugar. Vegetable fibers like Jute fibres are widely available in most developing countries and are known to be suitable reinforcement materials for brittle matrix albeit they present relatively poor durability performance (Rabi, Santos, Tonoli, and Savastan, 2009). Understanding the mechanical properties of such fibers also as their broad variation range, building materials with suitable properties could be developed by means of the adequate mix design (Agopyan, Cincotto and Derolle, 1989). according to Pacheco-Torgal & Jalali (2011) noted that a mean of 200 kg of steel rebar is used for each kiloliter of concrete structure, reinforced steel could also be a highly expensive material, and it is high energy consumption and comes from a non-renewable resource hence it is clear that the replacement of reinforced steel rebar by vegetable fibres like Jute fibres could also be a significant step to comprehend a more sustainable construction. Jute fibre is strong in tension hence can also be utilized within the cement matrix. Figure 6 shows Jute fibres.



Fig.6: Jute fibres building products

Figure 6a shows Jute plantation, Figure 6b shows Jute fibre, Figure 6c shows boards made from Jute fibres (Excel Composites Pvt. Ltd., 2020); while Figure 6d shows Jute fibre used as substitutes for woods in building houses (Gon, Das, Paul and Maity, 2012). According to Gon et al. (2012), Jute fibre could also be a promising reinforcement to be utilized in composites in buildings on account of its low cost, high specific strength and modulus, no health risk, easy availability, renewability and far lower energy requirement for processing. Additionally, Jute fibre composites enjoy excellent potential as wood substitutes in sight of their low cost, easy availability, saving in energy and pollution free production hence, its importance within the utilization as sustainable building materials.

g. Flax Fibres

Flax could also be a slender and erect plant grown mainly for its fibre. Both the durability and modulus of elasticity of flax fibres are extremely high compared to those of other natural fibres. Fernandez (2002) noted that the mechanical results of flax fiber shows that it are often used for buildings in developing regions with access to significant sources of cellulose fibers and small-scale industrial capacity to process them. The increase within the shear strength of structural members composed of the flax fiber ferroconcrete offers strategies that may cause substantial savings in construction materials, especially steel. Additionally, flax fibre has good potential that provides strategies which can cause substantial savings in construction materials, strength of structural members composed of the flax fiber ferroconcrete length of 3cm for flax fiber in concrete (Fernandez, 2002). Figure 7 shows Flax fibres and products.



Fig.7: Flax fibres and products

Figure 7a shows flax plants (Heber, 2018), figure 7b shows flax fibres, Figure 7c shows boards made from flax fibre (Visser, 2016); while Figure 7d shows flax fibres used for reinforced composite (Mustafa, Azmi, Zakaria and Lih, 2019). In summary, Fernandez (2002) noted the next properties that made flax fibres good product for building materials:

- Flax fiber contributes well to both the strength and toughness of concrete,
- Flax fiber in concrete is optimized at a length of around 3cm,
- Positive inclusion morphology of the fibers in concrete is possible with the proper mixing protocol,
- Flax fibers contribute to the augmentation of the mechanical properties of the concrete composite through a complicated ranger of fiber/matrix failure mechanism,

- Flax fiber ferroconcrete approaches to within reasonable expectation of overall strength and toughness for a viable structural material for buildings.

h. Bamboo Fibres

Bamboo could also be a stemmed monocotyledonous perennial plant belonging to the tribe Bumbasea of the family Graminea. Bamboo can grow old to a height of 15m with diameter within the range 25-100mm. It is grown naturally within the tropical and sub-tropical regions. Bamboo fibres are strong in tension which they are often used as reinforcing materials. Bamboo can also be fabricated to form endless reinforcing material. Figure 8 shows bamboo fibres and products.



Fig.8: Bamboo fibres and products

Bamboo is known to be a highly sustainable natural artifact and merchandise that tends to be durable and resilient, making it amiable to housing projects (Woodworkers, 2020) hence, its usefulness as a sustainable building material.

i. Cellulose/Wood fibre

There are different types of wood used for various purposes, and wood fibres are usually made up of cellulosic elements extracted from trees and are within the type of Sawdust. It is a spread of other practical uses including serving as mulch, an alternate to clay cat litter, or as fuel. It can be a hazardous material in manufacturing industry, in terms of its flammability (Ganiron, 2014). The use of sawdust for

creating lightweight concrete has received some attention over the past years (Udoeyo and Dashibil, 2002).

Mageswari and Vidivelli (2009) reported that as a substitution material for natural sand, sawdust ash could be the proper choice as fine aggregate in concrete. It can considerably reduce the dumping problem and simultaneously help the preservation of natural fine aggregate. Sawdust ash possesses unique characteristics, which makes it competitive among other construction materials and a far better material for concrete (Mageswari and Vidivelli, 2009). Figure 9 shows wood fibres and products.



Fig.9: Wood fibres and products

Figure 9a shows wood fibres gathered together, Figure 9b shows a board manufactured from the wood fibres, Figure 9c shows concrete blocks made up of wood fibres while Figure 9d shows cement-bonded wood fiber. The function of the utilization of wood fibres for energy efficient materials could include:

- Wind-shield- and double-floor boarding in roofs;
- Interior lining;
- Additional thermal insulation;
- Concrete moulds and other temporary structures (e.g. vacant lot fences and protective boarding).

j. Wild Arundo donax

The Giant reed, also referred to as bamboo reed, cane reed , Spanish reed, wild cane, is an aggressive wild agricultural species which may be found everywhere the planet . It is hollow, rigid, woody stalks which are nearly one inch in diameter and may grow over 13 feet tall . Continuous reduction of natural resources and at an equivalent time the environmental hazards posed by the disposal of several waste s create a chance to use this waste material in concrete (Ismail and Jaeel, 2014). Figure 10 shows wild Arundo donax products.

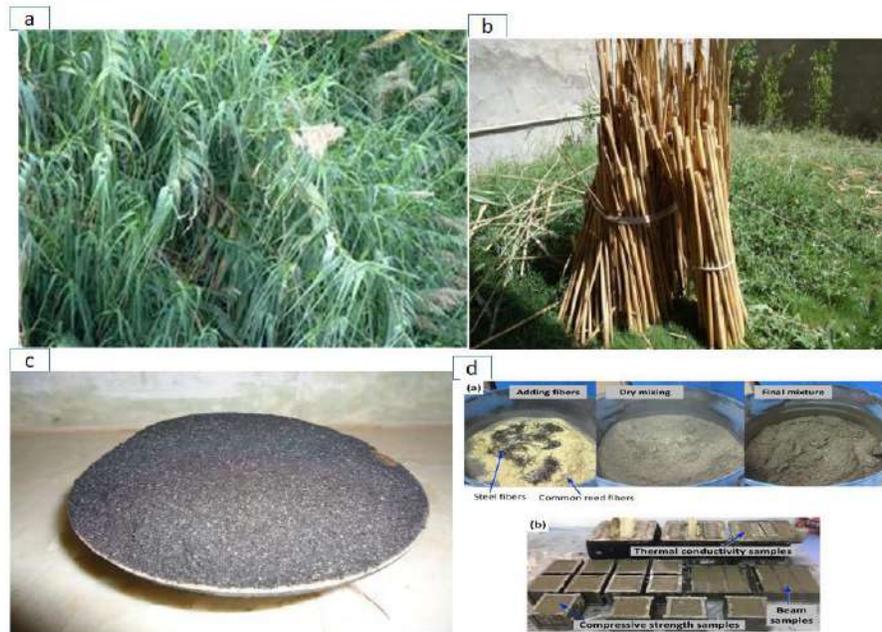


Fig.10: Wild *Arundo donax* products

Figure 10a shows an enormous reed plant, Figure 10b shows a newly collected *Arundo donax* (Ismail and Jaeel, 2014), Figure 10c shows giant weed ash used for reinforcement of concretes ((Ismail and Jaeel, 2014), and Figure 10d shows reed fiber-reinforced mixtures with (a) mixing procedure; and (b) mixture samples for hardened property test (Shon, Mukashev, Lee, Zhang and Kim, 2019). the enormous reed is a stimulating source of reactive ashes which will be used as building materials. For instance, it is used as a pozzolanic component in blended Portland cement or as a source of silica in geopolymeric systems, consistent with what Payá, Roselló, Monzó, Escalera, Santamarina, Borrachero and Soriano (2018) found that the reed has chemical and mechanical properties that made them suitable to be used as building materials.

V. CHALLENGES OF AGRO WASTES AS ENERGY EFFICIENT BUILDING MATERIALS

Although, several authors have noted the advantages and importance of using agro waste as energy efficient building materials towards enhancing sustainable housing, it is important to notice that there are several challenges and drawbacks that would hamper their usage as building

materials, Obakin (2009). Such challenges or disadvantages include:

- i. Agro waste materials have lower strength properties, particularly its impact strength
- ii. They even have variable quality, counting on unpredictable influences like weather.
- iii. They need moisture absorption tendencies, which cause swelling of the fibres. However, laminating or waterproofing can improve this.
- iv. They have a tendency to limit maximum processing temperature.
- v. They need lower durability, but fibre treatments can improve this considerably.
- vi. They need poor fire resistance but fire retardants can improve this.
- vii. Also, price can fluctuate by harvest results or agricultural politics.

An important thing to notice is that despite these disadvantages and challenges, the benefits of using agro waste as energy efficient building materials outweigh the disadvantages. Additionally, the disadvantages are often

improved upon and circumvented so as to achieve the aim of ensuring sustainable development (Obakin, 2009).

VI. CONCLUSION

The study has clearly enumerated selected agro-wastes that could be used as energy efficient building materials towards enhancing sustainable housing, and with references to the varied properties like mechanical and chemical, including their characteristics, it is evident to emphasize that agro-wastes could be deployed as energy efficient building materials. However, several challenges and drawbacks are noted accompanying the utilization of such agro waste as energy efficient building materials. Nevertheless, despite these disadvantages and challenges, the benefits of using agro waste as energy efficient building materials outweigh the disadvantages. Furthermore, such disadvantages that characterized the use of agro-wastes as energy efficient building materials are often circumvented and cushioned towards ensuring sustainable development.

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Biochar as an additive in the composting process

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Abstract— *The production of solid wastes from anthropic activities is following a growing increase and the wastes from agriculture and forestry do not escape this trend. In this context, composting emerges as a viable and inexpensive alternative to transform organic waste into compounds that have high potential for use as organic fertilizers. An alternative to optimize the composting process, ensuring compost as agronomic potential and in less time, is the use of Biochar in windrow composting. Based on this assumption, the present work analyses the behavior of pine sawdust and cattle manure compost piles submitted to different Biochar doses (0%; 1%;5% and 10%). The observed result was that Biochar was responsible for increasing the temperature of the windrow, thus indicating greater microbial activity, presented a higher tendency of moisture loss and gave rise to a more alkaline substrate.*

Keywords— *Cattle manure, Microorganisms, Organic compost, Pinuselliottii.*

I. INTRODUCTION

Agro industrial activities are responsible for generating a large volume of organic waste that, if left untreated, is a potential cause of environmental damage (Dias et al., 2010).

However, solid organic waste is a biodegradable material that has the possibility of being recycled when used as soil conditioners, which increase moisture retention, improve texture, and supply macro and micronutrients to the plants. Yet, in order for the solid waste to actually be used for agricultural purposes, the waste must be applied to the soil after undergoing a certain level of stabilization, and among the processes that can promote such stabilization, composting stands out (Dores-Silva et al., 2013).

According to Lim, Lee and Wu (2016) this method stands out due to its social and environmental benefits coupled with a low operating cost. Fornes et al. (2012) adds that composting is a process by which organic matter is stabilized through the aerobic process of native, thermophilic, and mesophilic microorganisms. This process provides the hygienization of the compost, enabling a substrate with low phytotoxicity due to the reduction of pathogens and the sanitation of the organic waste (Lim, Lee & Wu, 2016). Decreased phytotoxicity occurs because the high temperatures help to eliminate

phytopathogenic organisms, making the compost safer for use as an organic fertilizer (Ribeiro et al., 2017).

The composting process is influenced by various physicochemical factors such as, temperature, pH, particle size, moisture content, aeration and electric conductivity (Li et al., 2013; Juarez et al., 2015). Monitoring the behavior of these parameters is of utmost importance to indicate the maturity and phytotoxicity of the final compost (Ribeiro et al., 2017).

The temperature variation of the windrow composting, as well as microbial CO₂ production, vary throughout the process due to the succession of microbial communities and their metabolic activities, thus being important parameters in determining the phases of the process as well as the maturation of the compost (Hassen et al., 2001; Silva, Azevedo & De-Polli, 2007).

The use of materials that speed up the composting process and that give rise to substrates with agronomic characteristics that contribute to fertilization and increased microbial activity of the soil, have contributed more efficiently to the development of waste reuse technologies. One of the possibilities for the improvement of the composting process is the application of materials that provide a favorable environment for the decomposer microorganism, causing there to be an increase in its metabolic activity and consequently an optimized process.

Among these materials, Biochar, which can optimize the composting process, stands out (Xiao et al., 2017).

According to Melo and Silva (2018), Biochar is a solid, carbon-rich material that is obtained by the thermochemical transformation of biomass under low oxygenation condition, a process called pyrolysis. This material can be produced from waste rich in organic matter, and is therefore a waste reuse alternative that gives rise to a product that has the potential to be applied as a soil and substrate conditioner in order to better physical, chemical, and biological qualities, with productivity gain for several crops (Hamzah et al., 2013; Kookana et al., 2011).

The use of Biochar can optimize the composting process, due, for example, to its ability to provide, in the windrow, a favorable environment for the development of decomposer microorganisms. This is thanks to its large surface area and the ability to increase the porosity of the compost, serving as physical support for microbial development. However, characteristics of the Biochar used may influence the composting process favorably or unfavorably. Among these characteristics are the concentration used in the windrow, the type of raw material used in the production of the Biochar, the pyrolysis temperature, and the particle size (Sanchez-Monedero et al., 2018).

In this context, the aim of this work was to evaluate the influence of different doses of Biochar in the organic waste composting process.

II. METHODOLOGY

2.1 Composting process

All experiments were conducted at the University of Uberlândia's (UFU's) Monte Carmelo Campus. The compost windrows were prepared using cattle manure and eucalyptus sawdust (*Eucalyptus grandis*), whose amounts were, 12.0 Kg and 1.5 Kg, respectively. These amounts of manure and sawdust were obtained based on the concentration of carbon, nitrogen, moisture (Table 1), and calculated by Equation 1, cited by Brito (2016). Four compost windrows were prepared and Biochar was added to each in concentrations of 0% (B0), 1% (B1), 5% (B5) and 10% (B10) m/m in relation to the total dry mass of the windrow.

The windrows were placed on a cemented, covered surface without any direct interference from sunlight or precipitation.

$$(1) \frac{C}{N} = \frac{(P1[C1(100-U1)]) + (P2[C2(100-U2)])}{(P1[N1(100-U1)]) + (P2[N2(100-U2)])}$$

Where: P is the sample weight in kilograms; C is the percentage of carbon; N is the percentage of nitrogen; U is the moisture of the sample in question as a percentage.

Table 1. Carbon, nitrogen, and moisture content of waste used in composting

	Sawdust	Manure
Total nitrogen (%)	0.30	1.01
Total carbon (%)	55.22	20.94
Moisture (%)	8.99	42.20

The Biochar was produced through incomplete combustion by the slow pyrolysis process in a two-cylinder thermal oven adapted from a model used by Thai agriculturists (Prakongkep, Gilkes & Wiriyakitnateekul, 2015). The biomass source used for Biochar production was pine sawdust (*Pinuselliottii*).

The cattle manure was obtained from rural property in the municipality of Monte Carmelo, MG, which has beef cattle confinement. The Eucalyptus (*Eucalyptus grandis*) and Pine (*Pinuselliottii*) sawdusts were obtained from the wood processing industry also in the municipality of Monte Carmelo, MG.

2.2 Evaluation of the composting process

During the composting process, the temperature of the windrow and the composting environment were evaluated twice daily, in the morning and in the late afternoon. By doing so, average daily temperatures of the windrow and the composting environment were obtained. pH, electrical conductivity, moisture, and the density of the composted material were evaluated weekly.

The pH and electrical conductivity were determined using specific electrodes (combined glass electrode, and conductivity electrode, k=1,0) in aqueous extracts obtained according to European standards EN 13037 (CEN, 1999) and EN 13038 (CEN, 1999), respectively. For the pH, a 5 mL sample of the compost was stirred with 50 mL of 0.01 mol.L⁻¹ calcium chloride (CaCl₂) solution for 60 minutes. After this time period, the pH was read in the supernatant solution. To determine the electrical conductivity, 20g of compost was stirred with 200.0 mL of distilled water for 30 minutes. After this time period, the supernatant was read.

The moisture in the samples was determined weekly through the thermogravimetric method, where approximately 2g of the composted material were oven dried at 105 °C until it was a constant mass. The moisture was calculated by equation 2.

$$(2)U = \frac{A-B}{A} \times 100(3)$$

Where: U is the moisture (%); A is the wet mas (g); B is the dry mass (g).

The moisture was checked daily by the hand feel method. This test consists of taking a handful of material from inside the windrow and squeezing it with force. The ideal moisture point is when the water begins to well up between the fingers without dripping.

The density was monitored by the method described by MAPA (2008), in which a 500.0 mL beaker was filled up to the 300.0 mL mark with the substrate at the current moisture and was subsequently dropped under the action of its own mass from a height of 10.0 cm for 10 consecutive times. Therefore, the volume (mL) of the compost obtained was measured and the mass of that volume of material verified, discounting the mass of the beaker. The procedure was repeated three times with different subsamples. The wet density value was obtained by applying Equation 3.

$$(3)DU = [Mu / V] \times 1000$$

Where: DU is the wet density (Kg.m⁻³); Mu is the wet mass (g); V is the volume assumed by the compost (mL).

The microbial activity of the composted material was evaluated at six, twelve and twenty-four days after the beginning of the composting process according to the methodology adapted from Dionísio et al. (2016). To this end, 25.0 g of composted material was added to a 500.0 mL glass flask (Incubation Flask). Then, the test tube containing 10.0 mL of NaOH (0.5 mol L⁻¹ standardized) and another test tube containing 10.0 mL of distilled water were placed into the incubation flask.

A blank test was performed corresponding to two incubation flasks containing only one test tube containing 10 mL NaOH (0.5 mol L⁻¹ standard) and another tube containing 10.0 mL distilled water. The 500.0 mL glass flasks were hermetically sealed and incubated in an oven at 28 °C for one week (168 hrs). After the incubation period, the test tubes containing NaOH were removed from the incubation flasks, the solution of which was transferred to a 125.0 mL erlenmeyer flask, adding 1.0 mL of BaCl₂ (10% m/V) and two drops of phenolphthalein and excess NaOH was titrated with 0.5 mol HCl. L⁻¹. The activity of the composted material was evaluated by C-CO₂ mass per kg of composted material per hour of incubation and calculated according to equation 4.

$$(4)RBS = ((V_b - V_a) \cdot M \cdot 6 \cdot 1000) / P_s / T$$

Where: RBS (mg C-CO₂ Kg⁻¹ h⁻¹): amount of carbon in the form of CO₂ generated by the microbial activity of the

composting material V_b (mL): volume of the hydrochloric acid spent on the titration of the control (white); V_a (mL): volume spent on the titration of the hydroxide contained in the incubation flask containing the composting material; M = molarity of HCl; P_s (g) = mass on the composting material used in the test; T = the sample's incubation time in hours.

III. RESULTS AND DISCUSSION

The results of the temperature variation of the compost windrows and the environment temperature are presented in Figure 1.

It is verified that during aerobic composting, the average temperature curve of the composting piles presented the three classical phases, namely: the thermophilic, mesophilic and maturation phases, which are presented in Figure 1.

The four treatments (B0, B1, B5 e B10) reached the thermophilic stage of the process soon on the first day, presenting temperatures of 32°C, while the average environment temperature presented on this first day was 19°C. On the first day it was also possible to observe differences between the average windrow temperatures in relation to the biochar concentration, and the greatest biochar concentrations provided higher temperatures in the compost windrow. Treatment B5 presented the highest temperature among the treatments, being 38.4°C. Treatment B10 was responsible for the second highest temperature, averaging 36.5°C. Treatments B0 and B1 had the lowest averages, both of which presented temperatures of approximately 32°C.

This temperature increase in treatments with higher doses of Biochar reflect a higher microbial metabolism, which can be associated with the ability of the Biochar to provide a composting environment favorable to the development of the organisms involved in the process.

The presence of Biochar and its association with higher temperatures in the compost windrow at the beginning of the process was also observed by Wei et al. (2014) upon analyzing Biochar's influence on the microbial community in the compost pile with chicken manure and tomato stalk. López-Cano et al. (2016) cite in their study that the presence of Biochar in the windrow with sheep manure favored the activation of the composting process, presenting a faster temperature increase than the control. This temperature increase may be caused by the increase in microbial activity due to the environmental conditions that Biochar provides in the compost, those that favor the microbial activity that acts in the process (Sanchez-Monedero et al., 2018).

On the fifth day of composting there was a considerable decrease in the temperature of the windrows, a fact justified by the decrease in moisture. On this day, the moisture was corrected and in turn, there was a temperature increase observed the next day.

The high temperatures, characterized mainly by the substantial difference in relation to the average

environment temperature, lasted until the eighth day of composting, when the process left the thermophilic phase, presenting and maintaining lower temperature values (Figure 1A and Figure 1B).

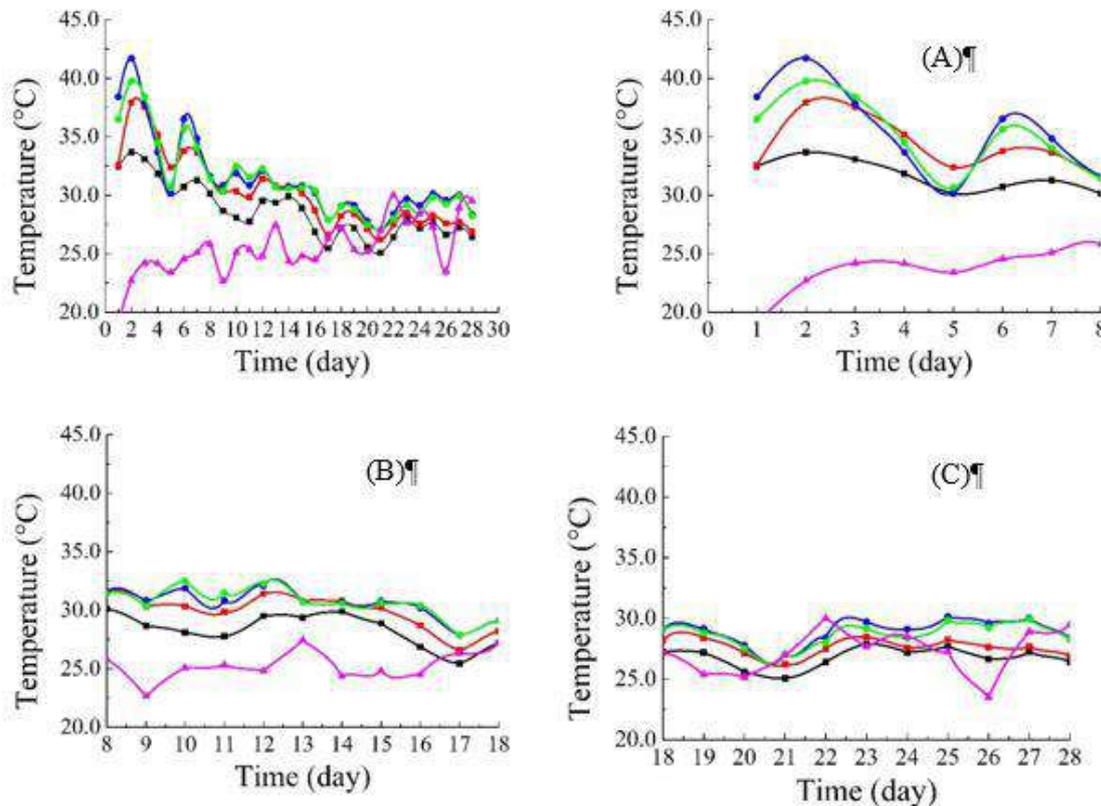


Fig. 1: Variation of the average environment temperature and the compost windrows during the process (A) and highlights for the thermophilic (B); mesophilic (C); and maturation (D) stages.

Note: -■- B0; -■- B1; -●- B5; -●- B10; ▲ Ambiente.

In the mesophilic phase (Figure 1B), windrow temperatures differed from treatment B0. The treatments with Biochar presented higher windrow temperatures, especially the treatments with more elevated concentrations of Biochar, treatments B5 and B10. It is important to note that the compost windrows of the four treatments maintained temperatures above the environment average until the 17th day of composting, a fact that characterizes this period as mesophilic, since despite presenting temperatures that were lower than in the beginning of the process, the windrow temperatures differed and were higher than the environment temperature.

However, from the 17th day of composting (Figure 1B and Figure 1C), the windrow temperature assumed values similar to the environment temperature,

presenting similar variations, which characterized this phase as the maturation phase since the microbial activity is already reduced and consequently there was no heat generated by microbial activity inside the windrow that was sufficient to exceed the environment temperature. This lower temperature behavior in the windrows and the fact that the windrow temperatures did not differ from the environment temperature for 11 days was an indication that the compost was mature, thus representing the end of the composting process, which took place after 28 days.

The water present in the compost windrow is fundamental for microbial growth. It is considered that contents above 65% will cause an anaerobic situation undesirable to microbial metabolism and if the moisture content remains below 40%, it may cause inhibition of microbiological activity (Berticelli et al., 2016). The results

of windrow moisture during the composting process are shown in Figure 2.

Until the 11th day of composting, all treatments remained within the recommended range for the maintenance of microbial activity, and for treatments B0 and B1, higher moisture values of the composting material were observed. From the 17th day of composting on, there was a decrease in the moisture content of the composting

material, especially for the treatments with a higher Biochar concentration, which may be related to observed increases in environment temperature (ranging from 24 °C to approximately 27 °C) associated with the presence of higher doses of Biochar in the windrow. This may have influenced the higher aeration and consequently faster moisture loss.

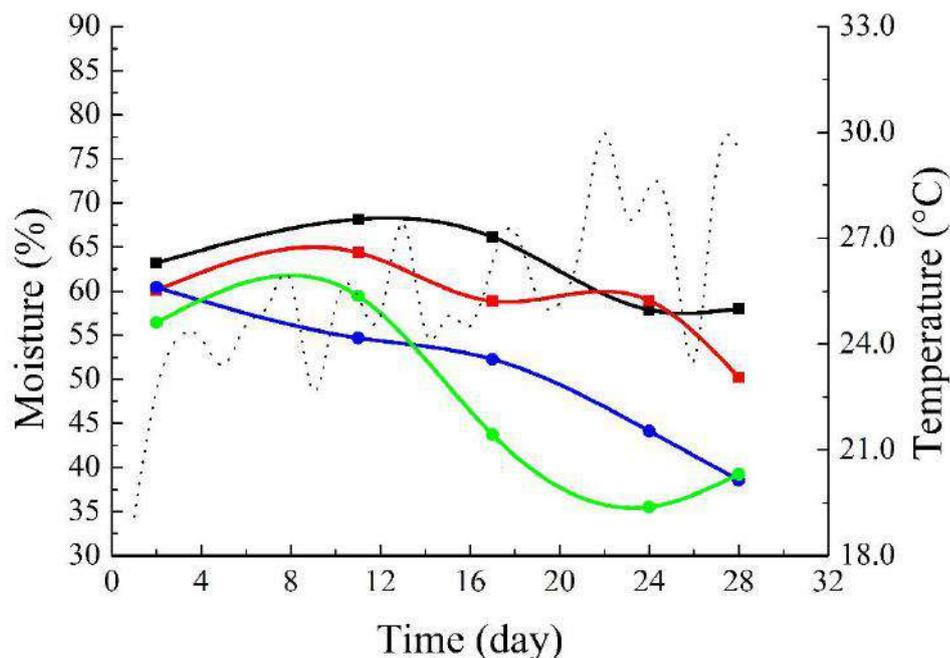


Fig. 2: Moisture of compost piles and variation in environment temperature throughout the process.

Note:-■- B0; -■- B1;-●- B5;-●- B10.

Biochar is reported as an agent that provides increased compost pile aeration, increasing gas exchange essential for microbial metabolism (Sanchez-Monedero et al., 2018), but compost windrow aeration provides water loss, causing the moisture content of the composting material to decrease throughout the process (Berticelli et al., 2016), a fact that explains the tendency for higher water losses in the treatments that had higher amounts of Biochar.

Treatments B0 and B1 remained within the ideal range, however, treatment B10 presented a percentage of water lower than the recommended amount at day 24 of composting (36% moisture). At the end of the process, all treatments were within the appropriate humidity range for microbial activity, and the highest moisture values were observed for treatments B0 and B1 (58 and 50%, respectively), while for treatments B5 and B10, 39%

humidity was observed in both compost windrows. The substrates obtained by treatments B5 and B10 presented moisture values in the recommended value range for the final compost, as stipulated by the Ministry of Agriculture, Cattle and Supplying for organic compounds, which is up to 40%.

Analyzing the material density (Figure 3), a decreasing trend was observed, with the substrate obtained at the end of the composting process having a lower density than the initial material being composted, which was observed for all treatments. This behavior indicates that the solid material presented a degradation process, showing a smaller particle size in the final substrate. Such lower density behavior in the final material compared to the original material may be due to moisture loss and organic matter degradation (Berticelli et al., 2016).

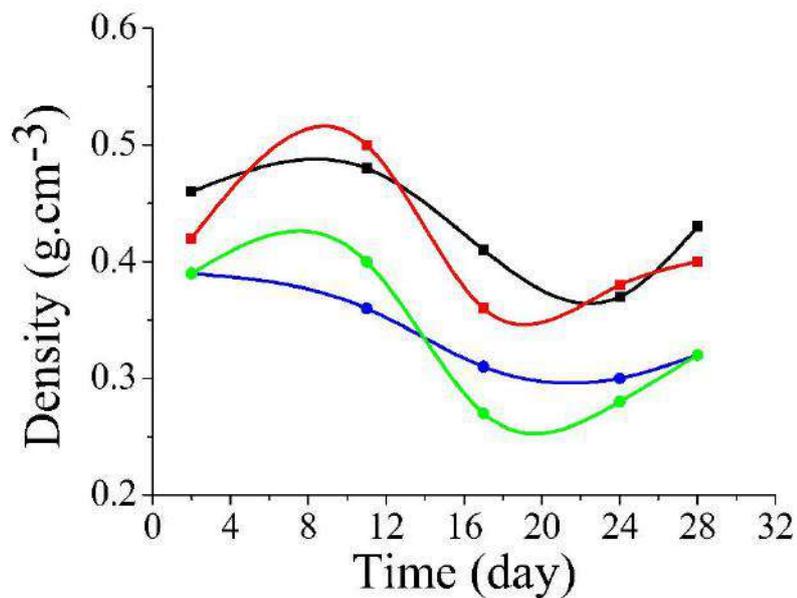


Fig. 3: Density of composted material between the treatments.

Note:-■- B0; -■- B1;-●- B5;-●- B10.

At the beginning of the composting process, treatment B0 presented a higher density (0.46 g.cm^{-3}) followed by treatment B1 (0.42 g.cm^{-3}) and lastly, treatments B5 and B10, which both presented the lowest density of 0.39 g.cm^{-3} . That is, the higher the concentration of Biochar in the windrow at the beginning of the composting process, the lower the density of the composting material, which is due to the larger volume occupied by the Biochar, which promotes a lower density for the same mass of composting material.

On the eighth day of composting, a slight increase was observed for all treatments, which is a consequence of the increase of the materials' moisture during this period, except for treatment B5, where there was a decrease in the windrow's moisture (Figure 2). From day 8 on, all composting materials showed a decrease in density which was observed until the 20th day of composting, the beginning of the compost maturation phase. From this moment, a small increase in the composting material's density was observed until the last day of the process, possibly caused by decreased moisture.

The substrates obtained at the end of the composting process showed the same behavior in the density values in relation to the treatments. Treatment B0 (0.43 g.cm^{-3}) presented higher density in relation to the others, the compost from B1, 0.40 g.cm^{-3} , and B5 and B10 both 0.32 g.cm^{-3} . Comparing the density values of the composting material at the beginning of the process with

the density values of the substrates obtained, it can be verified that higher concentrations of Biochar provided lower values of material density, which may be inherent to the fact that Biochar has a higher volume, or it may be attributed to the fact that it provided a higher rate of material degradation in the windrow and therefore a low density.

Results obtained for density are similar to those observed by Jindo et al. (2012) when analyzing the influence of Biochar in composting with chicken manure and cattle manure, where the compost with Biochar presented a lower density than the treatments without its application. The authors correlate this density decrease with the compost's increased porosity and consequently the formation of an environment conducive to microbial development.

The behavior of the composting material's pH during the different treatments is shown in Figure 4.

It can be observed that there were no major differences between the pH values of the composting material between treatments. All treatments showed the same behavior throughout the composting period, where an increase in acidity can be observed by the 11th day followed by an increase in the pH value of the material up to day 24 and then by day 28 the pH values had again decreased, except for the pH value of treatment B10, which provided a substrate with a higher pH value.

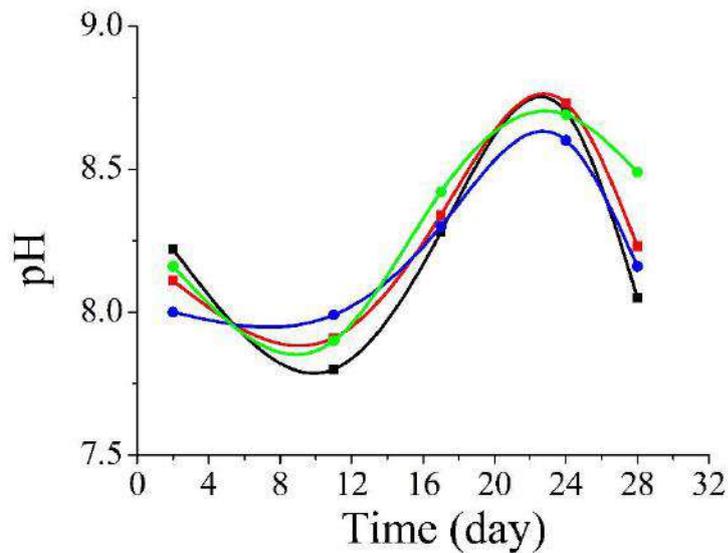


Fig. 4: Behavior of the composting materials' pH between treatments.

Note:-■- B0; -■- B1; -●- B5; -●- B10.

At the beginning of the process, a slight acidity of the compost was expected due to the production of acids by decomposer bacteria; however, after the compost windrow's temperature increase and a decrease in the available oxygen, the microorganisms began producing ammonia (NH_3) and at this stage the nitrogen tends to be mineralized, making the composting material more alkaline. Nevertheless, the ammonia produced tends to be lost by volatilization or consumed in the process, causing the pH to fall again (Zhang et al., 2014; Handreck, 1978).

The substrates obtained for each treatment had alkaline characteristics, with treatment B10 having a higher pH value (8.49) and treatment B0 having a pH of 8.05. These results are indicative of Biochar's alkalizing ability. Similar behavior was observed by Dias et al. (2010) when studying the effects of Biochar (*Eucalyptus grandis*), coffee fruit peel, and sawdust as additives in the compost with chicken manure, where the substrate containing Biochar presented the highest pH value.

The results of the electrical conductivity of the composting material and of the final substrate obtained between treatments are presented in Figure 5.

There was an increase in electrical conductivity (EC) throughout the composting process and EC values began to diverge from the 17th day of composting between treatments, where the final substrates obtained showed higher EC values than the EC values at the beginning of the composting process. Initially, the EC values for the treatments ranged from 1.56 $\text{mS}\cdot\text{cm}^{-1}$ (treatment B5) to 2.16 $\text{mS}\cdot\text{cm}^{-1}$ (treatment B0). In the final substrate, those with the highest concentrations of Biochar presented higher levels of electrical conductivity values, where the EC was 3.16 $\text{mS}\cdot\text{cm}^{-3}$ for treatment B0 and 4.13 $\text{mS}\cdot\text{cm}^{-3}$ for treatment B10. Increased conductivity throughout the composting process may be caused by a loss of mass with oxidation of organic matter, increasing the concentration of salts in the compost (Sanchez-Monedero et. al, 2001).

Electrical conductivity estimates the concentration of ions make available by the composting material or final substrate in aqueous medium, and, therefore, provides data about the material's salinity and whether it may present phytotoxicity problems, thus being a relevant parameter when the substrate is used for agricultural purposes (Brito et. al., 2014; Massukado& Schalch, 2015).

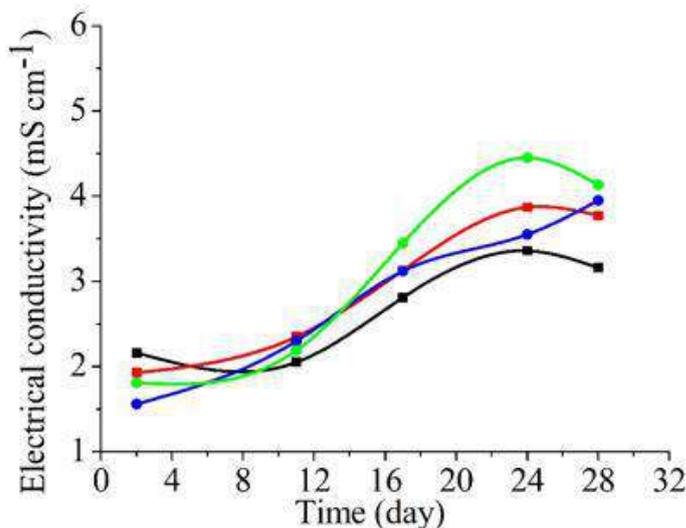


Fig. 5: Variation of electrical conductivity between treatments throughout the composting process.

Note: -■- B0; -■- B1; -●- B5; -●- B10

According to the authors Nisar et al. (2019); Li, Yang and Zhang (2019); Ibrahim (2016), elevated electrical conductivity values and a high concentration of organic acids inhibit seed germination. According to Kiehl (1998), the final compost must have conductivity values below 4 mS cm⁻¹ for complete benefit as organic fertilizer. The substrates obtained in this work, specifically those referring to treatments B0, B1 and B5, had conductivity values (3.16; 3.77; 3.95 mS cm⁻¹, respectively) as indicated by this author. Only substrate B10 showed EC values (4.13 mS cm⁻¹) slightly above the ideal range.

Microbiological respiration in the compost windrow was determined based on the amount of carbon in the form of CO₂ generated by the compost material's microbial activity, and the results are presented in Figure 6.

The results of the amount of carbon generated by composting material's microbial activity did not indicate differences between the treatments in this parameter. However, there were differences in relation to the composting time, and the results can be used to evaluate the phases of the composting process. These results also corroborate the temperature results of compost windrow.

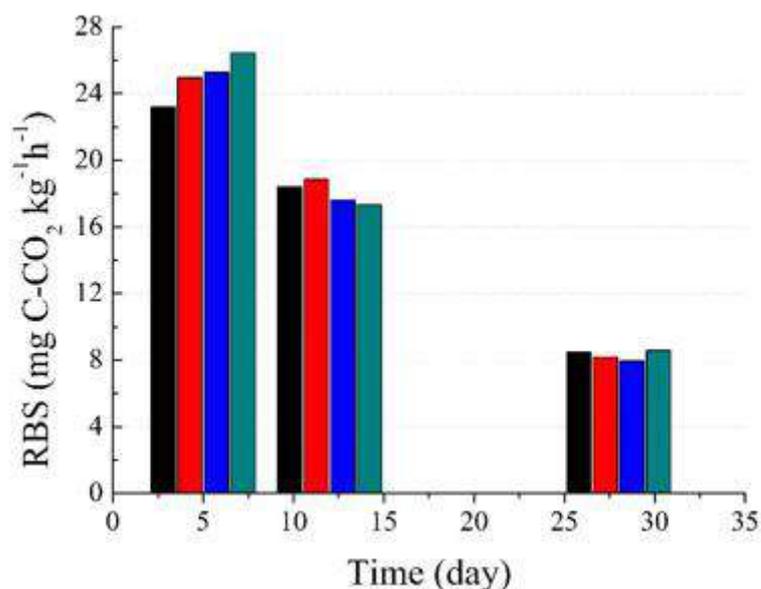


Fig. 6: Amount of carbon in the form of CO₂ generated by the microbial activity of the composting material.

Nota: ■ B0; ■ B1; ■ B5; ■ B10

The release of CO₂ is basically due to the oxidation of organic matter by microorganisms present in the composting material, such as aerobic and anaerobic bacteria and fungi, which use the O₂ as the final electron acceptor (Dionísio et al., 2016; Pereira & De Freitas, 2012). Based on this assumption, the quantification of CO₂ produced during the composting process can be a good parameter to indicate the degradation levels of organic matter as well as the microbial activity in the different stages of the process.

The data presented by the microbial respiration of the composts allow the differentiation of the two significant process phases, namely the biodegradation phase and the maturation phase. According to Berticelli et al. (2016), in the biodegradation phase there is intense microbial activity and rapid transformation of organic matter, which leads to a high consumption of O₂ and higher temperatures in the compost windrow. In contrast, in the maturation phase the microbial activity is lower and consequently the windrow temperature is similar to the environment temperature. At this moment, the transformations that occur in the material are responsible for the humification of the matter, a fact that occurs due to the polymerization of stable organic molecules (Moreira & Siqueira, 2006).

On the fifth and twelfth day of composting all treatments showed high temperatures (Figure 1A and Figure 1B) indicating the biodegradation phase, which corroborates the results of more intense C-CO₂ generation at these times in the composting process indicating higher microbial material and also that the microorganisms present in the compost windrow use labile fraction of the material during these periods.

On day 26, the results of the C-CO₂ amount corroborate with the temperature values from this period (Figure 1C), or rather, lower microbial activity in the compost windrow, lower temperature to the point of not standing out from the environment temperature, indicating the maturation phase of the composting material, which is due to the decreased concentration of labile organic substances and a higher concentration of more recalcitrant substances. These compounds generally have a more complex chemical structure, which decreases the microbial activity and, therefore, a smaller amount of C-CO₂ is generated and a consequent decrease of the windrow temperature takes place.

IV. CONCLUSIONS

The results obtained in this work make it possible to conclude that the use of Biochar provided an increase in

the windrow's temperature in the mesophilic and thermophilic stages.

Applications of 5% and 10% Biochar provided moisture loss from the windrow.

Windrows with 5% and 10% Biochar produced substrates with lower density.

The 10% dosage provided a windrow with higher pH value.

Biochar provided compounds with higher electrical conductivity values.

There were no differences between treatments regarding microbial C-CO₂ production.

Increases of 5% Biochar in the compost windrow showed itself to be the best dose for increasing the microbial activity within the windrow.

ACKNOWLEDGMENT

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Multicriteria model to create and implement an environmental indicator in organizations

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Abstract— Environmental monitoring through indicators is crucial for analyzing the performance of a company and its evolution over time, influencing in the quality of management decision making and in the competitiveness of the company. The aim of the present work is to develop a multicriteria model for prioritizing indicators and obtaining an Environmental Index to simplify the management of environmental indicators of a company as a way of monitoring its efficacy and evolution. To that end, an industry producing petroleum refining inputs, liquid effluents, solid waste, and atmospheric emissions was selected for a case study. The prioritization of criteria and indicators was performed by a team of specialists of the company by means of a combination of two decision-making techniques: the Weighted Sum Method (WSM) and the Analytic Hierarchy Process (AHP). An index is a form of obtaining a systemic view of the results of environmental indicators and guiding the decision-maker in a given direction with the identification of the most relevant points for the company.

Keywords— environment, monitoring, indicator, decision-making, AHP.

I. INTRODUCTION

Environmental impacts are intrinsic to industrial activities due to their generation of gaseous emissions, liquid effluents, and solid wastes. The great difficulty lies in finding the optimal point between maximizing the production profits and minimizing the environmental risks and impacts. This becomes even more important with the increase in environmental awareness society in general is developing (FIRJAN, 2008). After the occurrence of several accidents in the industry causing impacts to the environment, environmental legislations were created to regulate the sector. This encouraged the industry to invest in environmental management with a preventive focus (DE MARTINI and GUSMÃO, 2009). Innovative companies began to see the environment as an issue that allows for a good insertion in the competitive international market through shareholding, subsidiaries in other countries, or financing with foreign banks (CAMPOS and MELO, 2008; OLIVEIRA, *et al*, 2016). The organizations began to have their own environmental policies and adopt management tools in this area (MAZZI *et al*, 2016). Nowadays, environmental responsibility has become a relevant and

multidisciplinary subject that affects environmental policies and markets. Most countries have adopted new regulations and economic instruments, such as trade fees and permits as well as voluntary actions like environmental certifications and reports. Such actions contribute to environmental sustainability (MAZZI *et al*, 2016). Common activities in the business routine - such as merges, incorporations, privatizations, or strategic alliances - also began to consider environmental issues relevant. The 'due diligence process', an audit performed in companies that undergo those procedures, verifies from the very beginning whether there are labor and environment liabilities (ZYLBERSZTAJN *et al*, 2010). Since, according to the statistician and university professor William Edward Deming, "what cannot be measured cannot be managed", the continuous monitoring of indicators is critical for the environment management program to be successful. Based on indicators, it is possible to identify and correct deviations, analyze their causes, and suggest proposals of improvement (CAMPOS and MELO, 2008). However, a very large quantity of indicators can make it difficult to manage the operation. Thus, a joint-evaluation of a set of indicators makes it possible to have a systemic view of the

company's performance (RAFAELI and MULLER, 2007). Techniques designed to assist decision-making help in structuring the prioritization of the problem and achieving the best solution in the face of different criteria. In this sense, scientific research has a critical importance for the industry by performing studies that evaluate the adopted indicators and criteria, their prioritization methodologies, and the results of its application to environmental management. Thus, the present work proposes the construction of a model for measuring the efficacy of managing environmental indicators of a company based on the prioritization of criteria and indicators for the construction of an environmental index.

Multicriteria Decision Making (MCDM) Support Methods

The function of MCDMs is to help analysts and decision-makers structure their problems and obtain the best solution in the face of different criteria (FERREIRA *et al*, 2010). There is no favorite method in the business area. The choice of methods, rules, and procedures to solve problems depends on the problem at issue, on the project, and on the aim of a specific research (KUCUKALTAN *et al*, 2016). According to Ferreira *et al* (2010), all MCDMs follow certain steps:

- Identifying the decision-making group,
- Defining problem assessment criteria,
- Identifying alternatives,
- Determining the relative importance of those criteria by attributing them weights,
- Evaluating alternatives regarding the criteria,
- Determining the overall evaluation of each alternative.

The Weighted Sum Method (WSM) belongs to the American school of decision-making. It is applied to multicriteria issues and requires that decision-makers establish a fixed weight for each criterion. With this, the multicriterion problem becomes a single goal problem. Subsequently, values are attributed to each alternative according to each criterion so as to obtain a weighted sum for each alternative (HUANG *et al*, 2014). In its methodology, the objective-functions are aggregated, transforming the vector magnitude into a scalar magnitude. The results of WSM depend heavily on the decision-makers assigning weights to the criteria and on them evaluating each alternative regarding the criteria. It is important to normalize the weights so as to express their importance in relation to the other ones in the same order

of magnitude (LOBATO *et al*, 2006). Equation 1 presents the WSM:

$$f(x) = \sum_{i=1}^n w_i f_i(x) \quad \text{Equation 1}$$

where $\sum_{i=1}^n w_i = 1$

in which:

$f(x)$ is the multi-attribute function for alternative x ,

n is the number of criteria, and

w_i is the weight of criterion i ,

$f_i(x)$ is the value attributed to alternative x regarding criterion i .

The method called *Analytic Hierarchy of Processes (AHP)* is one of the most widely known and used methods, and much explored in the literature (LUZ *et al*, 2006; PODGÓRSKI, 2015). This is due to the simplicity of the method, to the availability of support software, and to its wide range of possible practical applications (PODGÓRSKI, 2015). According to HYUN *et al* (2015), AHP follows the concept of the human brain of making decisions hierarchically and with phased analyses.

II. MATERIALS AND METHODS

The selected company is a chemical plant that produces petroleum refining inputs and stands out in its line of business. This industrial plant has an annual production capacity of 34,000 tons. The company was chosen not only for its relevance in the area, but also for its concern with the environment. There are reliable operation data and a historical series that allowed calculating the index for a time interval and evaluating its variations. For reasons of contractual secrecy, the corporate identity of the company, the type of product it offers or any process flowchart will not be disclosed. The steps involved in the development of the environmental indicator are presented in Table 1.

Table 1. Steps involved in the development of an environmental indicator.

Technical visit to the selected company and meeting with the coordinator of the Safety and Environment area for an informal interview, evaluation of the company's environmental strategy, and data collection through documents
Identification of decision-makers

Identification of criteria and subcriteria, aligned both with the company's environmental policy and the bibliographical review
Identification of environmental indicators adopted in the company and collection of historical data
Prioritization of criteria and subcriteria, using the AHP tool in an electronic spreadsheet
Evaluation of indicators in relation to criteria, using the WSM tool in an electronic spreadsheet
Determination of indexes in an electronic spreadsheet
Evaluating results and proposing improvements

The Environmental Index allows for a synthetic view of the results of 26 environmental indicators of the company. Such indicators were evaluated based on 12 criteria, which belong to four areas of interest (Technical, Socio-environmental, Financial, and Strategic). The criteria with highest priority were: the Effect on Product Quality (26%) and Workers' Health (15%). The most important indicators were those regarding atmospheric emissions (41%). The Environmental Index was stratified into an Environmental Quality Index and an Environmental Performance Index, according to the informational objective of the indicator. Regarding type, the Environmental Index was stratified into liquid effluents, solid waste, and atmospheric emissions. The analysis carried out considered a period of 5 years in which the Environmental Index, which should be minimized, reached an average value of 34.13%, operating within a control range from 45.52% to 22.74%. The minimal value was reached in 2013 (27.57%), and the last result, in 2015, reached 35.80%. In order to assist the manager in monitoring the results and encouraging staff to minimize environmental impacts, an annual target (30.72%) was established based on the statistical analysis of the historical results.

III. RESULTS AND DISCUSSION

Currently, there is a wide range of environmental indicators. They summarize, simplify, illustrate, and communicate sets of more complex data that may be typical or critical for the environment. By including trends and advances over time, they help to provide insights into the state of the environment, thus contributing as a basis for decision-making (EEA, 2014).

In order to obtain a systemic view of the overall performance, the indicators can be integrated according to a methodology that must be adequate to the scenario and to the adopted strategy, forming an index. In the environmental area, an index represents an easier way of communicating data considering that, generally speaking, this is a complex environment due to the large quantity of interconnected variables (LUZ *et al*, 2006). The methodology for creating an index consists of seven stages: developing a theoretical framework, selecting the desired variables, adding missing data, removing variables, normalizing data, data weighting, and data aggregation (GARCÍA-SÁNCHEZ *et al*, 2015).

Identifying decision-makers

The chosen team of decision-makers works directly in the Safety and Environment area of the company under evaluation. They have a compatible technical formation and consist of five members occupying positions as coordinator, engineer, analyst, technician, and trainee. The group is heterogeneous in terms of age, training, and length of professional experience (in the studied company and in their career), allowing for a plurality of opinions that enrich the evaluation.

Although small in size, the team of decision-makers has the appropriate professional competence regarding their technical formation and their knowledge of the process on which they establish judgment. This is evidenced by the low variation in the responses of the team and the consistency in their answers, which proved to be lower than the acceptable limit by the AHP technique (10%) in all judgments.

Questionnaires were used for collecting information – as presented in Annex 1 – based on the AHP and WSM methodologies. Each decision-maker answered the questionnaire individually for a subsequent consolidation of the group responses, as defined by the methodology of each technique. Equal degrees of relevance were adopted for all participants, that is, no judgment was considered more important than the others.

Identifying criteria and subcriteria

According to ABRAMCZUK (2009), the criteria must be uniform and general, that is, all criteria must be adopted for all alternatives in the same way. In addition, they must be chosen previously to defining the alternatives - in the case of the present study, the indicators. One premise adopted to define the criteria and subcriteria was the possibility of decision-making based on the data available

presently in the company’s operation. Thus, the proposed model is a complement of the environmental management carried out by the company, not requiring additional information about the indicators. According to what was recommended by CASTRO *et al* (2005), criteria on the local environmental conditions will not be adopted because they evaluate the area where the operation occurs, and is thus influenced by the entire neighborhood. The company under study is located in an industrial area, influenced by several factories around it, besides the circulation of vehicles, among other factors. Thus, if environmental condition criteria were considered, the evaluation of the company’s performance could be influenced by factors that are external to its operation. The evaluation of the environmental condition rests with the governmental agencies, NGAs, and other investigation institutions.

Table 2 shows the criteria and subcriteria adopted in modeling the decision problem. These criteria are general, forming four large groups, whereas the subcriteria are specific.

Table 2. Criteria and subcriteria

Criteria	Subcriteria
Socio-environmental	Effect on Workers’ Health
	Effect on the Environment
	Effect on the Local Community
Financial	Investment for Treatment
	Maintenance
	Influence on Production Costs
Strategic	Effect on Company Reputation
	Influence on Legal Requirements
	Influence on Company Transparency
Technical	Effect of Product Quality
	Need for Process Change
	Effect on Process

The team of specialists evaluated the Technical criteria as the most important (36%), followed by the Socio-environmental (31%), the Strategic (20%), and Financial (14%) criteria. Figure 1 presents the results of criteria prioritization with AHP.

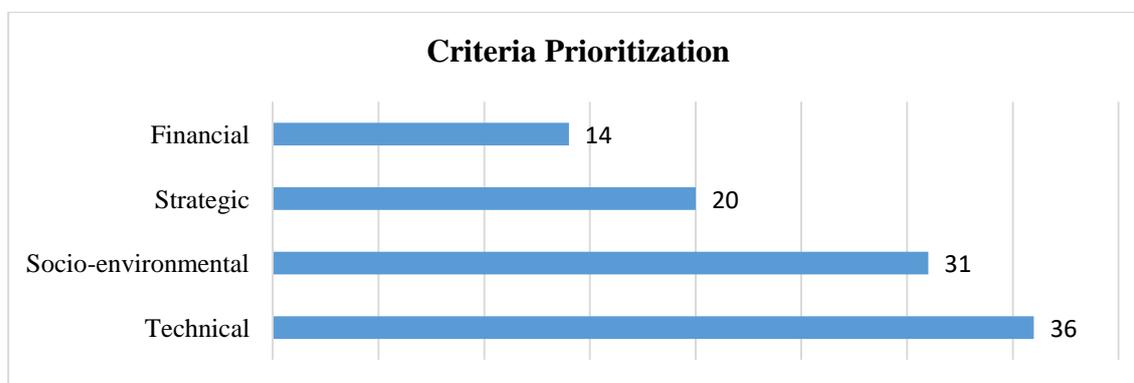


Fig.1: Results of criteria prioritization with AHP.

Source: The authors, 2017.

The importance given to the technical criteria is probably justified on account of the case study having been carried out in a company producing petroleum refining inputs, the major concern of which is product specification, a requirement demanded by the consumer market.

Figure 2 presents the results of technical subcriteria prioritization with AHP.

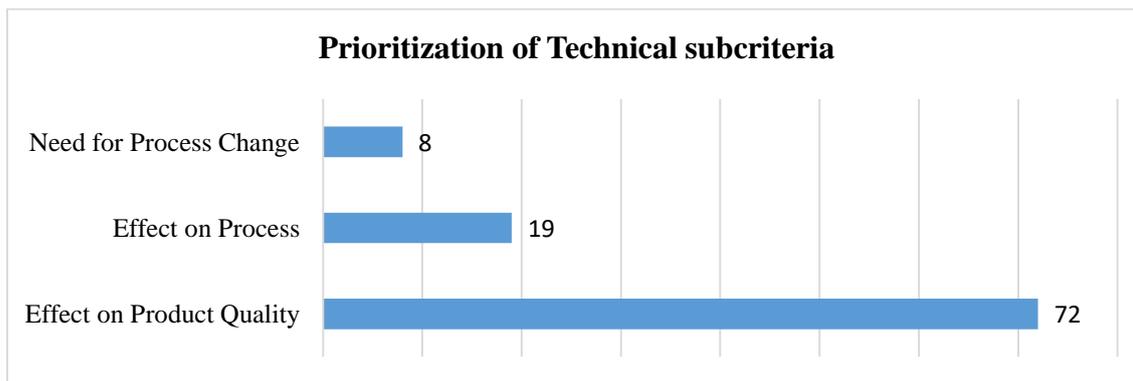


Fig.2: Prioritization of the Technical subcriteria with AHP

Source: Authors, 2017.

Among the technical subcriteria, the Effect on Product Quality obtained a higher percentage in prioritization (72%), emphasizing the concern with meeting the technical specifications of the product. The Effect on the Process (19%) was also considered important, since it is directly related to the quality of the product. But the Need for

Process Change (8%) obtained a low degree of prioritization, which is consistent with the high relevance of the technical aspects. Thus, the necessary changes in the process are performed due to their importance.

Prioritization of the Socio-environmental subcriteria with AHP is presented in Figure 3.

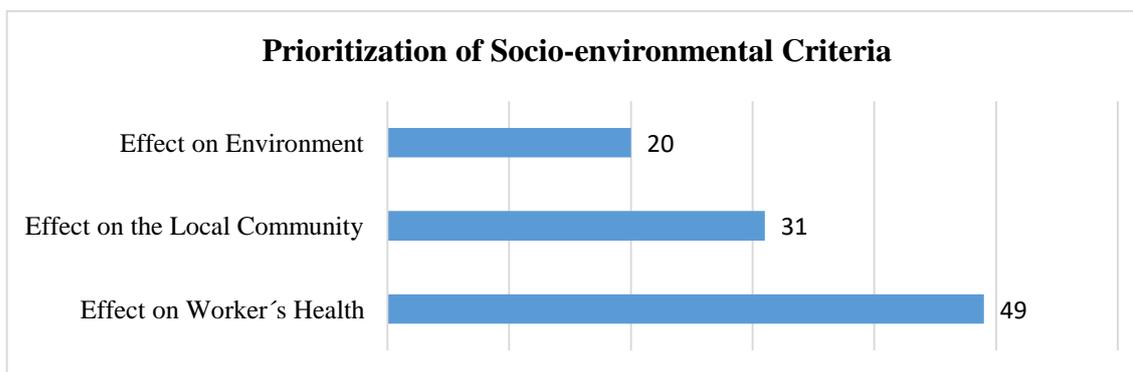


Fig.3: Prioritization of Socio-environmental subcriteria with AHP

Source: The authors, 2017.

The Effect on Workers' Health (49%) was highly representative in the prioritization of the Socio-environmental criteria by the team of specialists, possibly because of the concern the studied company has with its employees. Then, and following the same line of concern with people, appears the Effect on the Local Community subcriterion (31%) and, finally, the Effect on the Environment (20%).

Prioritization of the Strategic subcriteria was the most balanced among the four set of criteria. The greatest importance was given to the Influence on Legal Requirements subcriterion (41%), probably because it is mandatory for the operation of the plant. Then appears the

Effect on the Company's Reputation (33%), something intangible and difficult to recover, which was mentioned by research executives of the CNI (2015) as the biggest advantage for the company's engagement in environmentally sustainable practices. As for the Company's Transparency subcriterion (26%), focused on the last review of the ABNT NBR ISO 14.001, it obtained the lowest degree of prioritization among the strategic subcriteria. This happened possibly because the company under evaluation is already transparent regarding its results and is certified by the Environmental Management, Work Health and Safety, and Quality Systems.

The Influence on the Production Costs (59%) was identified as the most important among the Financial subcriteria, probably because it interferes in the factory’s budget in a continuous way. The Investment for Treatment (28%) and Maintenance (13%) subcriteria obtained the lowest prioritization, possibly because they represent occasional costs, not interfering so much in decision-making.

After prioritizing the subcriteria in each group, the obtained global priorities were calculated with AHP considering the individual prioritization of the subcriterion and that of its respective group.

The results are presented in Figure 4, and the calculations are available in Annex 2- 3rd step.

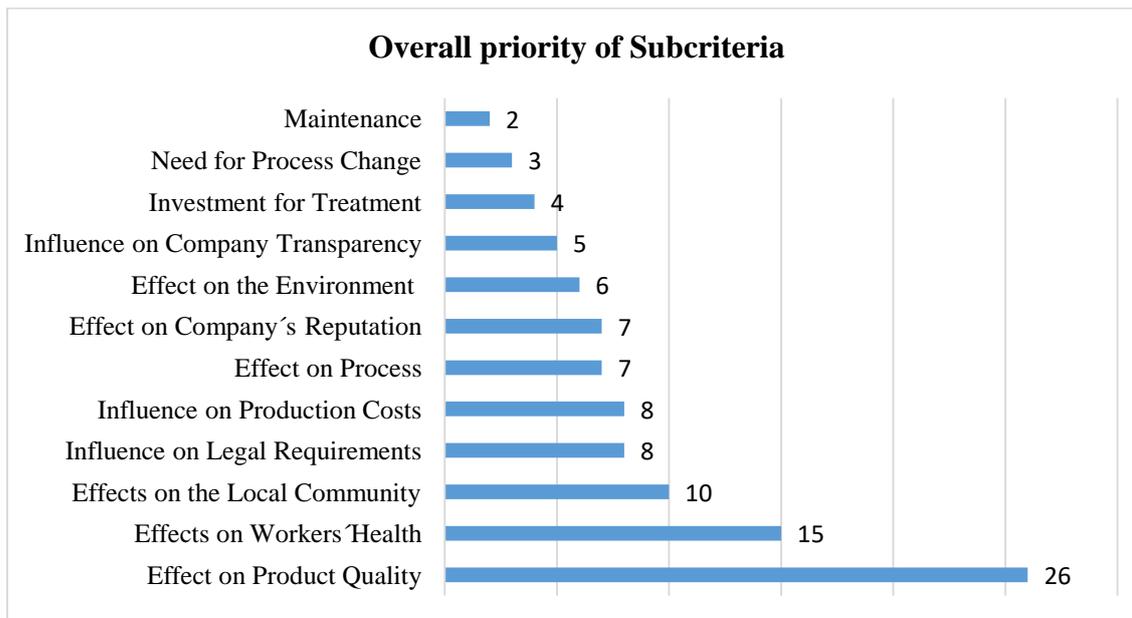


Fig.4: Overall Prioritization of Subcriteria with AHP

Source: The authors, 2017.

The subcriterion with the highest priority in decision-making is the Effect on Product Quality (26%), since it is critical to meet its technical specifications. The Effect on Workers’ Health (15%) and the Effect on the Local Community (10%) also stood out as relevant criteria for the team of specialists.

In the next step of applying the AHP technique, the team of decision-makers prioritized the Indexes of Liquid Effluents, Solid Waste, and Atmospheric Emissions two by two in the face of each subcriterion, focusing on obtaining the Environmental Index, according to Table 3.

Table 3. Evaluation of Indexes in each subcriterion index

Subcriteria	Liquid Effluents	Solid Waste	Atmospheric Emissions
Effect on Workers’ Health	0.10	0.11	0.79
Effect on the Environment	0.48	0.09	0.42
Effect on the Local Community	0.21	0.13	0.66
Investment for Treatment	0.28	0.07	0.64
Maintenance	0.36	0.08	0.56
Influence on Production Cost	0.40	0.40	0.20
Effect on Company’s Reputation	0.25	0.25	0.50

Influence on Legal Requirements	0.33	0.33	0.33
Influence on Company’s Transparency	0.33	0.26	0.41
Effect on Product Quality	0.40	0.40	0.20
Need for Process Change	0.40	0.40	0.20
Effect on Process	0.40	0.40	0.20

Source: The authors, 2017.

The Atmospheric Emissions Index showed to be more relevant than the other indexes in a greater number of subcriteria. The considerable importance attributed to the Atmospheric Emissions regarding Workers’ Health (79%) is possibly due to the physiological mechanism of exposure. Along 9 working hours, workers were exposed to air with its quality altered due to the operation of the factory. Liquid effluents and solid waste hardly come in contact with the workers.

The prioritization of Atmospheric Emissions regarding the local community (66%) follows the same exposition concept commented on in the effect on workers’ health. In addition, visual pollution produced by the emission of water vapor can possibly generate, in the local community, a tendency to think that the factory does not comply with the legal requirements and causes damage to the population.

As for the high prioritization of the Atmospheric Emissions Index regarding the investment for treatment (64%) and maintenance (56%), this is probably justified by the intense operational and maintenance routine of the company to maintain the emission control systems in 11 chimneys. Because it involves greater work, the specialists attributed a higher relevance to emissions even though the costs of treating liquid effluents are more significant for the company. The influence on legal requirements presents the same prioritization (33%) for those three indexes, since all legal obligations must be fulfilled for the plant to operate.

According to ABNT NBR ISO 14 031, it is recommended that an organization select indicators for its environment performance based on significant environmental aspects it can control and influence. Through data obtained from the Health, Safety, and Environment Coordination of the company under study, it was possible to identify the environmental indicators adopted in its environmental management. The company monitors its environmental indicators by means of five groups: liquid effluents, solid waste, atmospheric emissions, energy, and raw materials. The decision to keep the indicators separately in groups was made in order to help in the analysis of each of those areas, observing whether any deviations in the environmental index occurred due to the localized variations. Rafaeli and Muller (2007) do not recommend accumulating 10 or more indicators in the composition of a single index without performing partial branchings at different levels. This is due to the possibility of an indicator to have its performance camouflaged by another in an index composed of many indicators. Thus, an initially trivial problem may be aggravated by the lack of attention regarding small variations when one has a consolidated outcome.

Thus, in order to allow for a differential analysis of environmental indicators, a new division into two groups was proposed: environmental quality indicators and environmental performance indicators, according to Figure 5.

Identification of the indicators

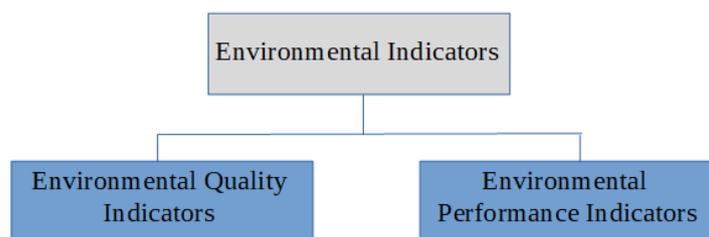


Fig.5: Division of Environmental Indicators

Source: The authors, 2017.

All environmental indicators are relative to the industrial production carried out in the respective period. In order to maintain the same frequency in all indicators, annual values were adopted in the period from 2011 to 2015. This facilitates managerial decision-making and

supports the company planning, because it makes historical analyses possible. Table 4 and Table 5 present the indicators used in the case study. The indicators were separated by groups showing their respective calculation formulas and polarity.

Table 4. Environmental Performance Indicators

Environmental Performance Indicator		
Liquid Effluents Indicators		
Indicator	Calculation formula	Polarity
Inorganic	Volume of inorganic effluent / product mass	-
Organic	Volume of organic effluent / product X mass	-
Sanitary sewage	Volume of sanitary sewage / product mass	-
Solid Waste Indicators		
Indicator	Calculation formula	Polarity
Industrial	Mass of industrial waste / product mass	-
GSW	Mass of GSW / product mass	-
Recycled	Mass of recycled waste / product mass	+
Atmospheric Emissions Indicators		
Indicator	Calculation formula	Polarity
Stationary source	Mass of stationary source emission / product mass	-
Fugitive emissions	Mass of fugitive emissions / product mass	-

Source: The authors, 2017.

The organic indicator was calculated regarding product X because liquid effluent is generated only when such product is manufactured. Although the company did not manufacture that specific product in 2014 and 2015, it is important to consider that indicator because there was a large organic load in the effluent. The industrial indicator corresponds to the industrial solid waste sent to a landfill, and to the mud destined to an outsourced company for treatment. The WGS indicator represents the 'general service waste', which comprises the organic waste from the dining hall, common refuse, and construction rubble. In

recent years, this indicator has been decreasing because such wastes are being recycled. The Recycled Indicator comprises the recycling of several materials such as: metal, iron, cardboard, plastic, wood, glass, organic refuse from the dining hall, construction rubble, vegetable oil, and mineral oil.

The company evaluated in the present case study conducted its emission inventory in accordance with the *GreenHouse Gas Protocol* (GHG Protocol), in which it identified its stationary and fugitive emission sources.

Table 5. Environmental Quality Indicators

Environmental Quality Indicator		
Liquid Effluents Indicators		
Indicator	Calculation formula	Polarity
Oils and greases	Mass of oils and greases / product mass	-
Settleable materials	Volume of settleable materials / product mass	-

Chemical Oxygen Demand	COD mass / product mass	-	
Biochemical Oxygen Demand	BOD mass / product mass	-	
Total Non-filtered Refuse	TNFR mass / product mass	-	
Indicator	Calculation formula	Polarity	
Ammonia	Ammonia mass / product mass	-	
Aluminum	Aluminum mass / product mass	-	
Chlorine	Chlorine mass / product mass	-	
Solid Waste Indicators			
Indicator	Calculation formula	Polarity	
Dangerous	Dangerous wastes mass / product mass	-	
Ferrous scrap	Mass of ferrous scrap / product mass	+	
Plastic scrap	Mass of plastic scrap / product mass	+	
Wood waste	Mass of wood waste / product mass	+	
Organic from refectory	Mass of organic refuse from the dining hall / product mass	+	
Construction rubble	Mass of construction rubble / product mass	+	
Atmospheric Emissions Indicators			
Indicator	Calculation formula	Polarity	
Particulate material	Mass of particulate material / product mass	-	
SO _x	SO _x mass / product mass	-	
NO _x	NO _x mass / product mass	-	
Ammonia	Ammonia mass / product mass	-	

Source: The authors, 2017.

All Environmental Quality indicators of the Liquid Effluents group were obtained from laboratory analyses after having passed through the industrial waste treatment plant (IWTP) of the company under study. The Chemical Oxygen Demand (COD) indicator refers to the sum of the COD of the inorganic effluent and the COD of the organic effluent when product 'X' is manufactured. For reasons of simplification, the present case study will consider COD as a whole, since the analysis focus on the impact to the environment. Indicator TNFR refers to the total non-filtered refuse, also known as 'solids in total suspension' (STS).

The Ammonia indicator considers the analysis of NH₃ in atmospheric losses. The Aluminum indicator considers the analysis of Al, and the Chlorine indicator considers the analysis of chloride (Cl⁻) and active chlorine (Cl₂) in the liquid effluent.

The Indicator labeled 'Dangerous' refers to different solid wastes of small representativeness, which have been aggregated for the sake of simplification. It considers obsolete asbestos plates that still exist in the factory, health care waste, used mineral oil, mercury lamps, among others.

Ferrous scrap, plastic scrap, wood waste, organic refuse from refectory and civil construction rubble indicators are all recyclable wastes. The plastic scrap indicator includes plastic in general and big bags for storing products. The Organic Refuse from the Dining Hall indicator is recycled by an outsourced company and part of it is used as fertilizer in a vegetable garden grown in the factory.

Determining the relative importance of the criteria and subcriteria

The relative importance of criteria and subcriteria was obtained by using the AHP tool. The priorities were established by means of a questionnaire (presented in Annex 1), which was filled out by the Security and Environment team. Based on the individual responses of the team of decision-makers, a global preference matrix was obtained (Annex 2) through the geometric mean. All calculations of the AHP methodology were carried out in an electronic spreadsheet in a way that the calculation memory could be provided to the company evaluated in the present case study, and it was possible to make alterations in case there were possible changes.

Evaluation of indicators regarding subcriteria

The evaluation of indicators regarding the subcriteria was carried out through the WSM tool. Since the subcriteria had already been prioritized in the previous step by using the AHP technique, the same weights were adopted in the present step. The evaluation of each indicator varies from 1 to 10 - 1 is adopted when there is no relevance and 10 when there is a great relevance between the indicator and the subcriterion. In this context, relevance can be understood as 'impact' or 'effect'. Thus, a high grade would be considered a bad evaluation and a low grade would be considered a good evaluation. The individual answers were consolidated through the arithmetic mean and later normalized, as presented in Annex 3.

Determining the indexes

The indexes were structured as follows: an environmental index that is divided into Quality and Environmental Performance, each one subdivided into Liquid Effluents, Solid Waste, and Atmospheric Emissions.

Those indexes are calculated based on the sum of products of each indicator with its respective prioritization, calculated with the WSM technique, as presented in Equation 2.

$$Index = x_1 \times Indicator_1 + x_2 \times Indicator_2 + \dots + x_n \times Indicator_n \text{ Equation 2}$$

in which:

$$x_1 + x_2 + \dots + x_n = 1$$

where:

x_i = prioritization of the indicator obtained in WSM

The Quality and Environmental Performance Indexes – presented in Equations 3 and 4, respectively – results from the sum of products obtained by multiplying their respective Indexes of Liquid Effluents, Solid Waste, and Atmospheric Emissions with the prioritization of each index, obtained through the AHP technique.

Index of Environmental Quality = x . (Liquid Effluents Index) + y . (Solid Waste Index) + z . (Atmospheric Emissions Index)

Equation 3

Environmental Performance Index = n . (Liquid Effluents Index) + y . (Solid Waste Index) + z . (Atmospheric Emissions Index)

Equation 4

where:

$$x + y + z = 1$$

and:

x , y , z : prioritization of indexes obtained in AHP

Liquid Effluents Index, Solid Waste Index, Atmospheric Emissions Index: formed by the Environmental Quality indicators

Liquid Effluents Index, Solid Waste Index, Atmospheric Emissions Index: formed by the Environmental Performance indicators

All indexes have a negative polarity, that is, the lower its value, the better the result.

Having defined the prioritization of indicators, it is necessary to define the working range of each indicator in an interval from 0 to 100 in order to keep the indicators equivalent. Table 6 and Table 7 present the unit and the interval considered for each indicator.

Table 6. Environmental Performance Indicators – Unit and working range

Environmental Performance Indicator		
Liquid Effluents Indicators		
Indicator	Unit	Range
Inorganic	m ³ /t	18.74 - 30.00
Organic	m ³ /t X	0.00 - 14.02
Sanitary sewage	m ³ /t	0.29 - 0.67
Solid Waste Indicators		
Indicator	Unit	Range
Industrial	kg/t	69.45 - 140.20
GSW	kg/t	0.00 - 11.28
Recycled	kg/t	8.65 - 22.59
Atmospheric Emissions Indicators		
Indicator	Unit	Range
Stationary source	tCO ₂ eq/t	1.51 - 1.78
Fugitive emissions	tCO ₂ eq/t	0.00 - 0.05

Source: The authors, 2017.

Table 7. Environmental Quality Indicators – Unit and working range

Indicator of Environmental Quality		
Indicators of Liquid Effluents		
Indicator	Unit	Range
Oils and greases	kg/t	0.00 - 0.13
Settleable materials	L/t	0.17 - 1.96
COD	kg/t	0.00 - 869.06
BOD	kg/t	0.00 - 0.37
TNFR	kg/t	4.38 - 13.70
Ammonia	kg/t	0.03 - 0.08
Aluminum	kg/t	0.018 - 0.031
Chlorine	kg/t	34.97 - 217.03
Solid Waste Indicators		
Indicator	Unit	Range
Dangerous	kg/t	0.00 - 4.86
Ferrous scrap	kg/t	2.38 - 3.82
Plastic scrap	kg/t	2.37 - 4.08
Wood waste	kg/t	0.25 - 2.86
Organic from dining hall	kg/t	2.20 - 2.52

Construction rubble	kg/t	0.00 - 8.85
Atmospheric Emissions Indicators		
Indicator	Unit	Range
Particulate material	kg/t	0.39 - 1.36
SO _x	kg/t	0.00 - 1.00
NO _x	kg/t	0.00 - 6.90
Ammonia	kg/t	1.97 - 13.50

Source: The authors, 2017.

The normalized values of the indicators that make up the environmental Performance Index are presented in Table 8, along with their respective Liquid Effluents Index, Solid Waste Index, and Atmospheric Emissions Index, for

the period between 2011 and 2015. Although the indicators have been based on the annual production, variations are perceived over time.

Table 8. Results: Environmental Performance Indicators

	Normalized Indicators (%)				
	2011	2012	2013	2014	2015
Inorganic	30.30	51.83	47.14	44.60	76.12
Organic	37.01	49.49	45.56	0.00	0.00
Sanitary sewage	39.91	53.12	75.90	49.19	31.88
Liquid Effluents Index	34.45	51.70	54.96	36.42	47.40
Industrial	53.61	36.92	28.74	66.49	64.24
GSW	68.55	37.42	50.87	20.08	24.10
Recycled	42.85	62.84	66.18	25.02	53.11
Solid Waste Index	41.61	19.81	19.27	36.06	31.31
Stationary Source	67.96	68.46	39.76	36.66	37.16
Fugitive Emissions	24.11	24.12	53.31	59.85	59.90
Atmospheric Emissions Index	47.70	47.98	46.02	47.37	47.66
Environmental Performance Index	41.84	41.52	41.60	40.82	43.14

The results of the Liquid Effluents Index, Solid Waste Index, and Atmospheric Emissions Index as well as their consolidation in the Environmental Performance Index are presented in Figure 6 for the same period.

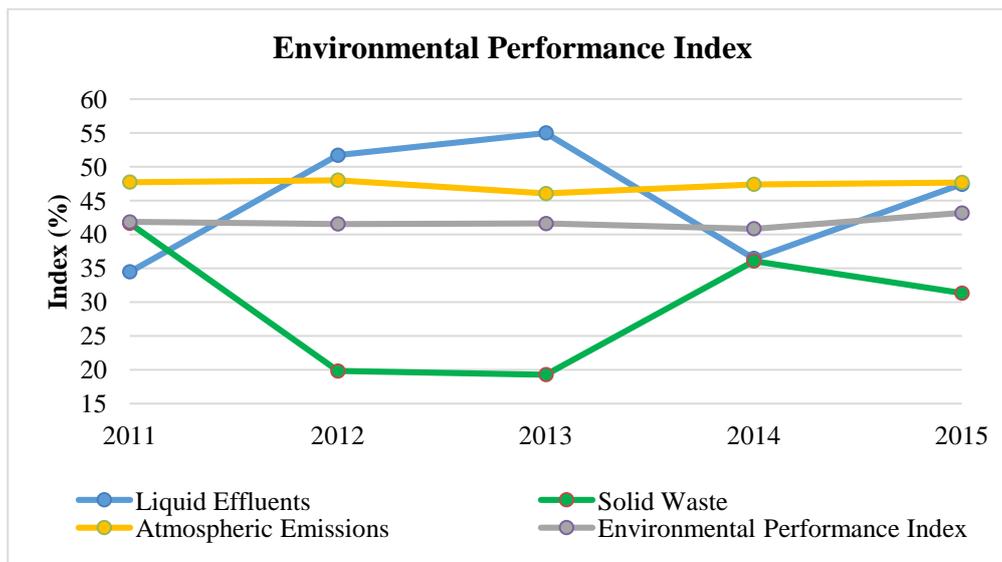


Fig.6: Results: Environmental Performance Index

Source: The authors, 2017.

The variation of the Environmental Performance Index was very small during the analyzed period – below 5% - although the indicators that compose it have had significant variations. This occurs because, from 2012 to 2015, the results of the Liquid Effluents Index and the Solid Waste Index were complementary, that is, when one of the indexes increased, the other decreased, minimizing variations in the Environmental Performance Index.

The same happened regarding the Environmental Emissions Index, which remained roughly constant, with a maximal variation of 4%, whereas its indicators had

variations of up to 72% in the Stationary Source indicator and 55% in the Fugitive Emissions indicator. Such variation occurred in the same year – while one indicator increased, the other decreased – and because they had similar prioritizations, the results of the Atmospheric Emissions Index were not impacted.

The indicators that integrate the Environmental Quality Index are presented normalized in Table 9, with their respective Liquid Effluents Index, Solid Waste Index, and Atmospheric Emissions Index, for the period from 2011 to 2015.

Table 9. Results Indicating Environmental Quality

	Normalized Indicators (%)				
	2011	2012	2013	2014	2015
Oils and Greases	28.12	62.51	11.01	7.51	44.45
Settleable Materials	62.86	46.18	28.40	42.38	70.17
COD	28.78	61.96	26.19	0.15	0.15
BOD	52.17	37.37	77.14	47.62	35.70
TNFR	41.63	71.94	61.26	45.48	29.69
Ammonia	37.71	35.46	40.66	66.20	69.98
Aluminum	28.13	47.09	57.94	66.84	100.00
Chlorine	39.75	38.97	37.31	58.43	75.54
Liquid Effluents Index	39.03	50.08	41.78	44.91	57.89
Dangerous	30.48	21.14	11.91	70.46	30.52

Ferrous Scrap (recycled)	46.95	29.64	50.73	46.69	75.99
Plastic Scrap (recycled)	52.30	72.36	54.07	26.24	45.04
Wood Waste (recycled)	74.60	31.87	50.92	37.68	54.93
Organic from Dining Hall (recycled)	0.00	67.33	57.19	28.23	47.25
Construction Rubble (recycled)	46.12	47.19	73.55	26.89	54.27
Solid Waste Index	-21.37	-28.79	-36.83	-2.47	-30.18
Particulate Material	51.80	55.78	42.53	72.51	27.38
SOx	63.18	41.31	8.55	19.66	44.29
NOx	22.21	40.78	18.74	65.69	52.93
Ammonia	69.58	61.08	28.64	38.08	52.61
Atmospheric Emissions Index	51.62	50.02	24.95	49.44	44.44
Environmental Quality Index	27.81	28.65	13.54	33.91	28.47

Source: The authors, 2017.

The results of the Liquid Effluents Index, Solid Waste Index, and Atmospheric Emissions Index as well as their consolidation in the Environmental Quality Index are presented in Figure 7 for the same period.

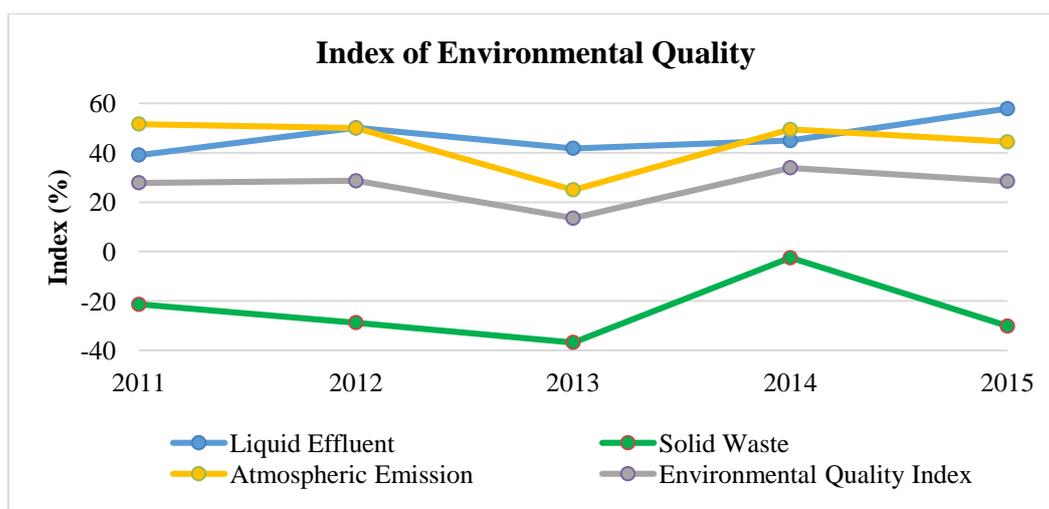


Fig.7: Results: Environmental Quality Index

Source: The authors, 2017.

The Solid Waste Index presents negative values because five out of six indicators that compose it refer to recycled waste and so they have positive instead of negative polarity. The Environmental Quality Index obtained lower values than the Environmental Performance Index because of the Solid Waste Index that, due to the recycling initiative, had its impact decreased. The other indexes - that of Liquid Effluents and that of Atmospheric Emissions - had results similar to those of the Environmental Quality and Environmental Performance Indexes. The Environmental Quality Index showed to be

more sensitive to the variations in the results of the indicators that compose it, presenting a variation of up to 112%. Its most stable index is that of Liquid Effluents, with a maximal variation of 20%.

In 2014, the Solid Waste Index presented a result different from that of the improvement trend, concerning the recycling initiative, because its Dangerous Refuses had a significant increase. This happened because of the destination given to the asbestos tiles. That year, the substitutions were more than normal, because corrective

maintenances were carried out in the factory. Besides, the Recycled Wastes also presented a decrease in the same year.

As for the Atmospheric Emissions index, which presented an improvement in all its indicators in 2013, had a decrease in its results in the following year, returning to the previous level.

The consolidation of the Performance and Quality Indexes in the Environmental Index is presented in Table 10 and Figure 8.

Table 10. Results: Environment Index

Year	Environmental Index (%)
2011	34.82
2012	35.08
2013	27.57
2014	37.37
2015	35.80

Source: The authors, 2017.

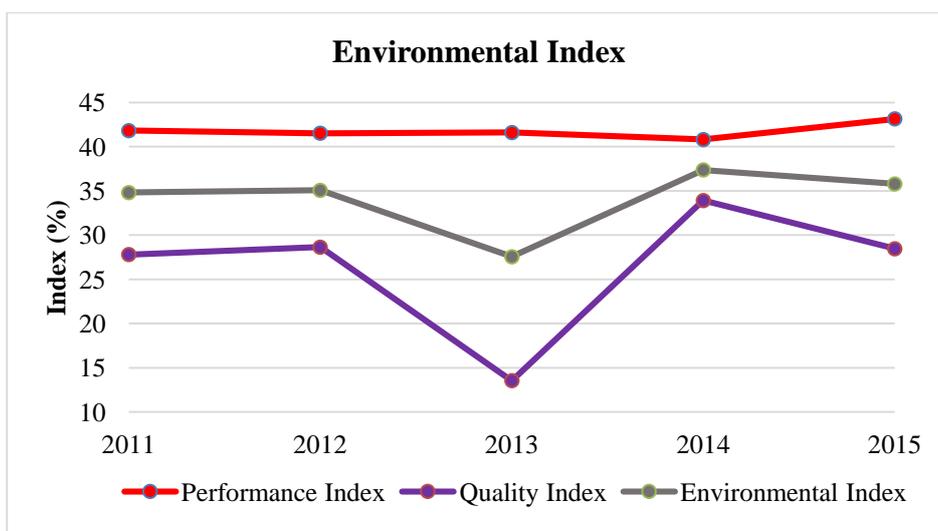


Fig.8: Results: Environmental Index

Source: The authors, 2017.

The Environmental Index presents a similar behavior to that of the Environmental Quality Index, with increases and decreases in the same periods. However, its variations are attenuated, since its result is also influenced by the Environmental Performance Index, which presents small variations. The most significant modification in the Environmental Index occurred in 2013 (-27%) and 2014 (26%), with an initial improvement and a subsequent worsening in the results, followed by an improvement in 2015 (-4%).

IV. CONCLUSIONS

The criteria and indicators identified in the review of literature and through the team of specialists for the construction of the Environmental Index were adequate to represent the management of environmental indicators over time in the company under study. Criteria referring to four different perspectives have been addressed, and the indicators cover a range of information on the environmental aspects of the factory. Regarding the aim of

the study which is to obtain an index that characterizes the state of the company in its environmental aspect during the period analyzed, the index, which must be minimized, reached an average value of 34.13%, operating in a control range from 45.52% to 22.74%. The minimal value was reached in 2013 (27.57%), and the last result - in 2015 - reached 35.80%.

The sensitivity of the indexes generated in the present case study is a function of the coefficients obtained by applying the AHP and WSM techniques. The indexes have the interaction of different indicators associated to their respective weights. Thus, the higher the prioritization of an indicator, the more sensitive the index is to its results. But, in general, the indexes obtained in the present work are robust, and are not influenced by small variations in the results of a single indicator.

According to the company evaluated in the case study, the analysis of the impacts that contribute the most to harm the environment becomes possible after prioritizing the criteria and indicators. According to the specialists, the

greatest impact refers to the Atmospheric Emissions (41%) justified by the exposure of workers and residents. As far as the latter are concerned, the impact was attributed to the visual pollution, in addition to the possibility of an extensive propagation and by the odor sensation.

The revision of the index may be extended to an evaluation of the criteria and indicators that compose it, so as to verify whether it is necessary to include or discard any measurement or even revise the range of action of any indicator. In the case of the factory under study, there is the production of inputs for petroleum refining. If the plant chooses to produce a new input, using new raw materials that may alter the quality of effluents, residues, or emissions, the insertion of a new indicator must be considered.

The creation of a new model to evaluate the management of environmental indicators of a company, as elaborated in the present work, is not intended to apply a pre-defined equation to different organizations, but to allow for adapting parameters of the model, according to their respective needs.

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Use of Parodies as Educational Technology in the Health Education Process

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Abstract— *Objective: to describe the development of a book as a health education strategy, which brings together 32 parodies on various health issues that can be worked from primary care to hospital care. Method: this is a methodological research, technological applicability, with a qualitative approach which was developed in four stages: (1) definition of the themes to be addressed; (2) preparation of parodies; (3) orthographic/metric review; (4) Graphic printing of the material produced. Results: based on the pertinent literature and the academic experience of the authors, the thematic areas addressed were first selected, being: infectious diseases, parasitic diseases, chronic-degenerative diseases, self-care with health and others such as prenatal care, health management, humanization and urban violence; then the parodies were elaborated and some dealt with matters in duplicate in order to complement the theme addressed, allowing its use in different contexts. Conclusion: the development of this type of educational technology in the health area is something new in the literature, therefore, the parodies compiled in the book can be used by any healthcare professional to facilitate the adherence of users/customers in the health education process.*

Keywords— *Educational Technology; Health Education; Music; Health Care.*

I. INTRODUCTION

Health education activities are one of the main approaches of the professional nurse in the practice of care. In this context, educational technologies emerge as

essential tools to assist and complement the best development of assistance to the user/client (Texeira & Mota, 2011). Viana (2011) broadly defines the term technology as applied knowledge, which in health can be

used in the prevention, diagnosis, treatment of diseases and even in the rehabilitation of its consequences.

Health technologies are classified into three types: light, light-hard and hard. Light technologies are those of a relational nature, such as bonding, reception and autonomy. The soft-hards are called technologies-knowledge that operate in the work process of a certain unit, with well-structured knowledge. And hard technologies are machines, devices, standards and organizational structures (Abreu, Amendola & Trovo, 2017; Aquino, Melo, Lopes, & Pinheiro, 2010; Merhy, 2002; Pereira, Sousa, Santos, Bezerra, Gomes & Santos, 2016).

In the health education process, nurses can use several light-hard technologies to assist in the practice of care. They favor communication between professionals and patients, and can produce knowledge and stimuli that help the development of practices considered healthy and positive for individuals health preservation (Pereira, Sousa, Santos, Bezerra, Gomes & Santos, 2016).

Among the various educational resources, there are booklets, audiovisual tools, multimedia and the use of music, which has been incorporated as a therapeutic resource, in addition to being widely used as a pedagogical tool, especially in educational contexts outside the care environment (Sant' Anna, Escudeiro, Ferreira, Teixeira & Branco, 2016).

The use of music as a pedagogical tool that is applied through parodies stands out. Several studies have demonstrated the importance and effectiveness of this type of methodology in teaching various subjects, such as chemistry, biology, environmental education, microbiology, but reports of its use as a resource applied to health education are not equally frequent (Paixão, Lima, Colaço, Lima, Casimiro, Castro & Pantoja, 2017).

Therefore, this study addresses the development of a book as a health education strategy, which brings together 32 parodies on health topics and can be worked since primary care to hospital care. It is a light-hard technology developed by two nursing students and a teacher, due to the need for practical, playful and applicable tools in different contexts of health care.

II. METHODS

It is a methodological research, of technological applicability, with a qualitative approach. The applied methodological research was adopted because it is a process of development of a new product, being this, an educational technology focused on health, specifically a

book containing a set of parodies to be used in different fields of health care according with the theme addressed in each of them (Polit, Beck & Hungler, 2009).

The study was developed in four stages: (1) definition of the themes to be addressed; (2) elaboration of parodies; (3) orthographic/metric revision; (4) graphic printing of the material produced.

The stage related to the selection of themes had as a criterion the coverage corresponding to care related to basic, primary, secondary and tertiary care and all of them should be permeated with an educational/preventive approach. Likewise, the themes should contemplate health problems of relevance in different contexts of health care, that is, conditions with epidemiological relevance that have some type of individual impact (morbidity, mortality and quality of life) and society impact (costs, time away from work or school and productivity), whose health education strategy could have some impact as a favorable intervention.

The musical selection had as main criterion the popular dissemination of the songs, that is, compositions known by the greatest number of people, thus enabling a greater reach of individuals. The resource would be made available to people whose professional practice would allow its use in different healthcare environments. For this reason, the language used in the texts could not be restrictive to the technical language of the health area, but be widely understandable by community health agents, teachers, teaching assistant, elderly or sick caregivers and, thus, also by professionals with higher education in the health area.

III. RESULTS

Based on the relevant literature and the authors' experience in extension and teaching activities focused on health education, the thematic areas addressed were selected first, as shown in Frame 1.

Frame 1: Thematic areas and respective subjects covered in educational technology.

Areas	Subjects
Infecçioous diseases	Aids
	Botulism
	Dengue
	Yellow fever
	Zika

	Mayaro Leprosy Tuberculosis (2) HPV (2) Leptospirosis Meningitis Mycoses (2)
Parasitics diseases	Pediculosis Helminthiasis (verminoses)
Chronic degerative diseases	Diabetes mellitus Arterial hypertension (2) Alergy Dyslipidemia
Self-care	Vaccination Physical ativity Santization of hands

	Food poisoning Trash Oral health (2)
Others	Prenatal care (2) Management heath Humanization Urban violence

Source: Celestino, Jr., Carvalho & Sousa (2018).

Duplicate subjects were designed to complement the topic addressed, to allow them to be used in different contexts, as well as to use music that may be of knowledge and taste better appreciated by different people who use the educational resource.

Frame 2 shows the list of parodies with the subjects covered and the respective songs that serve as the basis for the content worked.

Frame 2: Songs used for each specific theme of the parodies.

Subjects	Songs	Authors
Aids	Garota de Ipanema	Tom Jobim e Vinícius de Moraes
Botulism	Meu erro	Herbert Viana
Dengue Yellow fever Zika Mayaro	Terezinha	Chico Buarque de Holanda
Leprosy	Era um garoto que como eu	Franco Migliacci e Mauro Lusini,
Leptospirosis	Another brick in the wall	Roger Waters
Meningitis	Anunciação	Alceu Valença
Sepsys	Eu ameí te ver	Tiago Iorc
Pediculosis	Malandragem	Cazuza
Helminthiasis	A cobra e o pé de limão	Autor desconhecidos
Diabetes	Fico assim sem você	Abdullah e Cacá Moraes
Alergy	Romaria	Renato Teixeira
Dyslipidemia	Este ano quero paz no meu coração	Paulo Sérgio Vale
Vaccination	Já sei namorar	Tribalistas
Physical Ativity	É preciso saber viver	Roberto e Erasmo Carlos
Sanitization of hands	Superfantástico	Ignácio Balesteros e Edgard Poças
Food poisoning	Adivinha o que	Lulu santos

Trash	Meteoro	Fernando Fakri de Assis
Health management	Gita	Raul Seixas e Paulo Coelho
Humanization	Esse cara sou eu	Roberto Carlos
Urban violence	Felicidade	Gabriel Moura, Leandro Fob, Seu Jorge, Pretinho da Serrinha

Source: Celestino, Jr., Carvalho & Sousa (2018).

In addition to these themes that present only one parody, there are six for which two parodies were produced in order to further facilitate their approach, as we can see in Frame 3:

Frame 3: Songs with two parodies and the respective songs used for their production.

Subjects	Song	Author
HPV I	Te esperando	Bruno Caliman
HPV II	Saudade d'ocê	Vital Farias
Tuberculosis I	Faz um milagre em mim	Joselito e Kely Danese
Tuberculosis II	I want to break free	Queen
Mycosis I	Poeira	Lourenço Olegário filho
Mycosis II	Pororó	Ministério força e vitória
Arterial hypertension I	Em plena Lua de mel	Reginaldo Rossi
Arterial hypertension II	Romântico Anônimo	Bruno Calimam e Ivo Mozart
Oral health I	Ai se eu te pego	Sharon Acioly e Antônio Diggs
Oral health II	A história do pedregulho	José Paulo Fernandes
Prenatal I	1000 graus	Clóvis Pinho
Prenatal II	O natal existe	Edson Borges

Source: Celestino, Jr., Carvalho & Sousa (2018).

After the orthographic revision, the graphic design and editing was prepared, with the cover (Figure 1) in polychrome and monochromatic core. The book has 60

pages and was made in Couché Brilho 300g Offset 75g paper with the ISBN registered under the number 978-85-88314-69-6.

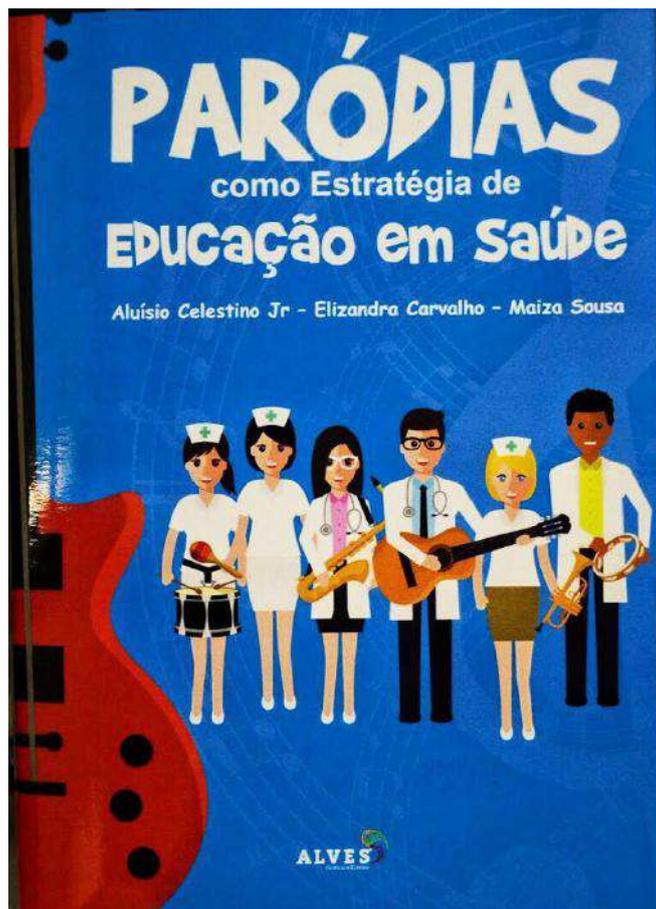


Fig.1: Parody book cover.

Source: Celestino, Jr., Carvalho & Sousa (2018).

IV. DISCUSSION

Educational technologies are resources used for different purposes and in the varied contexts. The thematic variation shown in the elaborated technology allows action in different contexts of care. The literature has described the use of parodies in the teaching of subjects such as environmental education, chemistry, geography, microbiology, as well as the use of educational booklets in the area of health, either to raise the awareness of patients about performing invasive procedures as for health education practices and self-care (Santiago, Souza, Mululo, Oliveira, Rodrigues, Melo, Aguiar, Mota & Santos, 2016).

There are elements that are often associated with health care practice: pedagogical practices and technologies. These are essential tools for a good interaction with the user. However, the inadequate approach can often be the cause of professional dissatisfaction, as the user does not always understand what is being passed on to him, and it is common to hear: "I have repeated it several times and he has not learned; I

don't know what I do anymore to change my behavior" (Vasconcelos, Grillo, & Soares, 2018).

Teixeira (2010) describes that educational technologies in different types: tactile and auditory, expositive and dialogical, printed and audiovisual; and its combined use helps to improve the relationship between professional-user, which has a greater assimilation of what the professional passes about health education. It also highlights that these are the types of technologies used for health education in the community. In this way, the parodies presented in this book work as accessible educational technology and can be used by any health professional in order to improve their educational activities.

Corroborating this, several studies showed that the technologies offering information about diseases and and living conditions of patients, increase their interest in learn more about the subject and know their health prospects (Silva, Carvalho, & Carvalho, 2015). So it was possible to know the risks offered by the disease and helps make decisions in performing procedures, for example.

Sant'Anna, et al. (2016) make this very clear when they publish their study on the social representations of patients submitted to cineangiography examination and verify that most of them attribute it a sense of death, in a symbolic or proper way, due to the lack of guidance about the procedure. To minimize the problem, an educational booklet with information and guidance on cineangiography was implemented, resulting in reduction in the level of stress, fear and anxiety of users, before the exam.

Instead playbooks, parodies are not widely used technologies in the health field. Literature shows its use especially in regular teaching of diverse subjects. For example, Paixão, et al. (2017) report the use of this technology in teaching of microbiology, highlighting the importance resulting in increasing students interest about this subject facilitating learning; and Machado (2015) spoke about the use of parodies as a learning object in teaching mathematics.

Due to its great plurality in human health themes and musical appeal of great public, the technology presented has full possibility of being used in the approach to health education with relevant motivational appeal in health care.

V. CONCLUSION

Therefore, we concluded that the use of parodies as methodological tool in health education process is an effective alternative, since it enables the dynamic and playful assimilation of the contents passed by the professionals. The book presented in this study comprises 32 parodies on various topics in health area to enrich the exchange user/client information, as well as ensuring their participation in health education process.

Thus, it is highlighted that the development of this type of educational technology is something that could be more valued in literature, and the existence of many products like this in the health area is not documented. So, the compiled parodies can be used by any health professional and in varied audiences, facilitating the health education process and contributing to increase the interest of users/clients, mainly in the practice of self-care.

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The prevalence of sexual abuse of children and adolescents people in the municipality of Tucuruí - PA and region in the period from 2010 to 2016

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Abstract—Introduction: Child and youth sexual abuse is considered one of the biggest public health problems. Because of this, this work aims to identify by DATASUS the epidemiological profile of children and adolescents victims of sexual abuse in the municipalities of Tucuruí and region in the period from 2010 to 2016. Materials and Methods: In order to carry out this research, quantitative and qualitative research and epidemiological analysis of bibliographic character were used. The collection of quantitative data was performed by the DATASUS platform through the epidemiological survey of children and adolescents victims of sexual abuse <1 to 14 years old. Results and Discussion: Through data collection performed on the DATASUS platform, we obtained the number of reported cases of sexual abuse in Tucuruí and region (Pacajá, Parauapebas, Breu Branco, Goianésia do Pará, Novo Repartimento), from 2010 to 2016. After analyzing the data, it was observed that in this period there was an increase in the number of victims of sexual abuse in the municipalities mentioned between the age range of <1 to 14 in both genders. Final Considerations: Sexual abuse is still taboo in our society and many cases are not reported due to fear, shame and even the dependence in which they find themselves in relation to the perpetrators. As a result, lectures, preventive and educational programs are needed for children and adolescents so that both understand that abuse is a crime according to § 4 of Law 12,015 of August 7, 2009.

Keywords— public health, violence, sexual violence, child sexual violence, child sexual abuse, combating child sexual exploitation, breaking the silence of sexual abuse.

I. INTRODUCTION

According to the World Health Organization, child and youth sexual abuse is considered one of the biggest public health problems, as it is a complex phenomenon and difficult to face, it is inserted in a historical-social context of endemic and cultural violence [1].

Among the different types of violence, sexual abuse is a constant concern. It is estimated that around 40 million children and adolescents worldwide suffer sexual abuse

annually. However, this estimate may be underestimated due to the circumstances in which these events occur, the frequent dependence of the victims in relation to their aggressor, in addition to the fear and embarrassment related to difficulties in reporting this type of violence [2].

Between 2011 and 2017, Brazil had an increase of 83% in general notifications of sexual violence against children and adolescents, according to an epidemiological bulletin released by the Ministry of Health. During the period,

184,524 cases of sexual violence were reported, of which 58,037 (31.5%) against children and 83,068 (45.0%) against adolescents. Most of the occurrences, both with children and adolescents, occurred at home and the aggressors are people who live with the victims, usually family members [3].

Because of this, this study aims to identify through DATASUS the epidemiological profile of children and adolescents victims of sexual abuse in the municipalities of Tucuruí and region in the period from 2010 to 2016.

II. MATERIAL AND METHODS

To carry out this research, quantitative-qualitative research and epidemiological analysis of bibliographic character were used. Bibliographic research is characterized by the search in the literature of several aspects of a theme to be studied and analyzed, which can contribute to a broader and more structured future research [4].

Quantitative and qualitative methods provide more credibility and legitimacy to the results found, avoiding reductionism with just one option. Among the contributions of quanti-qualitative / quali-quantitative research, the author highlights: it brings together bias control (quantitative methods) with understanding, from the agents involved in the investigation (qualitative methods); adds the identification of specific variables (quantitative methods) with a global view of the phenomenon (qualitative methods); enriches findings obtained about controlled conditions with data obtained within the natural context of their occurrence; and the validity of the reliability of the findings through the use of differentiated techniques [5].

The epidemiological analysis assesses the association between individual factors (both the child and the perpetrator of the abuse), family and / or ecological / contextual with the event of interest. It has the potential to estimate the magnitude of a health problem, its determinations, as well as to indicate population groups that can be prioritized in the allocation of health care and other actions of potential impact. Thus, from an epidemiological point of view, sexual abuse of children can be analyzed as a cause / predicted event by other factors [6].

As a result, a search was performed in MEDLINE, DATASUS, WHO databases and the SCIELO portal; afor being the most important sources. The survey of articles in certain databases and portal was carried out in January

2020. During the search, the descriptors were used: "public health", "violence", "sexual violence", "child sexual violence", "child sexual abuse", "combating child sexual exploitation", "breaking the silence of sexual abuse". Tucuruí is located on the bank of the Tocantins River, has a territorial area of 2,086,189 km² and a population of 113,659 inhabitants and has 37 SUS health establishments [7].

The collection of epidemiological data was carried out in a DATASUS database in the municipalities of Tucuruí, Breu Branco, Novo Repartimento, Goianésia do Pará, Parauapebas and Pacajá. The study subjects were children and adolescents victims of sexual abuse in the age group <1 to 14 year.

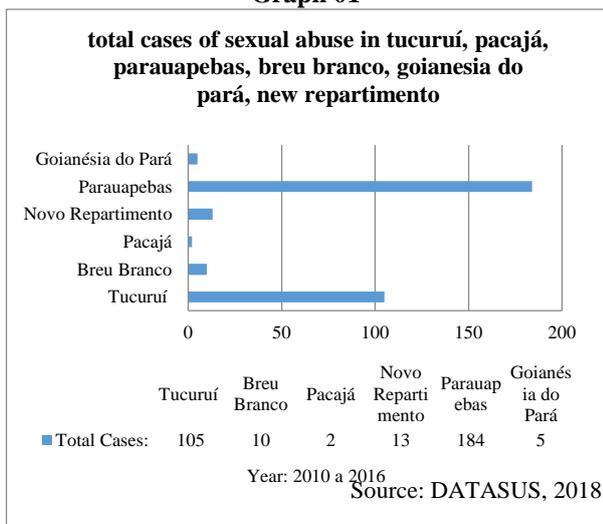
III. RESULTS AND DISCUSSION

Although the underreporting of cases of sexual violence against children and adolescents is still high, the prevalence and the individual and collective consequences are serious enough to make it a public health problem. Considering this, this study presents the number of reported cases of child and juvenile sexual abuse in the municipality of Tucuruí, Pará and Region. Through data collection performed on the DATASUS platform, we obtained the number of reported cases of sexual abuse in Tucuruí and region (Pacajá, Parauapebas, Breu Branco, Goianésia do Pará, Novo Repartimento) in the period from 2010 to 2016. The age group of <1 to 14 years old and the gender (male and female) that most suffers from this type of abuse.

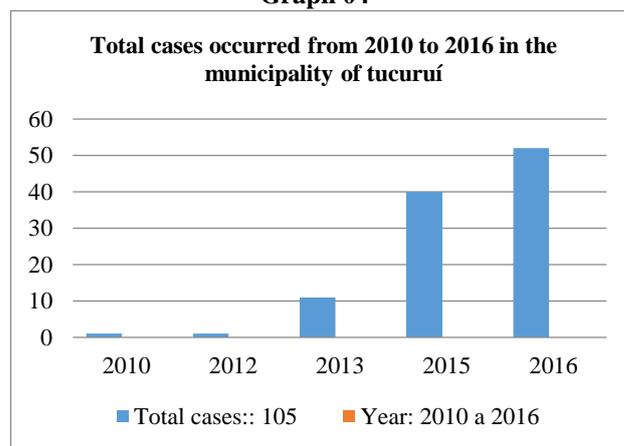
- Graph 1 - Total cases from 2010 to 2016 in the municipality of Tucuruí;
- Graph 2 - Total cases of sexual abuse in Tucuruí, Pacajá, Parauapebas, Breu Branco, Goianésia do Pará, Novo Repartimento;
- Graph 3 - Total cases of sexual abuse related to the age group <1 to 14 in the period from 2010 to 2016 in Tucuruí and region (Pacajá, Parauapebas, Breu Branco, Goianésia do Pará, Novo Repartimento);
- Graph 4 - Total cases according to Gender in the municipality of Tucuruí and Region;

Below, the epidemiological data obtained through the DATASUS platform will be demonstrated through the graphics.

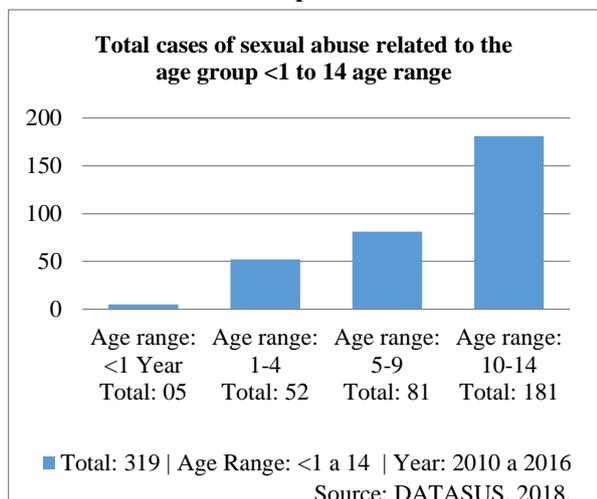
Graph 01



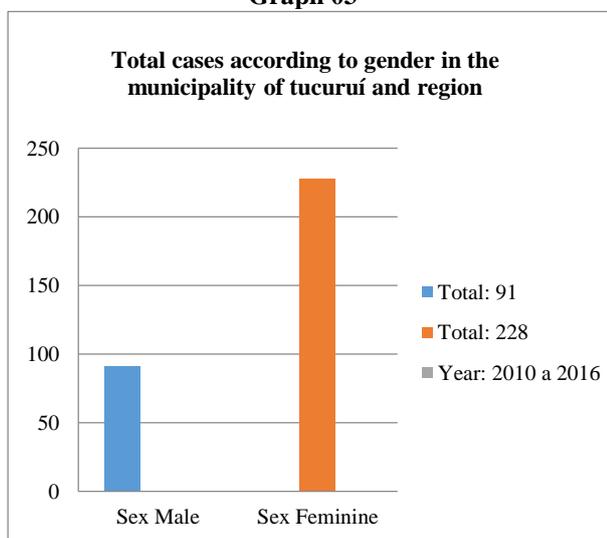
Graph 04



Graph 02



Graph 03



Source: DATASUS, 2018.

After analyzing data on the DATASUS platform, it was observed that in the period from 2010 to 2016 in the municipality of Tucuruí, there was an increase in data of approximately (50%) compared to the year 2010 and 2012, to which, they had only one notification. In 2016, 52 notifications were made. Among the different municipalities, in Tucuruí a total of 105 notifications were made, totaling an increase of (50%) between 2010 and 2016, Parauapebas made 184 notifications with an increase of (58%) of cases between 2010 and 2016, both are the municipalities with the highest number of notifications made between the current years.

In Breu Branco, 10 notifications were made, totaling an increase of (3%), in the period from 2010 to 2016. In the municipality of Novo Repartimento, 13 notifications were made, with an increase of (4%), in Goianésia do Pará 5 notifications were made, with an increase of (1%), and in Pacajá, 2 notifications were made, totaling an increase of (1%). Among the age group <1 to 14, those who suffer the most from this type of abuse are children and adolescents, in the first place being in the age group of 10-14 years old 57% (n = 181) in second place being in the age group of 5 - 9 years old 25% (n = 81) and thirdly the age group 1-4 years old 16% (n = 52).

Regarding gender, it was identified that the female sex (71%) occupies the first place, being the one who suffers the most from sexual violence (n = 228) cases. The male gender (29%) appears in second place in the survey with (n = 91), of the cases. The results corroborate with the findings of the National Center for Victims of Crimes (National Center for Victims of Crimes) estimates that 1 in 5 girls and 1 in 20 boys have already suffered some form of sexual abuse [8].

In this context, sexual violence harms the development of children and adolescents, often irreversibly. The result

of the aforementioned research, “the prevalence of sexual abuse of children and adolescents people in the municipality of Tucuruí - pa and region in the period from 2010 to 2016”, whose data collected were related to the records made in the year 2010 to 2016, revealed that 71 % were female victims, 29% were male.

Through the notifications made by the DATASUS platform, it can be concluded that the incidence of sexual violence against children and adolescents increased in the municipality of Tucuruí and in the other municipalities mentioned.

IV. CONCLUSION

A Due to the large increase in quantitative data of victims of sexual abuse, several cases are omitted, we know that sexual abuse is still taboo in our society and many cases are not reported due to fear, shame and even dependence, to which, they are found in relation to perpetrators.

Through this, we realize that sex education needs to be discussed inside and outside the school environment, because this subject is of great relevance and through it children are able to identify that something wrong is happening, causing them to seek help.

Sexual abuse is a public health problem and a preventive duty of the state, the aggressors need treatment and abused children need help. As a result, lectures, preventive and educational programs are needed in schools aimed at children and adolescents so that both understand that abuse is a crime according to § 4 of Law 12,015 of August 7, 2009, which says: The law will severely punish the abuse, violence and sexual exploitation of children and adolescents [9].

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Epidemiology and risk factors associated with deaths from tuberculosis in older people who live in the capital of the Northeastern part of Brazil

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Abstract— *Introduction: Tuberculosis (TB) is an extreme relevance pathology to the Public Health due to the morbidity and mortality high rates, with emphasis on the older population. The bacillus characteristic is intracellular, so a competent immune system must be needed to fight it through the cellular mechanisms.*

Methods: Cross-sectional, documentary and analytical study based on the review of 128 medical records from the patients, who aged 60 years old or older at the time of the care due to TB or its complications from January 2006 to December 2016.

Results: The death prevalence was 44.5%. The bivariate analysis revealed that the men died 30% more than the women (PR = 1.3; CI 95% 0.81 - 2.07). In regard to the outcome (death and discharge), there was a statistical significance related to: a) clinical and epidemiological characteristics: Outpatient care (p = 0.002), ICU (p <0.001), Coma (p = 0.005), Hospitalization days (p <0.001), Treatment Adherence (p = 0.006), Treatment Abandonment (p = 0.036); b) risk and some associated factors: Malnutrition (p = 0.018), Hypertension (p = 0.024), HIV / AIDS (p = 0.010); The Poisson regression model for the outcome death / discharge shows ICU admission (p<001), Treatment adherence (p=002), Proccedence origin (p=046).

Conclusion: The study showed different risk factors toward the death occurrence from the tuberculosis among the older people and illustrates the relevance of a continuous surveillance in order to monitor the TB.

Keywords— *Tuberculosis, Epidemiology, immune system.*

I. INTRODUCTION

Tuberculosis (TB) is an extreme relevance pathology to the public health due to the morbidity and mortality high rates with emphasis on the older population. Despite of presenting itself as a millenary disease, which is widely studied around the world, it is also offered an effective vaccination to avoid the contagion as well as effective treatments, there is still an enormous challenge to the global public health, especially in the underdeveloped countries without resources and diagnostic for the population treatment [1].

Its dissemination by the etiological agent Mycobacterium Tuberculosis occurs in an aerial way, by affecting a large number of people. Due to the bacillus characteristic that it is intracellular, a competent immune system must be needed in order to fight it through the cellular mechanism. In a healthy patient, the answer is given by the formation of the granulomas, which is the host's reaction to the bacillus invasion. In the older people, there is a weakness in the defense system and there is an increasingly frequent occurrence of TB cases in this age group [2].

As many developing countries, Brazil is in the process of demographic transition, by increasing significantly the number of older people in the recent decades. It is known that the older people's organic condition, associated with other comorbidities, such as malnutrition and diabetes mellitus predispose the TB occurrence. In addition, the excessive consumption of the multiple medications and the lack of knowledge can result in the TB treatment abandonment, thus favoring the emergence of drug-resistant strains [3,4].

Drug-resistant tuberculosis (TBDR) is a priority concern from the World Health Organization (WHO). It is estimated that, in 2014, 480 thousand people developed TBDR and 190 thousand died [5].

Since 1997, WHO has published the global TB report to promote the epidemiological understanding from the disease, that it is a facilitating tool in the strategy developments and goals for its treatment as well as the control. It has been emphasizing the problem scale with more than nine million cases registered in 2014, which were increased to 10.4 million in 2015.

Approximately six million cases of the disease were new in both periods. Four countries were responsible for 60% of its incidence, namely: India, Indonesia, China, Nigeria, Pakistan and South Africa. It also counts approximately one million and a half of deaths each year [6,7]. It is important to be mentioned that almost half of the global TB cases as well as two thirds of the TBDR cases come from Brazil, Russia, India, China and South Africa (BRICS) and some other emerging economies. These countries have a fundamental role toward the compliance with the global milestones defined by the "End TB Strategy" [6].

In Brazil, since 2003, TB has become a priority pathology for the Secretary of Health, because it is associated with social factors such as poverty and poor income distribution, precarious housing conditions, demographic pressure, disorderly growth of populations in cities, among some others.

Although there was a reduction in the incidence rate (41.5/100,000 inhabitants in 2005 to 32.4/100,000 inhabitants in 2016) and a mortality (2.9/100,000 inhabitants in 2003 to 2.2/100,000 inhabitants in 2015) TB in the country is a cause for a great concern due to the low treatment adherence, which it is one of the factors that can lead to the TBDR [8]. In addition, there was an increasing in the cases of Acquired Immuno Deficiency Syndrome (AIDS) among the older population and co-infection with the Human Immuno Deficiency Virus (HIV) further aggravating the TB and TBDR problem in the country [9].

In this context in order to characterize and analyse the risk factors for the TB development, it is necessary some epidemiological studies. The cross-sectional study has several advantages such as work easiness, execution low cost, and also presents quick results, by allowing the choice of the best strategy together with the most adequate public policy. Its greatest disadvantage is, that, it makes impossible the causality, since the exposure and the outcome factors are collected concomitantly [10]. For this disease, the correlations among explanatory and dependent variables can be made and the risk factors can be identified for the TB occurrence.

As it was shown above, this study aims to characterize the TB epidemiology, by associating possible risk factors to deaths from TB in older patients, who were admitted to a referral hospital in State of Ceará, Brazil.

II. METHODS

The study was conducted at São José Hospital (HSJ) for infectious diseases in Fortaleza, Northeastern part of Brazil. It is the fifth largest capital in the country with a population of 4,074,730 million inhabitants and a demographic density of 7,786.4 inhabitants / km².

HSJ is a large hospital with excellence in the patients' care affected by the infectious diseases and a reference center in the treatment from TBDR in Ceará State. It is a public hospital linked to the Brazilian Unified Health System (SUS).

HSJ maintains all patients' information on file through the medical records on the paper and they are daily stored at the Medical and Statistics Archive (SAME). The registration of each patient is carried out in the "Record from the Patients' Discharge and Deaths" as well as the information such as: occurrence year, medical record number, age, origin and entry diagnosis.

Study Design and Data Collection

Cross-sectional, documentary and analytical study based on the review of patients' medical records, who aged 60 years old or older at the time of the care due to TB or its complications. The information collection obtained from medical records was for the period from January 2006 to December 2016, and it occurred during the months of July 2016 to September 2017.

The initial data survey was carried out from the consultation in the "Records from the Patients' Discharge and Deaths", where each chart with the diagnosis of TB or TBDR was initially included in the study. The collection in the medical records was carried out in a census form in the SAME sector, by considering the older people assisted by

TB in the outpatient clinics, emergence, infirmary or intensive care unit (ICU) of HSJ.

TB or TBDR cases were diagnosed according to the medical criteria and they were performed only by the infectious professionals at HSJ. It was considered a lack of the treatment adherence, the patients whom the information was explicated in the medical record history. As this is a cross-sectional study, adherence to the treatment was not evaluated after hospitalization or consultation at the health service.

The information in the medical records was transcribed into forms that included the following data: a) sociodemographic and economic (number of medical records, age, origin, education, occupation, income and service sector; b) clinical (clinical disease form, risk factors and comorbidities that may follow the disease, immunosuppressed patient for any other reason); c) adherence to or abandonment from the treatment; d) outcome: discharge, death or moved to another hospital. All the information from each medical Record was filed year by year in the Microsoft Excel format spreadsheets.

Statistical Analysis

The spreadsheets made up an information bank, and they were analyzed by statistical software called "Statistical Package for Social Science"- SPSS version 20 (SPSS Co., Chicago, USA).

Bivariate analysis were performed, by using the Chi-square or Fisher's exact test. The measurement from the association used to measure the magnitude of the associations was the Prevalence Ratio (PR) and the respective confidence intervals (95% CI). For all statistical tests, it was considered a significance level of 5%.

In order to obtain PR estimates adjusted for confounding variables, multivariate analysis was performed, by using the Poisson regression model with some robust variance. The variables that were associated with the outcome in the bivariate analysis were selected for the multivariate analysis, with a value of $p < 0.25$ and only those with a significant association at the level of $p < 0.05$ were maintained in the final model.

III. RESULTS

From the total of 128 medical records included in the study, the prevalence of deaths was 44.5%. The age of the patients ranged from 60 to 93 years old, with a mean of 68.8 (SD \pm 7.2). Prevalence: male gender (90; 70.3%), age group from 60 to 69 years old (80; 62.5%), income from a minimum wage (59; 46.1%) and low education (70; 54, 7%). From the total participants, 94 (73.4%) were from Fortaleza.(Table 1)

Table 1: Prevalence of death in older patients diagnosed with tuberculosis according to sociodemographic characteristics (n = 128).

Variables	Total	Death	Discharge	PR (IC 95%)	Value p
	n (%)	n (%)	n (%)		
Gender					0.255
Male	90 (70.3)	43 (47.8)	47 (52.2)	1.3 (0.81 - 2.07)	
Female	38 (29.7)	14 (36.8)	24 (63.2)	1	
Age group					0.921
60 to 69 years old	80 (62.5)	35 (43.8)	45 (56.3)	1.05 (0.51 - 2.14)	
70 to 79 years old	36 (28.1)	17 (47.2)	19 (52.8)	1.13 (0.53 - 2.41)	
80 or more	12 (9.4)	5 (41.7)	7 (58.3)	1	
Occupation					0.383
Unemployed	18 (14.5)	6 (33.3)	12 (66.7)	0.75 (0.38 - 1.49)	
Employee / Retired	106 (85.5)	47 (44.3)	59 (55.7)	1	
Income					0.605
< 1 SM	33 (25.8)	17 (51.5)	16 (48.5)	1.16 (0.71 - 1.9)	
= 1 SM	59 (46.1)	24 (40.7)	35 (59.3)	0.92 (0.57 - 1.48)	
> 1 SM	36 (28.1)	16 (44.4)	20 (55.6)	1	

Education					0.482
None	55 (43.0)	26 (47.3)	29 (52.7)	1.42 (0.61 - 3.31)	
Up to 7 years old	35 (27.3)	13 (37.1)	22 (62.9)	1.11 (0.45 - 2.77)	
8 to 12 years old	26 (20.3)	14 (53.8)	12 (46.2)	1.62 (0.67 - 3.88)	
More than 12 years	12 (9.4)	4 (33.3)	8 (66.7)	1	
Origin					0.095
Fortaleza	94 (73.4)	46 (48.9)	48 (51.1)	1.51 (0.89 - 2.56)	
Another city	34 (26.6)	11 (32.4)	23 (67.6)	1	

Source: research data. Chi-square test.

The bivariate analysis revealed that men died 30% more than women (PR = 1.3; CI 95% 0.81 - 2.07).

Table 2 highlights the study results, by showing the outcome related to the clinical and epidemiological characteristics with predominance of pulmonary TB as a clinical form (102; 79.7%). All the 128 patients were admitted to the hospital and 41 (32%) were undergoing outpatient's treatment and had to be hospitalized, over the

study period, 48 (37.5%) were admitted to the ICU due to some severe conditions or complications, 26 (22.6%) abandoned the treatment and only three cases were followed up at home by Directly Observed Treatment (ODD).

Table 2. Outcome from the older patients diagnosed with tuberculosis according to the clinical and epidemiological characteristics.

Variables	Total	Death	Discharge	PR (IC 95%)	Value p
	n (%)	n (%)	n (%)		
Clinical form					0.468 ¹
Pulmonary	102 (79.7)	45 (44.1)	57 (55.9)	1.32 (0.58 - 3.03)	
Extrapulmonary	12 (9.4)	4 (33.3)	8 (66.7)	1	
Pulmonary + extrapulmonary	14 (10.9)	8 (57.1)	6 (42.9)	1.71 (0.68 - 4.3)	
Outpatient care					0.002¹
Yes	41 (32.0)	10 (24.4)	31 (75.6)	0.45 (0.25 - 0.8)	
No	87 (68.0)	47 (54.0)	40 (46.0)	1	
UTI					<0.001¹
Yes	48 (37.5)	42 (87.5)	6 (12.5)	4.67 (2.92 - 7.46)	
No	80 (62.5)	15 (18.8)	65 (81.3)	1	
Coma					0.005²
Yes	10 (7.8)	9 (90.0)	1 (10.0)	2.21 (1.64 - 2.99)	
No	118 (92.2)	48 (40.7)	70 (59.3)	1	
Baar result (n=84)					0.922 ¹
Positive	47 (56.0)	17 (36.2)	30 (63.8)	1.03 (0.58 - 1.84)	
Negative	37 (44.0)	13 (35.1)	24 (64.9)	1	
Culture result (n=65)					0.431 ¹
Positive	25 (38.5)	10 (40.0)	15 (60.0)	0.8 (0.45 - 1.42)	

Negative	40 (61.5)	20 (50.0)	20 (50.0)	1	
Hospitalization days					<0.001 ¹
Up to 10 days	43 (33.6)	28 (65.1)	15 (34.9)	1.91 (1.32 – 2.76)	
More then 10 days	85 (66.4)	29 (34.1)	56 (65.9)	1	
Treatment adherence					0.006¹
Yes	67 (57.8)	20 (29.9)	47 (70.1)	1	
No	49 (42.2)	27 (55.1)	22 (44.9)	1.85 (1.18 - 2.88)	
Treatment Abandonment					0.036¹
Yes	26 (22.6)	15 (57.7)	11 (42.3)	1.66 (1.07 - 2.56)	
No	89 (77.4)	31 (34.8)	58 (65.2)	1	

Chi-square test; ² Fisher's exact test

Risk Factors Related to TB Deaths

In the bivariate analysis, it was observed that in relation to the outcome (death and discharge), there was a statistical significance related to the outpatient's care ($p < 0.002$), ICU admission ($p < 0.001$), patients in coma ($p < 0.005$), treatment abandonment ($p = 0.036$). Meanwhile, the treatment adherence was a protective factor ($p = 0.006$).

From the 48 (37.5%) older people, who were admitted to the ICU, 42 (87.5) died, by representing 4.67 times higher RP, when it was compared to the outpatient's care. Likewise, the older people in coma had a PR 2.21 times greater chance of dying, when they were compared to those who were not in coma. The smear test showed a positive

result in 47 cases (36.7%) and the culture test in only 25 (19.5%), however, without statistical significance.

Table 3 shows that among the risk factors related to the death outcome, the most prevalent are: smoking (63; 49.2%), followed by alcoholism (46; 35.9%), HIV / AIDS (39; 30.5), malnutrition (34; 26.6%), DM (28; 21.9%) and chronic obstructive pulmonary disease (COPD) (16; 12.5%). The other risk factors had a prevalence less than 10%. The factor associated with arterial hypertension was present in 45 cases (35.2%). There was a statistical association between risk factors for malnutrition ($p = 0.018$) and HIV / AIDS ($p = 0.010$) arterial hypertension ($p = 0.024$) and the occurrence of death from the disease.

Table 3. Outcome from the older patients diagnosed with tuberculosis according to the risk and associated factors.

Variables	Total	Death	Discharge	PR (IC 95%)	Value p
	n (%)	n (%)	n (%)		
Malnutrition					0.018¹
Yes	34 (26.6)	21 (61.8)	13 (38.2)	1.61 (1.12 - 2.33)	
No	94 (73.4)	36 (38.3)	58 (61.7)	1	
Smoking					0.737 ¹
Yes	63 (49.2)	29 (46.0)	34 (54.0)	1.07 (0.73 - 1.57)	
No	65 (50.8)	28 (43.1)	37 (56.9)	1	
Alcoholism					0.574 ¹
Yes	46 (35.9)	22 (47.8)	24 (52.2)	1.12 (0.76 - 1.66)	
No	82 (64.1)	35 (42.7)	47 (57.3)	1	
Drugs using					0.088 ²
Yes	6 (4.7)	5 (83.3)	1 (16.7)	1.96 (1.29 - 2.95)	
No	122 (95.3)	52 (42.6)	70 (57.4)	1	
Diabetes Mellitus					0.055 ¹

Yes	28 (21.9)	8 (28.6)	20 (71.4)	0.58 (0.31 - 1.08)	
No	100 (78.1)	49 (49.0)	51 (51.0)	1	
Hypertension					0.024¹
Yes	45 (35.2)	14 (31.1)	31 (68.9)	0.6 (0.37 - 0.97)	
No	83 (64.8)	43 (51.8)	40 (48.2)	1	
Imunossupressed					0.834¹
Yes	12 (9.4)	5 (41.7)	7 (58.3)	0.93 (0.46 - 1.87)	
No	116 (90.6)	52 (44.8)	64 (55.2)	1	
HIV / AIDS					0.010¹
Yes	39 (30.5)	24 (61.5)	15 (38.5)	1.66 (1.15 - 2.4)	
No	89 (69.5)	33 (37.1)	56 (62.9)	1	
DPOC					0.638¹
Yes	16 (12.5)	8 (50.0)	8 (50.0)	1.14 (0.67 - 1.95)	
No	112 (87.5)	49 (43.8)	63 (56.3)	1	
Pulmonary emphysema					0.585²
Yes	3 (2.3)	2 (66.7)	1 (33.3)	1.52 (0.66 - 3.45)	
No	125 (97.7)	55 (44.0)	70 (56.0)	1	
Contact with sick person					1.000²
Yes	7 (5.5)	3 (42.9)	4 (57.1)	0.96 (0.4 - 2.31)	
No	121 (94.5)	54 (44.6)	67 (55.4)	1	
Inadequate housing conditions					0.465²
Yes	8 (6.3)	5 (62.5)	3 (37.5)	1.44 (0.81 - 2.56)	
No	120 (93.8)	52 (43.3)	68 (56.7)	1	
Chronic kidney					0.689¹
Yes	12 (9.4)	6 (50.0)	6(50.0)	1.14 (0.62 - 2.08)	
No	116 (90.6)	51 (44.0)	65(56.0)	1	

¹ Chi-square test; ² Fisher's exact test

Table 4. Poisson regression model for the outcome (death) from older patients diagnosed with tuberculosis.

Variables	PR adjusted	IC 95%	Value p
ICU admission			<0.001
Yes	5.72	3.32 - 9.87	
No	1	-	
Treatment adherence			0.002
Yes	1	-	
No	1.68	1.22 - 2.32	
Origin			0.046
Fortaleza	1.52	1.01 - 2.96	

Source: research data.

To be adjusted a regression model for the patients' outcome, statistical significance remained with the variables: admission to the ICU ($p < 0.001$), treatment adherence ($p = 0.002$) and the ones from Fortaleza (state capital), ($p = 0.046$).

IV. DISCUSSION

The study showed that the death occurrence from TB is associated with the identified risk factors, such as older people with HIV/AIDS co-infection, malnourished or with DM are more likely to develop severe forms and death than those who do not have these comorbidities. The high percentage of lethality demonstrates a weakness in the active search for the symptomatic respiratory cases in the older, who are followed up at the health service for some other causes. Therefore, our results point to the need of reassessing the program to combat tuberculosis in Ceará, with a higher qualification for monitoring the occurrence of the cases and standardized follow-up to the Secretariat of Health protocol.

The higher frequency from the disease in men corroborates with researchers, who point out a very strong correlation with the death in males, when they were compared to females, by including the fact that males are in a major risk factor in relation to the females [11-13].

Low income and education were marked in the studied population, by considering that 85.5% were retired and/or employees with an income of up one minimum wage. It is known that TB is related to some unfavorable economic situations. Studies concluded that TB is associated with the social context, the low level of education, in addition to some other socioeconomic factors. These factors make the patients, especially the older people, vulnerable to the maintenance of the basic supplies, which can affect access to the health service continuity and the treatment success, as well as the health condition itself that aggravates the clinical condition [14,15,16]. Likewise, other studies emphasize that, in general, the socioeconomic conditions from the population affected by the disease are always more precarious than the general population, thus favoring the emergence of more severe forms of the disease [11,15,17,18].

In the bivariate analysis, it was possible to demonstrate a moderate relationship from the DM in relation to death. The relationship between TB and DM follows the same line as the other factors, since the coexistence of both in the individuals leads to a clinical picture worsening. Studies report that blood hyperglycemia is related to the changings in immune responses, thus making diabetic older people more likely to contract the disease, in addition

to the condition of the chronic hyperglycemia, as well as a lack of glycemic control, by having a negative impact on the TB treatment, thus suggesting a higher probability of death [19-21].

In the present study, arterial hypertension was associated with the older people's outcome ($p = 0.024$). In a population-based cohort study on the increased risk of an acute coronary syndrome in patients with TB, was found a significant ($p = 0.03$) positive prevalence of arterial hypertension in the TB cohort (38.7 %) compared to the cohort without the disease (37.5%) [22]. Despite of this, it should be noted that there are contradictions in regard to the theoretical framework in the literature on this subject, since a systematic review, shows that there was no evidence in order to support an association between TB and hypertension [23]. For this reason, the authors from this review interpret the results with caution due to the lack of properly designed studies in relation to the methods.

Malnutrition and alcoholism were important risk factors for death. A percentage of 26.56% from patients had some level of malnutrition. In this context, authors emphasize that malnutrition has a high impact before the TB onset, as well as the frequent disease occurrence among the older people. This factor may be directly linked to the poor socioeconomic conditions from the population in this study. In addition, the malnutrition is also important in patients, who suffer from HIV / AIDS, since they often experience weight loss [24,25].

Although the alcoholism did not show statistical significance, it was decisive in the death outcome, since 47.8% from the alcoholics died. The association between alcohol consumption and tuberculosis is already known. However there have been inconclusive results related to several confounding factors and the complexity of combining the illicit drugs using with the tuberculosis, together with the profile from the affected population and the study scarcities that address this issue [26].

Smoking was a risk factor in the study population. Its high impact for the disease acquisition and death due to the complications in its treatment is a habit that is often associated with the bilateral pulmonary parenchyma, that often cause an advanced disease. In addition to be associated with lung injuries, it becomes an aggravating factor for TB, thus contributing to an unfavorable outcome

and death. The same happens with the consumption of illicit drugs [27].

Another serious problem found in the study population concerns HIV/AIDS, that it is a complicated factor, by considering that through the bivariate analysis it was possible to observe statistical significance between HIV and death in this population ($p = 0.010$). HIV/AIDS co-infection with TB has become a problem worldwide, and also by considering that these two pathologies represent combinations with high mortality, especially in the most vulnerable population at the immune level [28].

This panorama is in a large part due to the antiretroviral treatment that contributes even more to the older people's immune depression, by making TB treatment difficult and facilitating opportunistic infections, aggravating other comorbidities that the older people may present and, therefore, increasing the number of deaths [29,30]. In health services, the two diseases are investigated and treated together, through the rapid HIV test, since the virus investigation, when there is a demand for TB in the system, is a priority [31].

In regard to the outcome, TB is still one of the most lethal diseases on the planet, especially when it is associated with HIV / AIDS. In 2015, 1.2 million cases of co-infection occurred in the world (12% from the total cases), since the male gender was the most affected one. Likewise, people with the HIV virus are 26 times more likely to develop TB [32]. In this context, HIV / TB co-infection is at the top of the infectious diseases that kill the most in the world, as in the year of 2014, in which, one in three deaths from TB was associated with the virus [5].

The fact that ICU hospitalization, treatment adherence and the origin from the capital remained significant, when they were adjusted by the regression model, it is in line with the findings of some other studies that demonstrated associations from these factors for the patients' outcome.

Duro et al.[33] in a cohort study of TB patients, who need some intensive care had a high mortality rate. For the authors, most of the risk factors for mortality were related to the organ failure, however, other variables could be related, such as the delay in the diagnostic as well as therapeutic approach, which are important targets for the intervention.

It is important to mention that the treatment abandonment by 26 older people (22.6%) proved to be relevant, by considering that these older people, 15 (57.7%) died as an outcome. Therefore, abandoning treatment is a marker of a great importance, since it is inversely proportional to the increasing rate of cure, mortality and recurrence of the disease. In addition, it provides an increasing in resistant

strains, difficulties in the healing process, an increasing in the treatment time and its cost [34].

The low financial condition results in displacement to the large centers in the search for survival, by implying people's clusters in precarious health conditions. The county of Fortaleza has improved its Human Development Index (HDI) over the years, yet 75.21% (88 neighborhood) are classified as very low HDI, with only 6.83% (8 neighborhood) of the neighborhood classified high or very high HDI. As it was already mentioned, the hospital in which this study was carried out serves, for the most part, the population of most neighborhood with low HDI, with low education and income, and who are unable to have a private health service [35]. Meanwhile, Wang et al. [15] emphasize that to be older people is a risk factor for the development of extrapulmonary TB, as well as being retired and living in the urban areas.

Some limitations from the study can be highlighted, by emphasizing the deletion of records due to some information that is no longer explored, because there were incomplete medical records or because there was prospective information, such as the patient's treatment adherence after being a patient from the Health Service. It is also noteworthy the fact that the prescription and formula were not evaluated in regard to the type of medication and treatment adherence. Although the study is limited to a large referral hospital, and cannot extrapolate its results to the general population, however, it is expected to reinforce the dimension of the TB problem in the older population and the need for further study of the topic in any other part of the world.

However, as important as the pathological aspects of the disease, are the psychosocial and economic nuances that present and feed an old disease, which has a vaccine and methods to reduce the likelihood of its development, emphasized, in this study, its large percentage death (44.5%) as an outcome.

V. CONCLUSION

The study showed a high occurrence of death from tuberculosis among older people. Risk factors for this outcome were co-infection with HIV/AIDS, malnutrition, hypertension, ICU admission, lack of adherence to the treatment and origin. An educational strategy is needed with a focus on detecting new cases with the assessment of close contacts with the patient diagnosed with TB. The study illustrates the relevance of continuous surveillance for TB monitoring in the city of Fortaleza. It is recommended to accompany the older people to reduce the number of patients that abandoning the treatment for the

disease. It is hoped that the risk factors identified can contribute as a tool to reduce cases among the older people through early identification and control.

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The Fatigue Failure Analysis of Steel Structure and Review of Collapse Accidents

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Abstract— Bolt-ball grid structure is a high order statically indeterminate spatial grid structure that made up of multiple root bars and the bolt-ball nodes according to a certain grid form, It has the advantages of good appearance ,simple and applicable for large span, lighter weight, stress reasonable and it used in industrial and civil architecture widely. It is important to note that many bolt-ball grid structure engineering collapse has happened in recent years though the bolt net structure has developed more mature. It is necessary for us to analysis this kind of bolt-ball serious engineering accident carefully to find out the cause of the accident, summarize experience and lessons, promote the healthy and secure development of the bolt net structure .

In this paper, exemplified by a certain factory building of Shanxi bolt-ball rack collapse as the research background, we will study the area of collapse network frame through the methods of field observation, deformation measurement, fracture analysis and sampling test, and analyze the failure process of the network frame, find out the accident reason finally. Main job:

- (1) Find out the key clues of the accident through the field observation and measurement, including the measurement of component size, the inspection of construction quality, the analysis of fracture macroscopic and the photos, etc. and retain the component samples from the collapse area.
- (2) Conduct the material test of the component, including mechanical properties test and chemical composition test, find out the changes in composition and property after 13 years, then determine the bolt fracture type of the high strength bolt.

Keywords— Bolted spherical joints, Stress concentration; Fatigue failure; space structure; Accident.

I. INTRODUCTION

Because special function and other reasons, more and more buildings in modern society require the structure to have a large span. In china, since the 2008 Beijing Olympic Games and 2010 Shanghai World Expo, the spatial structure has developed to a higher level, and the requirements for the space structure will be higher and higher, it is such a good opportunity to great promote the space structure of the country. With the progress and development of China, there are more and more high-standard large-span space structure in various regions, and various new forms and technologies are constantly applied. The technical level of china's space structure has also been continuously improved [1].

Among the many structure forms of space structure and steel structure, the grid structure is one of the most important traditional structure forms. It's a spatial structure composed of several members connected by nodes

according to certain grid form, which has the characteristics of high order statically indeterminate. The United States was the first to use the grid structure, which was only used in military buildings and facilities at the beginning, and gradually applied to various civil and industrial buildings after a period of time. The appearance of grid structure is simple and beautiful, and it has many advantages of steel structure, and the stress of each member is reasonable, so it is very suitable for the application of large-span structure. Since the late 1980s, China began to introduce relevant technologies and component processing technologies of grid structure, and widely used in practical projects. The cumulative projection area of grid structure in China has increased at a rate of about 900000m² every year, and its development and application in China can be described as fierce and rapid [2] [3].

In terms of the technical level and application scale of the grid structure, China has surpassed the United States, the birthplace of the grid structure, and has become the largest country in the grid structure. Now in our country, the grid structure can be seen everywhere, from canteen, storage room, stadium, large auditorium, conference hall, industrial workshop, etc., the application of grid structure is very wide. The first use of grid structure in China is the roof of a building in Shanghai Normal University. The building was built in 1964. The plane size of the grid is $40.5\text{ m} \times 31.5\text{ m}$, the members are made of angle steel, and the joint form is welded plate joint. The installation and construction of the grid structure marks the beginning of the application and development of China's space structure, and symbolizes the expansion of China's space structure technology Righteousness. After the introduction of the grid structure form, a lot of domestic research resources have been spent on the research and innovation of this structure form, and a new type of grid structure, welded hollow spherical joint grid, has been explored. Up to now, the bolt ball node grid structure and welded hollow ball node grid structure have become the two most important structural forms of the grid structure, and gradually become the two centers of the development of the grid structure. In terms of the use scale or technical level, the bolt ball grid has surpassed the latter and won the first place [4].

Bolt sphere grid is a kind of grid structure which uses welded steel pipe or seamless steel pipe as member, bolt sphere as node and high-strength bolt as connection. The bolt ball joint design is composed of a variety of components, including solid steel ball, hexagon socket, fastening screw, high-strength bolt, sealing plate or cone head, which can effectively connect the steel pipe members, not only ensure the strength, but also make the construction more convenient. The structure of bolt ball joint is shown in "Fig.1-1".



Fig. 1-1: The bolt-ball node joint

With the rapid development of bolt ball grid structure there are also some problems. The collapse accidents of bolt ball grid structure still occur frequently which needs to be paid more attention. The bolt ball grid structure is often used in stadiums, auditoriums, conference halls and other buildings where a large number of people gather, workshops such as warehouses and workshops where a large number of valuable instruments and equipment are stored, The allowable error rate is lower, the risk factor is higher, and there is no effective prediction method at present. Once the bolt ball grid collapses, it will not only cause heavy casualties, but also cause huge economic losses, which will pose a major threat to national property and people's life safety, the consequences are unimaginable, and the social impact is extremely bad [5]. Because of such a position, it is particularly important to conduct a more in-depth analysis and research on the bolt ball grid structure accident. Through scientific research to explore the root mechanism of the bolt ball grid structure accident starting from the design, construction, use. etc., comprehensively and objectively understand and analyze the problems existing in each link [6][7], and learn lessons from the lessons of experience, and then carry out more reasonable bolt ball grid frame design, formulate more complete specification, regulations and more effectively reduce the occurrence of bolt ball grid accidents.

II. RIVEW OF COLLAPSE ACCIDENT

Most of the failures with steel structures investigated are with key clues of the accident through the field observation and measurement, including the measurement of component size, the inspection of construction quality, the analysis of fracture macroscopic and the photos, etc.

Fatigue accidents and fatigue problems occur frequently at China and The world, many fatigue accidents occur in the flight, this has attracted the shock and high attention of all countries in the world, especially the aviation industry[8]. Some fatigue problems cannot be detected in time due to the appearance only, but in the long-term of flight and combat, there is fatigue of instruments and aircraft, it leads to sudden failure of functions in aviation operations, Causing major flight accidents [9]. For example, in 1985, jal-123 aircraft, in the rear of the aircraft pressure diaphragm metal fatigue failure, resulting in the fall.

Fatigue failure not only exists in aviation industry, but also poses potential threat to civil engineering, mechanical engineering, etc. For example, in March 1991, metal fatigue failure occurred in the steam tube of MEIHONG atomic power station in Japan [10]. September 1992, bolt

ball grid structure collapse due the large number of high-strength were broken in Shenzhen International Exhibition Center China [11]. November 1994, warehouse of Tianjin Carpet import and export company collapse of bolt ball grid structure in China [12]; In 1994 SHENGSHUI bridge, the central section collapse accident in South Korea [13]. In June 1998, the wheel metal fatigue of German high-speed train caused derailment [14]. On November 7, 2001, NANMEN bridge, known as "the first arch in Asia", located in YIBIN City, Sichuan Province, suffered fatigue fracture of its suspension cable and bridge deck [14]. On May 23, 2004, the collapse accident of 2E terminal in Paris Charles de Gaulle airport was due to the initial crack at the joint between the ceiling of the terminal and the circular steel structure pillar. Due to the long-term effect of the repeated load, the initial crack continued to expand, and the joint finally reached the critical size, resulting in sudden fatigue fracture [14]. July, 2005, the grid collapsed suddenly due to the fatigue failure in Inner Mongolia XIFENG Thermal Power Co., Ltd. China [15].

Fatigue problem was first put forward in 1829 by W.A.ALBERT, a German mining engineer, in the repeated loading test of welding chain for mine hoisting [16].

In 1839, French PONCELET first used the term fatigue.

In 1843, RANKINE, a Scottish physicist, encountered the first fatigue strength problem in railway transportation engineering, that is, the number of cycles of failure of Locomotive Axles under static failure load and repeated bending beam load is quite different, and the failure cycle times of crystal failure load can be as long as 4 years without failure, However, the number of failure cycles of the beams subjected to repeated bending 1000 time.

In 1961, Stuart et al. First introduced probability distribution into material fatigue limit in mechanical design.

At present, the American Society for testing and materials (ASTM) defines fatigue as follows: when a point or some points are subjected to torsional stress, and cracks or complete fracture are formed after enough cyclic action, the development process of local permanent structural change in materials is called "fatigue" [17].

The main mechanism of fatigue failure is as follows: there are various kinds of small defects in the process of steel production, processing and transportation. When the alternating load is applied on the component or structure, the stress distribution on the defective section is uneven, resulting in stress concentration. With the development of cracks, when the section is gradually weakened to resist the failure, the component will be destroyed [18][19].

III. ANALYSIS OF A TYPICAL STRUCTURE

The most serious of the collapse cases under service in terms of the consequences in the classification analysis of steel structure accident, personal losses and great economical losses. etc..

In this paper, exemplified by a certain factory building of SHANXI bolt-ball rack collapse as the research background, we will study the area of collapse network frame through the methods of field observation, deformation measurement, fracture analysis, sampling test, and analyze the failure process of the network frame to find out the accident reason finally. Main job:

(1) Find out the key clues of the accident through the field observation and measurement, including the measurement of component size, the inspection of construction quality the analysis of fracture macroscopic and the photos, etc. and retain the component samples from the collapse area.

(2) Conduct the material test of the component, including mechanical properties test and chemical composition test, find out the changes in composition and property after 13 years, then determine the bolt fracture type of the high strength bolt.

3.1 PROJECT OVERVIEW

A workshop was built in 2002. The main structure of the workshop building is reinforced concrete frame. The roof was adopts orthogonal square pyramid type bolt sphere grid with grid size of 3M×3M, the grid frame height of 3.0M, and a grid frame size of 62.8M×29.6M. The building project area is about 1859M², the building height is about 27M and two-way slope rise is 4%. The grid steel is Q235B high-frequency welded or seamless steel pipe with long axis direction around Each three bolt ball on the top chord of the edge are provided with a support. See "Fig.3-1 " for grid structure.

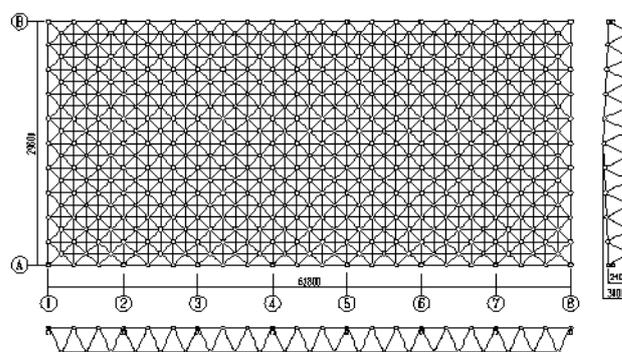


Fig. 3-1: Network frame structure diagram

3.2 THE ACCIDENT CONSEQUENCE ANALYSIS

On May 17, 2015, local collapse occurred in the southwest corner of the bolt ball grid roof of the plant, and the lower chord of some grid frames was bent greatly, See "Fig.3-2 "-"Fig.3-3 ". At night of May 20, the whole collapse occurred in three sections of a span on the west side of the bolt ball grid. See "Fig.3-4 "~"Fig.3-7 ". Some large equipment was damaged and no casualties were caused due to unmanned operation at night.



Fig. 3-2: Partial collapse.



Fig. 3-3: Lower chord bending



Fig. 3-4: The overall collapse



Fig. 3-5: The collapse of the scene



Fig. 3-6: The collapse of the scene



Fig. 3-7: The collapse of the scene

3.3 THE SITE INVESTIGATION

The on-the-spot investigation of the accident site is one of the important means to initially determine the cause of the accident, to understand the actual situation of the accident site and to find the key clues of the accident. After the collapse of the grid structure, we immediately informed the workshop to isolate the site of the accident for protection, and rushed to the accident site for a general survey. Through observation, we found that there are many problems with the bolt ball grid structure[20].

3.3.1 PRODUCTION PROBLEM

Through the observation of the bolt sphere grid structure in the area without collapse, it is found that some high-strength bolts connecting the web members are missing sleeve pins, but the outer skin is complete, as shown in Figure "Fig.3-8 ". It can be seen from the field photos that the pin is missing before painting. If the pin is missing before installation and the sleeve does not have the snap action of the pin, the high-strength bolt will not rotate and tighten with the sleeve during installation, it is likely that the high-strength bolt will not screw into the bolt ball or the screw in length is not enough, but it cannot be checked from the appearance, resulting in huge safety All hidden dangers. See "Fig.3-8"



Fig. 3-8: Bolt sleeve pin is missing

3.3.2 INSTALLATION PROBLEM

The M42 high-strength bolt connected to the diagonal web rod at the southwest corner of the grid frame has two rounds of ball thread. See "Fig.3-9 " the high-strength bolt out of the thread. This is caused by the slippage of the M42 high-strength bolt and the lower chord ball. The bolt ball grid has the problem of false bolts during the installation and construction, and the construction quality is not high, and the bolt ball grid is used by thousands of high-strength bolts. It is not excluded that other bolts also have the same problem, and the hidden danger is huge.



Fig. 3-9 M42 high-strength bolt out of the thread

3.3.3 DUST PROBLEM

The ash on the side of the bar and bolt ball is 1-3MM, with an average thickness of about 2MM. See "Fig.3-10" - "Fig.3-11" . This shows that the maintenance problem of the bolt ball grid in the daily use process has not attracted the attention of the user, and there is a management problem of long-term maintenance and troubleshooting, which makes the bolt ball grid unable to meet the durability of its original design, and it cannot be timely in case of structural problems It is found that there is a large potential safety hazard.



Fig. 3-10: Bar of formation



Fig. 3-11: Bolt ball formation

3.3.4 FATIGUE FAILURE

Through the observation of the accident site, it is found that the fracture surface of M33 high-strength bolt connecting the upper chord at the long axis of the southwest corner support of the grid structure shows a clear fatigue fracture morphology. See "Fig.3-12" - "Fig.3-13" which indicates that the bolt ball grid structure has fatigue problems, and the fatigue fracture belongs to brittle fracture, which can be the failure source of the grid structure collapse, so it needs to be paid attention to



Fig. 3-12: The bearing



Fig. 3-13: M33 high strength bolts fracture

IV. INDOOR TEST

4.1 CHEMICAL COMPOSITION TEST OF STEEL

The chemical composition has a great influence on the performance of steel. Now, on-site sampling is carried out for the collapsed grid structure of the workshop, and the chemical composition test is carried out for the steel pipe and bolt of the grid structure.

4.1.1. TEST CONTENT

a) The chemical composition of the steel pipe with a diameter of $\phi 60 \times 3.25$, $\phi 75.5 \times 3.5$, $\phi 114 \times 4$, $\phi 140 \times 4$, $\phi 159 \times 6$, and $\phi 159 \times 8$ was detected.

b) High strength bolt M20, M24, M27, M33, M36, M39, M48, M56, a total of eight specifications of chemical composition detection.

4.1.2. TEST CONCLUSION

In the original design drawing, the steel pipe material is Q235B, and the high-strength bolt material is 40Cr. The test results of carbon structural steel (GB / T700-1988), alloy structural steel (GB / T3077-1999), material certificate and accessories.

Through the comparative analysis of test result, the following conclusions are drawn.

a) The carbon content of the steel pipe with a diameter of 159×8 is 0.21%, which does not meet the requirement of 0.20%.

b) The carbon content of M20 high strength bolt is 0.46%, which does not meet the limit of 0.44% [20].

4.2 MECHANICAL PERFORMANCE TEST OF STEEL

At the same time of testing the chemical composition of steel, in order to further determine whether the material is qualified, we carried out mechanical performance tests on the steel pipe and high-strength bolts of the mesh frame.

4.2.1 TEST CONTENT

a) The chemical composition of the steel pipe with a diameter of $\phi 60 \times 3.25$, $\phi 75.5 \times 3.5$, $\phi 114 \times 4$, $\phi 140 \times 4$, $\phi 159 \times 6$, and $\phi 159 \times 8$ was detected.

b) High strength bolt M20, M24, M27, M33, M36, M39, M48, M56, a total of eight specifications of chemical composition detection.

4.2.2 TEST CONCLUSION

In the original design drawing, the steel pipe material is Q235B, and the high-strength bolt material is 40Cr. The test results of carbon structural steel (GB / T700-1988), alloy structural steel (GB / T3077-1999), material certificate and accessories.

Through the comparative analysis of test result, the following conclusions are drawn.

a) The tensile strength of steel pipe with four specifications, namely, $\phi 60 \times 3.25$, $\phi 77.5 \times 3.5$, $\phi 114 \times 4$ and $\phi 140 \times 4$, does not meet the requirements of the specification.

b) The yield strength of M48 high strength bolt does not meet the requirements of the specification.

4.3 OTHER PERFORMANCE TEST OF HE HIGH-STRENGTH BOLT

The high-strength bolts of the grid are produced by Shijiazhuang city Standard Parts II Plant, and the material is 40Cr. On the basis of testing the chemical composition and mechanical performance testing of high-strength bolts, in order to further determine whether the high-strength bolts are qualified, the other performance of the high-strength bolts of the grid is further tested. The test results are show : All indicators are qualified.[20]

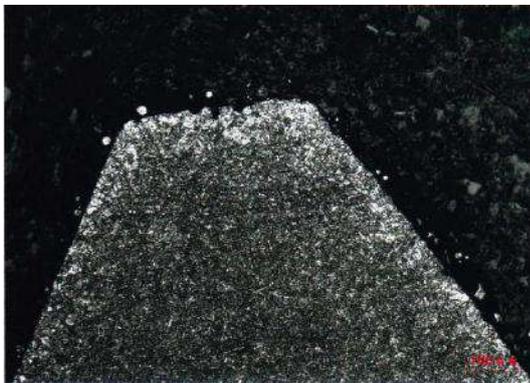


Fig. 4-1 Thread 1



Fig. 4-2 Thread 2

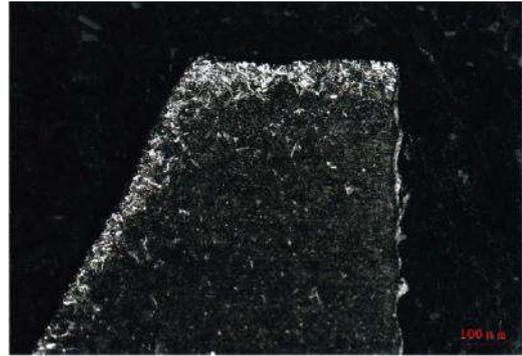


Fig. 4-3 Thread 3



Fig. 4-4 Thread 4



Fig. 4-5 Thread 5

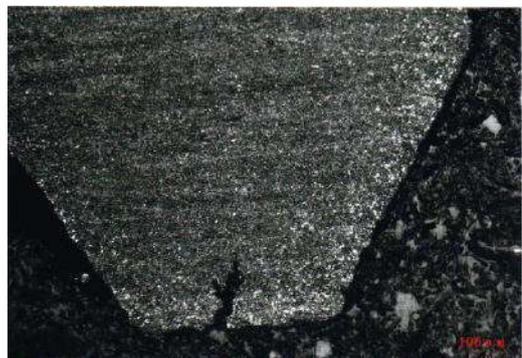


Fig. 4-6 Thread 6



Fig. 4-7 Thread 7

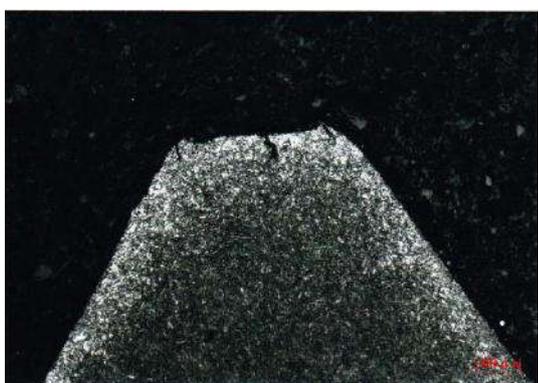


Fig. 4-8 Thread 8

4.4 FRACTURE ANALYSIS OF HIGH-STRENGTH BOLT

Fracture analysis is an important technical means to judge whether fatigue failure or not. Fracture analysis can be divided into macro analysis and micro analysis. Macro analysis of fracture can be used to determine the nature of fracture, such as ductile fracture and fatigue fracture. However, if we want to get more information, we must use the micro analysis method of fracture to observe, and we can see the details of fracture that cannot be seen in macro view under the micro level, which is very helpful to explore the formation and propagation mechanism of cracks [5]. According to the references and data, the fatigue fracture of high-strength bolt shows three different characteristics in the micro view, which are fatigue source area, expansion area and brittle fracture area.

4.4.1 FATIGUE SOURCE AREA

The fatigue source is most likely to occur in the place where the stress concentration is the most serious. For high strength bolt, the most serious place of stress concentration is the outermost thread where the high-strength bolt contacts with the bolt ball. The first thread near the head of the bolt and the intersection of the bolt rod

and the bolt head are also places where the stress concentration is more serious. In general, cracks begin to appear from the outside. If the fatigue fracture surface is observed by microscope, it can be found that the area of fatigue source area is far smaller than that of propagation area and brittle fracture area. There are a lot of shellfish lines in the area, and there are many black spots or patches. If there are such black spots in many areas, it means that there are more than one fatigue source area of the fracture. When the shell pattern of fatigue fracture is not obvious enough to be observed, we can find the position of fatigue source by observing radiation and fatigue fringe.

4.4.2 EXPANSION AREA

If the high-strength bolt is fatigue fracture, then the fracture surface of the bolt is bound to show a crack growth area. The fatigue source region is smoother, while the extended region is rough. The shellfish and fatigue stripes in the region are more obvious, so it is easier to observe. The shell line will extend from the fatigue source as the starting point, and its density can reflect the crack growth rate, and it is also an important judgment basis for the load form and stress concentration degree. When there are multiple fatigue sources, the cracks propagate in different curvature centers. When they meet in two different planes, steps or long tear edges are formed by shear or tearing. When the fatigue failure of high-strength bolt is variable amplitude fatigue failure, the characteristics of the fracture surface such as shell lines will show greater irregularity, in contrast, the fracture surface of the bolt with constant amplitude fatigue failure is more regular.

4.4.3 BRITTLE FRACTURE ZONE

When the crack size reaches a certain limit, the area of the propagation zone exceeds a certain limit, and the effective bearing section of the high-strength bolt is not enough to resist the external tensile force, the instantaneous brittle fracture of the high-strength bolt will occur. The instantaneous fracture zone often appears in the position opposite to the fatigue source area. Its roughness is the largest in the three regions, and the irregularity of its shape is the largest among the three regions. The appearance of brittle fracture zone is very similar to that of bolt fracture in static failure test. There are obvious radial or herringbone pattern in the middle plane strain area and shear lip in the edge plane stress area. The M33 high-strength bolt connecting the top chord of the grid angle support is taken for microscopic analysis of the fracture. After cleaning, rinsing and drying the fracture surface of M33 high strength bolt for inspection, it is placed in the scanning electron microscope for microscopic fracture

observation and micro analysis of fracture surface. See "Fig.4-9 " ~ "Fig.4-12 " for details.

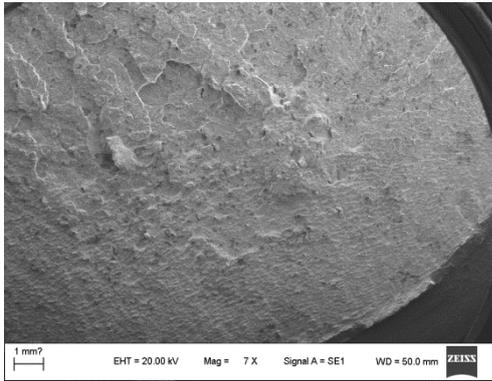


Fig. 4-9 The fracture morphology (7 times)

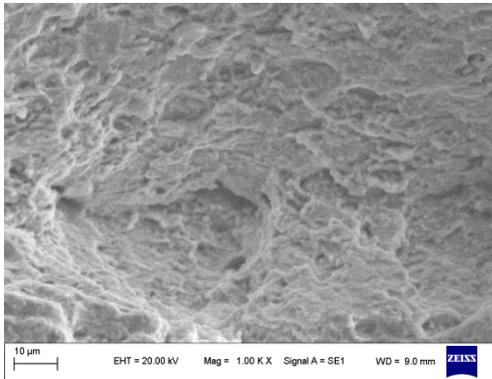


Fig. 4-10 Fatigue striations (1000 times)

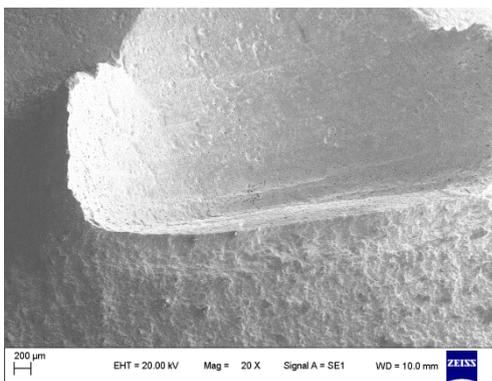


Fig. 4-11 Pin hole crack source (20 times)

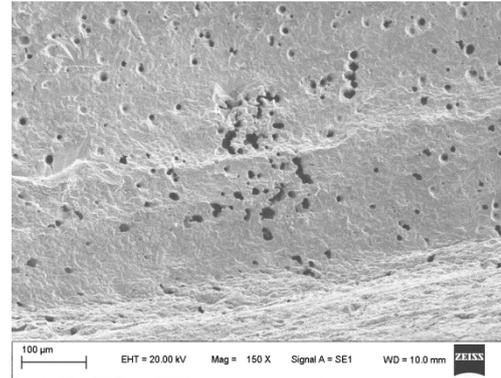


Fig.4-12 Pin hole inner surface pitting corrosion pit (150 times)

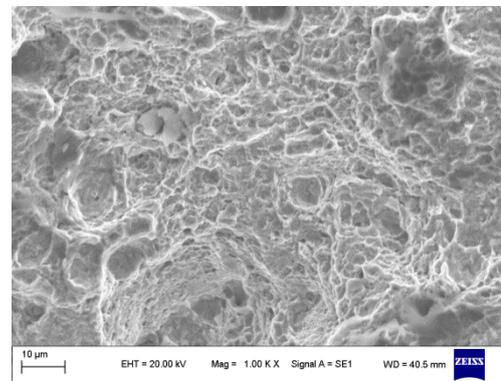


Fig. 4-13 Extension area morphology (1000 times)

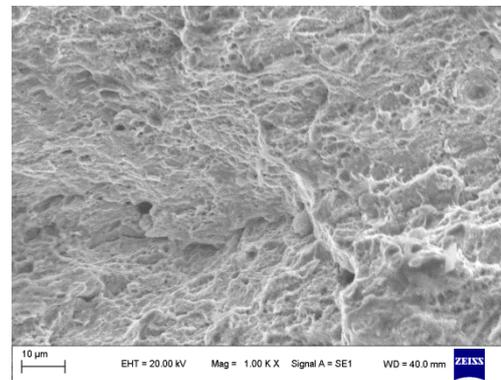


Fig.4-14 Transient breaking area morphology (1000 times)

The results show that the fracture morphology presents typical characteristics of fatigue source region, propagation region and instantaneous fracture zone. There are two fatigue source regions in the fracture. One is that the crack starts at the root of the thread, showing fracture dimple morphology and radiation striation morphology; the other is that the crack starts at the pin hole, and there are many corrosion pits on the inner surface of the pin hole;

there are secondary cracks in the propagation area of the fracture; the instantaneous fracture area of the fracture is a mixed fracture morphology. The fracture morphology is low cycle fatigue.

V. CONCLUSION

It is of great significance to study the causes of the accidents. In this paper, taking the collapse accident of a bolt sphere joint grid workshop as the research background, the causes of the accident are analyzed and explored through scientific and effective technical means such as field survey and software simulation. The conclusions are as follows:

(1) In the bolt sphere grid structure, the fatigue phenomenon of high-strength bolt often occurs on the bolt sphere grid with the suspension crane, while the bolt sphere grid without the suspension crane rarely has fatigue problem. Through this accident analysis and appraisal, it can be seen that when the suspension crane is not set under the bolt sphere grid, the fatigue failure of high-strength bolt may also occur, such as the wind load. Some factors will lead to bolt fatigue failure, which needs our attention [21-23].

(2) Through the analysis and research, it is found that the direct cause of the collapse accident of the bolt sphere joint grid workshop is: the accidental overload causes the low cycle fatigue fracture of the high-strength bolt. The indirect reason is that there is a problem of false tightening in the construction of high strength bolts. [20]

(3) Through the fatigue researcher it's found that the bolt in bolt grid structure need more researcher and more studies.

ACKNOWLEDGEMENTS

In this paper, a large number of technical means are used to identify the collapse accident of bolt sphere grid structure in a factory building. On the basis of sufficient data and in an objective, responsible and prudent manner, the failure source of the collapse accident of grid structure is finally determined, and the collapse process of grid structure is simulated by using the finite element analysis software. In the whole process of technical appraisal, the author found that the collapse accident of the bolt sphere grid is caused by multiple factors, and there are some problems in the design, construction and use process. Today, the application of bolt sphere space truss is more and more extensive. In order to make a contribution to the health and safety development of the industry, combined with the actual problems existing in the project, I would

like to put forward some suggestions with my own shallow views [24-25].

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Informational Flow Model: A case study in the textile and confection sector

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Abstract— Consumer-oriented companies are pressured to seek for constant innovations in short term for product launches. Thus, to become competitive, they use processes and tools that can qualify information for decision making. The objective of this study is to apply a reference model of information flow in small company in the textile and confection sector, to increase the responsiveness to product development teams and the commercial area. The methodological approach is qualitative, developed through the case study, characterizing it as of an applied nature. The results suggest the importance of seeking greater alignment of the commercial and marketing teams in product planning, providing a more comprehensive view of the activities and information channels that guide each element of Product Planning and Development (PPD).

Keywords— Product planning, Clothing Manufacturing, Information flow, Management model, Decision making.

I. INTRODUCTION

According to [10], in Brazil, the textile and clothing industry reached in 2016, 29,500 companies scenario with more than five (5) employees and 1.5 million direct jobs. Data from [11] shows that clothing manufacture in the state of Santa Catarina, except underwear, rose 7.6% and sales increased by 0.3% in the period between 2014 and 2017, including domestic and [7].

Consumer-oriented companies are pressed to meet their desires, including constant innovations in short delivery term and being a difference against competitors [12]. In addition, the offer of new products requires efficient processes and tools and therefore "a strong product development system is an essential skill core for success of any company dedicated to the consumer" [17]. In this context, according to [21], the monitoring of information originated within and outside organizations determine partly its competitiveness. From this, information can be defined as usable data, descriptions or inferences, supporting the organizational processes.

The need to organize and share information arises from the opportunity to guide the information flow [3], which is determined by activities network performed by certain number of people [18]. [22] define activity as the actual action to perform design task. On the above, we see the possibility of bringing together departmental efforts and focus on the design of an information flow able to answer

to product development teams and commercial area of the textile and clothing industry. In this sense, the use of a well-designed information flow between those involvements in the PDP is among the ways to achieve the optimization of time, which is essential in the clothing industry.

The methodology used in the design of information flow model in the product development for companies in the textile and clothing manufacture industry is guided by the deductive method, and are based also by a conceptual and theoretical framework [13]. The adopted approach is qualitative, through a case study of a small business in the state of Santa Catarina (Brazil). The adopted model is designed and implemented in a sequence of Steps comprising the respective Steps. In parallel, the case study draws an analogy between the information flow model built on the basis of the literature and information flow linked to the reality of company studied [13].

The selection of the case study took place in order to choose a company among those participating in South Santa Catarina Fashion Center (NMSC) in the city of Criciúma, Santa Catarina. The criterion was added by activities required to implementation according to the template such as: fashion planning; trends research and interaction between product team and commercial area.

In this context, the main features of the template are outlined. Next, the content analysis is presented of the implementation and the results thereof.

II. INFORMATIONAL FLOW TEMPLATE FOR TEXTILES AND CLOTHING MANUFACTURE COMPANIES (REFERENCE TEMPLATE)

Starting on the assumption that the information flow is given by mapping activities and the work processes to be reviewed in a continuous data transfer between sender and recipient through a transformation process and subsequent generation of knowledge, guided by the proposals by [18], [8], [15] and [6].

The steps and stages (Figure 1) are shown in flowchart, according to its performance logic, subject to feedback between steps. In Step 1, the strategic planning information are the inputs for product planning in its design phase, thus requiring to choose the business environment.

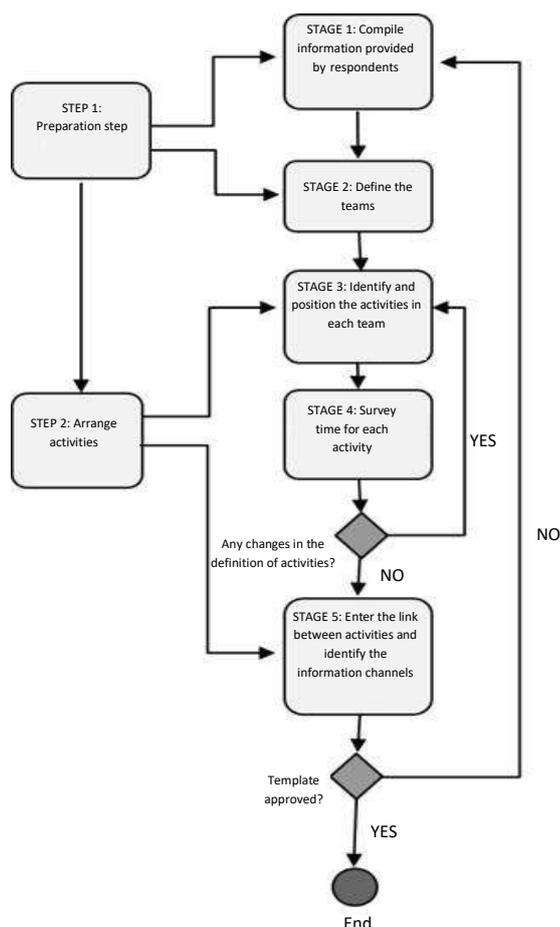


Fig. 1: Informational Flow for Textiles and Clothing Manufacture Industry (Reference Template)

Stage 1 is to know the reality of the organization, with brief history and its current moment, such as: which fashions worked by the company and which products set is developed and delivered at certain times of the year [20].

In the information flow template for product planning in companies in the textile and clothing marketing industry, teams composition (Stage 2) is used as identified by [16] in which five teams participate in the product planning: senior management; marketing; product team; commercial department and engineering. They can relate to external teams for activities involving product planning. We also have path structure extracted from [6] and [19].

In Step 2, using the assumptions by [18] and [6], both the organization, represented by people, and the structure of activities implemented by them in product planning should be considered in understanding the exchange of information. In Stage 3, we identify activities that each team developed and perform the survey of performance time of each activity in Stage 4.

The performance time of the activities related to product planning depends on a few strategic definitions of the company, as: number of fashions to be developed; if the sale is to wholesale or retail; and how much of its production depends on suppliers [2]. Before proceeding to the next Step, you should check if the activities require any changes. In the event of significant changes, return to the Stage 3; otherwise, the design of the activities could be made to be followed within the product planning and identification of communication channels (Stage 5).

To identify the types, sources and information channels, [8], [16] and [11] templates are used, highlighting the need to check which information is transmitted within the product planning. The Bizage software enables representing the information to be sent to the next activity with the data object symbolism and seek additional information in the data repository analyzed.

On the refinement of the proposed template (Figure 2), the survey of user(s)' data and their requirements are activities taking place together and generate information to build a Product Mix. The schedule allows guiding all product chain, requiring information access relating to the compilation of the resulting activities, i.e. from the commercial department and the product team. On definition of the Schedule, activities information are shared and set which shall be developed in the current fashion, as well as the dates on which they should be performed.

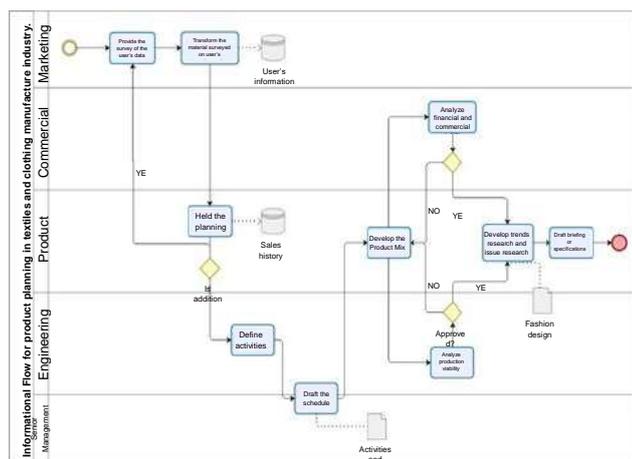


Fig. 2: Informational Flow for product planning in textiles and clothing manufacture industry

The communication channels, i.e. tools that people use for relationship contribute to the information flow framework, which should take place orally, in writing or electronically [5]. The communication channels between the activities should be sequential, such as e-mail, for example, or simultaneously as a meeting. If any extemporaneous need is found, return to the Stage 1, reviewing the other stages described for the appropriate adjustments.

III. IMPLAMENTATION OF REFERENCE TEMPLATE

3.1. Preparation Step

Data was collected in individual semi-structured interviews, following a predetermined script, in order to determine the current situation of the company, the scenario on the fashion planning, the type of each management activities set, the existence of management tools, information shared between teams and information channels. Therefore, individuals in the sample have been represented by general management, marketing, the product development and the commercial area. The interviews purpose convergent and different aspects were defined between the Reference Template and the reality of the company in order to represent a more consistent information flow on product planning.

Stage 1 or Preparation Stage aimed at contextualizing the respondent's opinion, representing the flow described in path by management. The X Brand and Y Brand recently acquired were selected, each with a designer responsible for the fashion design called designer A and designer B.

The initial focus of the interview with product and marketing manager was focused on the X Brand, considering that it can present a product planning with the most significant advances in respect to Y Brand. But on the contrary, it was found that the development processes are best designed in the Y Brand. Thus, the templates chose as the standards the best in each development in its the practices within their overlapping by co-existence of two brands.

The X Brand features two product categories: pieces of clothing (jackets, skirts, blouses, dresses) and accessories (handbags, belts and bags). In 2018, according to the product and marketing manager for X Brand three fashions were designed for pieces of clothing: 2018 Winter; 2018 high winter and 2019 summer. Six fashions were included for accessories in the women's segment and one fashion in the men's segment.

The Product Team for X Brand consists of: one product and marketing manager, responsible for the creative and marketing management; one owner of the company, which helps with the planning and development of products; one designer and one engineer, responsible for creating the pieces of clothing and accessories; and a pattern maker, whose assignment is to develop the molds for the pieces. The engineer is an outsourced professional who is responsible for the prototype of X Brand products and perform productive analysis, indicating the best manner to enable production and indicate the machinery to be used. The product Team for Y Brand also is under the management of the same product and marketing manager and includes a pattern maker. The productive viability of this brand is analyzed by the pattern maker, which draws upon her experience to decide.

The commercial area includes one manager, responsible for working with the commercial representatives in the wholesale and responsible for stores, and serving the retail. The latter also holds the shipping department's responsibilities, which controls the finished products for both brands.

In senior management, one administrative director is responsible for strategic planning together with the product and marketing manager, and both build the proposed scenarios for company's management.

To check the activities design that follow the Reference Template, presenting to each respondent a list, requesting to product and marketing manager to check to check if they were performed within the fashion management. The result of this sequence was:

- Survey consumer's data through the outcome of sale;

- Hold meeting for fashion framework:
- Check commercial viability (analysis of previous fashions);
- Specify consumer’s needs;
- Develop the Product Mix;
- Prepare schedule, survey trends, research raw material;
- Research the issue;
- Draft briefing or specifications of fashion.

Noting that, even before a planning meeting, there is a data survey of consumption and sales outcomes through the company's ERP system with an analysis by the commercial area that highlights the existing market opportunities. In Table 1 the information is specified and sources of collection described the product and marketing manager; the most used communication channels are e-mails and meetings. Before you start formatting your article, write and save the contents as a separate text file.

Table.1: Types and sources of information

Types of information	Sources of information
Consumer’s data (outcome of sale)	Report via ERP system, feedback from representatives and storeowners.
Growth calculation designed by the company, number of pieces of each type or gender of each compose the Product Mix.	Planning Meeting
Previous dates and corresponding activities	Schedule
Trends, theme and raw materials	WGSN, internet, international travel, suppliers

When considering that the commercial area is in contact with both the end customer and storeowners, commercial manager considers it important his attendance to planning meetings. However, as to the development schedule of the fashions, he does not have a specific follow-up tool for development of fashions.

The survey of consumer’s data and product specifications (size, color, model etc.) is frequent, while the planning meeting is held once every new fashion. It is noted that the commercial manager has a more specific view of the area in which he acts, i.e. the activities are restricted to the object of interest in the area.

The sales report is also a rich source of information to understand the performance of the products sales, so it is discussed in detail in the planning meetings. The stores selling the X and Y Brands are an important source of information for the success of a product or fashion relating to expected sales percentage. The main communication channels used in this interface by the commercial manager are: WhatsApp; onsite meeting; telephone call and e-mail (less common).

According to the managing director, Brand X works with two product categories: the first is pieces of clothing, the second is accessories. Two fashions are released for pieces of clothing: one for winter in which 35 (thirty-five) to 40 (forty) pieces are designed, mainly jackets; and one for summer in which pieces like skirts and dresses are designed, an average of fifteen (15) to twenty (20) pieces.

For Y Brand also according to the managing director, two fashions are released: winter and summer, with forty (40) to fifty (50) types of pieces varying the amount of reference from hundred (100) to two hundred (200) introducing pieces with different patterns in the same type of piece. Owning the stores, both the wholesale and retail, complements for fashions should be released, i.e., new pieces, according to the sales in each store, adding recent trends (novelty, details).

The managing director further describes that in addition to internal staff, some representatives of fashion centers, business owners of the clothing industry in the region and some suppliers are involved with the product planning. Consumer’s data is surveyed raised through the analysis of sales performance for the previous year by representatives and sellers, which are transmitted via e-mail or by the WhatsApp application. Next, based on this information and aiming at the market, specificities are determined for the pieces; according also to the identity of each Brand, the Product Mix is designed after a planning meeting that sets each fashion. The Schedule is developed and controlled by the use of Excel spreadsheets as to the identification of the types and sources of information transmitted. The trend research still uses international travel, suppliers’ feelings and blogs consultation via web, in addition to the research on issue.

The product development environment being set, we follows to Stage 2.

3.2. Stage 2 - Arrange the Activities

According to the Reference Template, the activities are listed for product Planning in charge of the involved teams (7, 24). The commercial manager presents activities relating specifically to his scope: survey of consumer’s data through access to feedback from stores’ employees and representatives. However, in the reference template, such activity should be performed by the marketing team, which performs it using business information that allow the understanding of consumer’s habits and result in the building of consumption profiles, based on a closer look at the consumer’s behavior [1].

As for the opinion by the managing director and product and marketing manager, an alignment is noted on activities allocated in product planning, except for materials research, which feasibility of use, according to the reference template, should be adjusted in the product planning, which does not happen in fact in the fashion design in the company.

According to product and marketing manager, the schedule is drafted by him and approved in the strategic meeting by internal teams and for the managing director, internal teams jointly draft it. Defining the activities, sequence and schedule, according to [23] and [16], should be under the liability of engineering and senior management, in order to guide the entire chain of the product.

It is appropriate to highlight the importance we all attribute to planning meetings, which sets the guidelines for fashions, develops the design of Product Mix of Brands and define the research trends and themes, and compiling at the end the briefing and the specifications set.

The time required for each activity would only be established through actual follow-up of an entire fashion. As to the understanding on the activities taking place within the company, attention is drawn to the amount of fashions and the release dates of each. According to the product and marketing team manager, X Brand has seven series of accessories and three series of clothes. The accessory line of X Branch, considering two of the seven series, holds a planning meeting in January and the closing schedule in the same month, and research on trends and materials in September and another in October which is released in March and in April.

The X Brand also releases two series. Owing the retail stores, it is possible to introduce new pieces to the fashions, taking into account percentage of reported sales.

The approximate time being determined on the perspective of each respondent, the difference is

determined. This reinforces the importance of a broad understanding of information flow and how it can guide the implementation of the mentioned activities, and using the Reference Template, reach a sequential standardization and a broad understanding of management responsibilities within the product planning.

The manager of product and marketing team and the managing director were presented the activities related to product planning, according to the Reference Template, in order to obtain a comparison against the flow defined by the management teams. The outcome is in Table 2.

Table.2: Activities by order of performance of the X and Y brands

Managing Director	Product and Marketing Manager	Reference Template
1. Schedule;	1. Planning meeting;	1. Survey user’s data;
2. Research trends;	- Survey consumer’s data and sale outcomes;	2. Transform the material surveyed on user’s requirements;
3. Research the issue;	- Commercial viability (analysis of the previous fashions);	3. Held the planning meeting;
4. Survey consumer’s data	- Specify consumer’s needs;	4. Define activities and sequence and draft schedule;
5. Specify consumer’s needs;	- Product Mix;	5. Check the productive viability;
6. Planning Meeting;	2. Schedule;	6. Check the financial (economic) viability and commercial;
7. Product Mix;	3. Meeting strategy	7. Develop the Product Mix;
8. Briefing or specifications of fashion.	4. Research trends;	8. Research trends and theme;
	5. Research raw material;	9. Draft briefing or specifications.
	6. Research the issue;	
	7. Briefing.	

IV. FINAL CONSIDERATIONS AND CONCLUSION

The study showed, by applying the Reference Template, the universe researched requires further alignment of product planning teams. As seen in Table 2 and in opinion of the research subjects, key decision makers lack information, even if compiled for the PDP. It is understood that all organization is basically composed by communication processes, with the dissemination of information involving seeing different groups of people [6]. In product planning, the information flow is based on two pillars: the understanding of customer's needs and identification and anticipation of market trends. Customer requirements (Customer Requirement - CRs) according to [24], have an important role in the PDP, particularly in the product design phase. Noting that the process in the studied company is supplied by different sources, but the subjectivity of interpretation by the managing person. Competitive tools should be created to the acquisition, organization and information in the current market [3], provided that such processes are guided by coherent and concise information flow.

The first pillar of an information flow is a survey of consumer data. Such activity is carried out under the management of commercial manager through feedback received from employees of the area, also including the sales results via ERP system considered not to be fully integrated into the PDP, by the lack of that manager's concern to store and record such information (see Table 2), which corroborates the statement by [25], that the Knowledge Management (KM) in small and medium-sized companies is guided by a lack of planning and informality.

As for the productive viability to [23], [16] and [8], this is on the engineering team's liability. It appears that the technical feasibility of company production is deemed completed after making the first piece (pilot piece), which contrasts with the Reference Template: on the absence of employees skilled in such activities, the analysis are carried out with based only on the professional experience of product planning teams.

It should be noted that the reality of a family business, in the case described, contains an imperative of informal control methods resulting from the accumulation of practical experience of the owners and employees according to [4].

Important to remember that informal decision systems can be useful in some stages of the life cycle of companies; however, the increase in business volume and complexity from acting in different markets require the introduction of better defined processes. According to [14], some

characteristics contribute to the non-standardization of information flow particular to this niche of companies such as short term strategies limited resources; and centralized management, accounting obstacles to the product innovation process [9]. As an alternative to this centralizing perspective of the decisions on the PDP, it is suggested the cooperation of external agents (by apparent proximity of the company with its market), so that the design of information flow can use the full potential of knowledge it can produce.

Moreover, it is observed that the marketing model in wholesale and retail of company enables real-time acquisition of a diversity of information from the perspective of their sales representatives and stores. Therefore, it is suggested the strengthening of relations between the commercial area with its market activities (marketing), and the initiatives of creation core institution together with customers in order to sustain a significant external interaction channel for more assertive development of products, according to suggestions by [1].

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The effect of shielding gases in the Ferrite Number of austenitic stainless steels joints through GMAW

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Abstract— In order to better understanding the effect of shielding gases in the volume fraction of δ ferrite in welded deposits through GMAW, the microstructures of four welded joints of austenitic stainless steel produced by the MIG/MAG process with different shielding gases were studied. The deposits were produced using the same welding electrode ER309L and welding parameters, but different shielding gases from pure argon to mixtures with increasing contents of CO_2 . Each of the welding deposits were produced with 100% Ar, Ar+2% CO_2 , Ar+4% CO_2 and Ar+20% CO_2 . The chemical compositions and the variation of the volume fractions of δ ferrite in the deposits was measured. There was an increasing pickup of carbon and decreasing volume fraction of δ ferrite in the all weld metals produced using shielding gases with increasing concentrations of CO_2 . The results confirm that carbon is a strong austenite stabilizer in austenitic stainless steels. Complementary techniques of microstructural analysis were used, such as optical emission spectrometry, optical microscopy and quantitative image analysis.

Keywords— Austenitic Stainless Steels; Solidification Mode; Ferrite Number; GMAW.

I. INTRODUCTION

In addition to iron, chromium and nickel, stainless steels have other chemical elements in their composition that can stabilize ferrite and austenite. Schaeffler [1] grouped these elements into two expressions called chromium equivalent and nickel equivalent, respectively, and proposed a diagram that is shown in Figure 1, considering the ferritizing and austenitizing effects of different alloying elements.

The Schaeffler diagram is not an equilibrium diagram. It was determined experimentally in order to predict the δ ferrite content in stainless steel welds.[2,3]

$$\text{Creq} = \% \text{Cr} + \% \text{Mo} + 1.5\% \text{Si} + 0.5\% \text{Nb}$$

(Equation 1)

$$\text{Nieq} = \% \text{Ni} + 0.5\% \text{Mn} + 30\% \text{C}$$

(Equation 2)

In addition to the expressions of chromium and nickel equivalent proposed by Schaeffler, several other expressions have been suggested in the literature incorporating other elements, using other solidification conditions and different chemical compositions. [2-11]

In welding of high alloy steels, the δ ferrite content is normally estimated from the constitution diagrams such as the Schaeffler[1], DeLong [6] and Kotechi[11].

In these diagrams, the ferrite contents of various welds had been measured experimentally by either metallography (Schaeffler) or magnetic methods (DeLong and WRC-92).[12]

From the Schaeffler diagram, the first striking change was made by DeLong [6], which includes the austenitizing effect of nitrogen in the nickel equivalent formula and proposed a diagram that is shown in Figure 2.

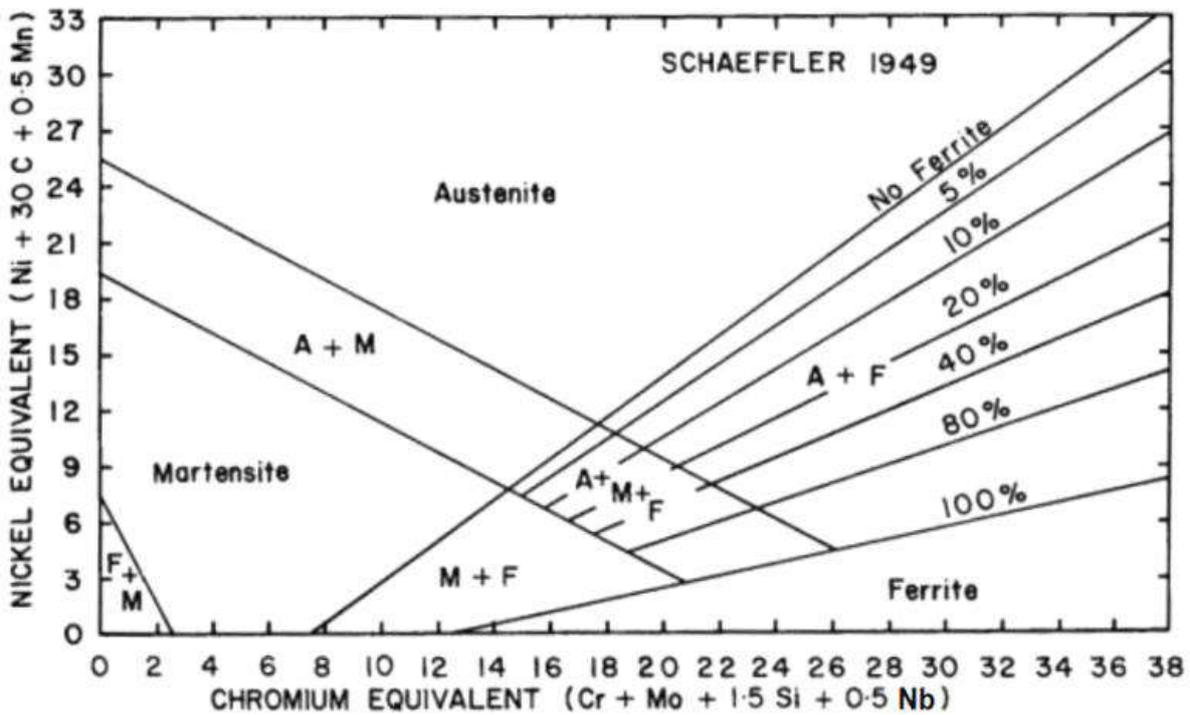


Fig.1: Schaeffler Diagram. [1]

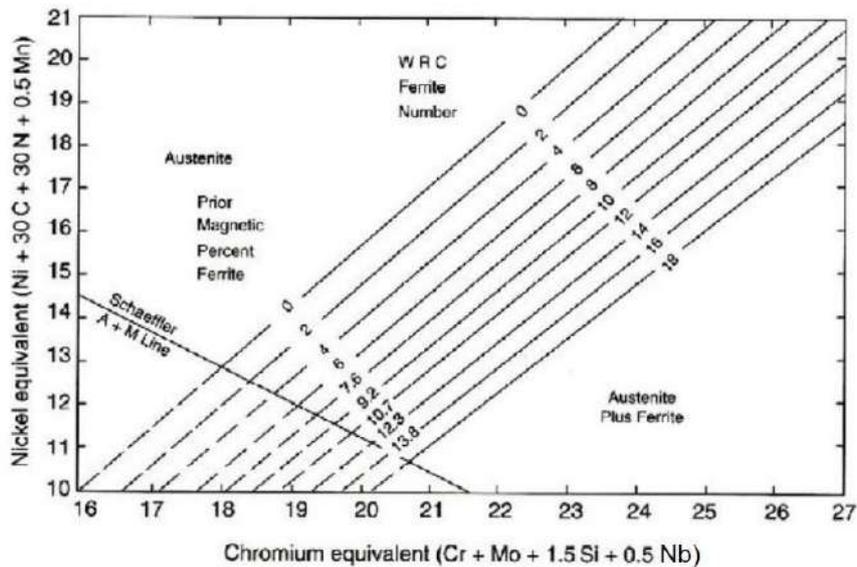


Fig.2: DeLong Diagram.[6]

O. Hammar and U. Svensson[4] showed that the addition of carbon and nitrogen decreases the volumetric fraction of ferrite in austenitic stainless steels. Taking as an example the austenitic stainless steel of type AISI 316, which usually solidifies through a ferritic-austenitic solidification mode. With the increasing of carbon and nitrogen contents as alloying elements, the solidification mode changes to

austenitic-ferritic. There is, therefore, a carbon equivalent value that can change how this steel solidifies.

$$C_{eq} = \% C + 0.65\% N \quad \text{(Equation 3)}$$

Figure 3 shows the variation of the volume fraction of primary δ ferrite as a function of carbon equivalent.

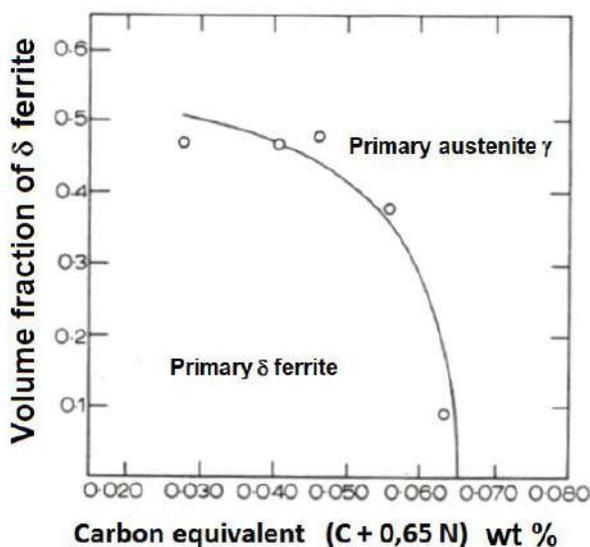


Fig.3: Volume fraction of δ ferrite as a function of C_{eq} . [2,4]

The WRC – 92 diagram estimates the ferrite content to reasonably good accuracy and also provides additional information about the solidification mode as shown on figure 4.[12]

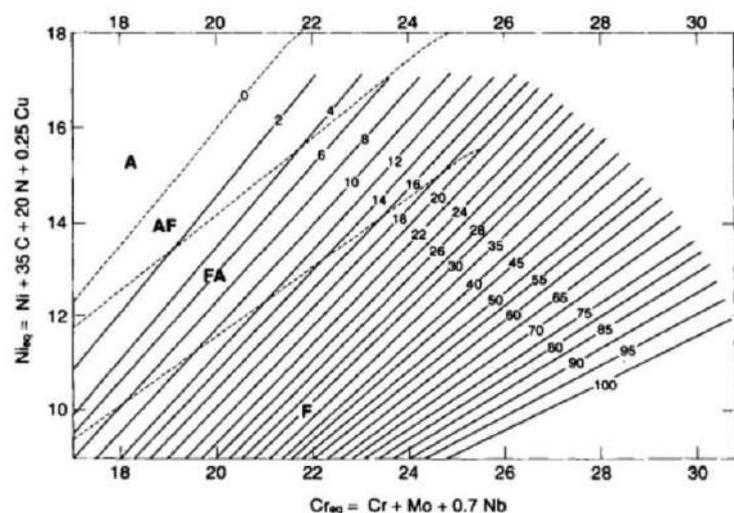


Fig.4: WRC-92 Diagram.[11]

Kotechi[11] has pointed out that there are number of alloying elements that have not been considered in the most accurate diagram to date, the WRC – 92 diagram. Elements like silicon, titanium, tungsten are not given due considerations though they are known to influence the ferrite content. He also stressed the point that cooling rate effects need to be considered more thoroughly in these constitution diagrams.[12]

Table1 shows the expressions of chromium and nickel equivalents proposed by Schaeffler[1], DeLong [6] and Kotechi[11].

Table 1 - Cr_{eq} and Ni_{eq} formulae used for estimating the delta-ferrite content from constitution diagrams[12]

Constitution Diagram	
Schaeffler Diagram (1949)	$Cr_{eq} = Cr + Mo + 1.5xSi + 0.5xNb$
	$Ni_{eq} = Ni + 30xC + 0.5xMn$
DeLong Diagram (1973)	$Cr_{eq} = Cr + Mo + 1.5xSi + 0.5xNb$
	$Ni_{eq} = Ni + 30xC + 30xN + 0.5xMn$
WRC-92 Diagram (1992)	$Cr_{eq} = Cr + Mo + 0.7xNb$
	$Ni_{eq} = Ni + 35xC + 20xN + 0.25xCu$

When the Cr_{eq}/Ni_{eq} ratio < 1.5 , the solidification may be austenitic (mode I) or austenitic-ferritic (mode II). When the ratio $1.5 < Cr_{eq}/Ni_{eq} < 2.0$ the solidification will be ferritic-austenitic (mode III). And finally, when Cr_{eq}/Ni_{eq} ratio > 2.0 the solidification will be ferritic (mode IV).[2,3,13-15]

The possible solidification modes in the Fe-Cr-Ni system are:

- I) Austenitic solidification ($L \rightarrow L + \gamma \rightarrow \gamma$):
The only solid phase to form is austenite. In austenitic solidification, called solidification mode I, there is no other phase transformation at high temperature.[2-3]
- II) Austenitic-ferritic solidification ($L \rightarrow L + \gamma \rightarrow L + \gamma + \delta \rightarrow \gamma + \delta$):

Austenite solidifies as a primary phase in a dendritic or cellular way. As the temperature decreases, ferrite δ is formed from the remaining liquid. Solidification occurs through a peritectic reaction ($L+\delta\rightarrow\gamma$). This is called solidification mode II. [13-15]

III) Ferritic-austenitic solidification
($L\rightarrow L+\delta\rightarrow L+\delta+\gamma\rightarrow\delta+\gamma$):

The duplex stainless steels solidify according to ferritic-austenitic solidification ($L\rightarrow L+\delta\rightarrow L+\delta+\gamma\rightarrow\delta+\gamma$). δ ferrite solidifies as the primary phase in dendritic or cellular fashion. As temperature decreases, austenite is formed by a peritectic ($L+\delta\rightarrow\gamma$) or eutectic ($L\rightarrow\delta+\gamma$) reaction. In the case of a peritectic reaction, the initially formed austenite completely surrounds the ferrite and subsequently grows into ferrite and liquid. Depending on the rate of diffusion through the austenite, the reaction may or may not be complete, and at the end of the solidification ferrite may be involved in austenite. Between the two reactions - peritectic and eutectic - the transition takes place where, during the initial formation of austenite by peritectic reaction,

ferritizing elements secrete to the liquid, provoking their enrichment in these elements and consequently the simultaneous formation of ferrite and austenite by means of a eutectic reaction. This is called solidification mode III.[13-21]

IV) Ferritic solidification ($L\rightarrow L+\delta\rightarrow\delta$):

The only solid phase to form is ferrite. In ferritic solidification, called solidification mode IV, ferrite is the only phase to form during solidification and, depending on the chemical composition, austenite can precipitate only in the solid state in the ferritic grain boundaries.[2,3]

The solidifications of austenitic stainless steels can occur according to the first three solidification modes. Depending on the conditions of solidification, the factors for the elements in the expressions of chromium and nickel can vary widely and some elements that do not influence the expressions, depending on the process, can be important when dealing with different solidification modes.

Table 2 shows the expressions of chromium and nickel equivalents suggested by different researchers, considering different production process of stainless steels.

Table.2: Expressions of Cr_{eq} and Ni_{eq} suggested by different researchers. [2, 19]

Author	Schaeffler	DeLong	Pryce e Andrews (1)	Giraldeng	Potak e Sagalevich apud Hull	Hull (2)	Hammar e Svensson
Production Process	Welding	Welding	Hot Rolling	Casting	Casting	Gravity Casting	Thermal Analysis
Ferritizing Alloying Elements	Cr	1,00	1,00	1,00	1,00	1,00	1,00
	Mo	1,00	1,00	1,00	2,00	1,00	1,21
	Si	1,50	1,50	3,00	1,50	2,00	0,48
	Nb	0,50	0,50	4 Nb'	-	0,90	0,14
	Ti	-	-	10 Ti'	4,00	4,00	2,20
	W	-	-	-	-	0,50	0,72
	V	-	-	-	-	1,50	2,27
	Al	-	-	-	3,00	4,00	2,48
	Ta	-	-	-	-	-	0,21
Austenitizing Alloying Elements	Ni	1,00	1,00	1,00	1,00	1,00	1,00
	Mn	0,50	0,50	0,50	-	0,50	Mn'
	C	30,00	30,00	21,00	30,00	27,00	24,50
	N	-	30,00	11,50	20,00	27,00	18,40

Cu	-	-	0,44	-	0,33	0,44	1,00
Co	-	-	-	-	0,40	0,41	-

(1) $Nb' = Nb - 8x[(C-0,03)+N]$ and $Ti' = Ti - 4x[(C-0,03)+N]$

(2) $Mn' = 0,11xMn - 0,0086xMn^2$

II. EXPERIMENTAL

Four welded joints of austenitic stainless steel produced by the MIG/MAG process with different shielding gases were studied. The deposits were produced using the same welding electrode ER309L1,2 mm according to AWS 5.9, and welding parameters, but different shielding gases from pure argon to mixtures with increasing contents of CO₂. Each of the welding deposits were called sample 1, sample 2, sample 3 and sample 4 and produced, respectively, using 100% Ar, Ar+2% CO₂, Ar+4% CO₂ and Ar+20% CO₂, as the shielding gases. The GMAW welding machine was adjusted to allow a stable welding for the four shielding gases.

After adjustment of optimum welding parameters to have arc stability with the different shielding gases, an automatic welding tractor was used to guarantee the correct travel speeds to have similar heat inputs for all the four samples.

In order to minimize the effect of base metal chemical composition, 6 layers of 5 beads each were deposited. Overlapping passes were used, depositing approximately 25 mm on the base metal that was an AISI 304L type stainless steel. The weld pads were cut in longitudinal and transversal directions. Chemical analyzes

were carried out in all samples at 20 mm from the base metal, by means of an optical emission spectrometer, according to ASTM E 1086-08. [22]

Afterwards, the samples transversal and longitudinal samples were embedded in hot-cure resin (bakelite). The conventional manual polishing was applied using water slicks (100, 240, 320, 400, 600 and 1000 mesh) in order to standardize the surface finish of the samples. A cloth polishing with 9, 3 and 1 μm diamond abrasive paste was carried out in this sequence. The samples were electrolytically attacked in 20% NaOH solution, 6V, for 90 seconds. This allowed the microstructural characterization of the samples through optical microscopy. The quantitative metallographic analysis for the determination of volumetric fractions of δ ferrite and austenite were performed according to ASTM E 562 ed. 08, [23] using a 4X5 grid (20 points) with a magnification of 400X in 30 different regions per test piece.

III. RESULTS AND DISCUSSION

Table 3 presents the welding parameters used to weld the samples. It is important to emphasize that the welding wire used to produce samples 1, 2, 3 and 4 was the ER309L according to AWS 5.9, 1.2 mm diameter.

Table.3: Welding parameters.

	Shielding gas	Flow (l/min)	Current (A)	Tension (V)	Driving Speed (mm/min)	Heat Input (kJ/mm)
Sample 1	Ar	20	199	26	230	1.35
Sample 2	Ar + 2% CO ₂	20	216	27	261	1.34
Sample 3	Ar + 4% CO ₂	20	210	26	243	1.35
Sample 4	Ar + 20% CO ₂	20	200	27	237	1.37

Table 4 presents the chemical compositions and the calculations of C_{eq}, according to O. Hammar and U. Svensson[4], of the filler metal and the all weld metals of the four joints. It is important to emphasize that the chemical analyzes were carried out in all samples at 20 mm from the base metal.

The calculations of C_{eq} were done using Equation 3.

Table.4: Chemical compositions and the calculations of C_{eq}

	C	Si	Mn	P	S	Cr	Ni	Mo	Cu	N	C_{eq}
309L	0.017	0.48	1.77	0.016	0.015	24.23	12.91	0.05	0.06	0.071	0.063
Sample 1	0.014	0.46	1.69	0.016	0.015	23.33	13.09	0.05	0.06	0.072	0.061
Sample 2	0.017	0.44	1.62	0.016	0.015	23.30	13.11	0.05	0.05	0.069	0.062
Sample 3	0.018	0.42	1.55	0.016	0.015	23.30	13.10	0.05	0.05	0.068	0.062
Sample 4	0.023	0.41	1.52	0.016	0.015	23.23	13.11	0.05	0.05	0.068	0.067

Table 5 presents the calculated values Cr_{eq} , Ni_{eq} and Cr_{eq}/Ni_{eq} ratio according to the expressions of chromium and nickel equivalents proposed by Schaeffler[1], DeLong [6] and Kotechi[11]. The calculations of Cr_{eq} , Ni_{eq} and Cr_{eq}/Ni_{eq} ratio were done using formulas taken from Table 1.

Table.5: Cr_{eq} , Ni_{eq} and Cr_{eq}/Ni_{eq} ratio according to the expressions of chromium and nickel equivalents proposed by Schaeffler, DeLong and Kotechi.

	Schaeffler Diagram (1949)			DeLong Diagram (1973)			WRC-92 Diagram (1992)		
	Cr_{eq}	Ni_{eq}	Cr_{eq}/Ni_{eq}	Cr_{eq}	Ni_{eq}	Cr_{eq}/Ni_{eq}	Cr_{eq}	Ni_{eq}	Cr_{eq}/Ni_{eq}
309L	24.95	14.31	1.74	24.95	16.43	1.52	24.28	14.94	1.63
Sample 1	24.01	14.38	1.67	24.01	16.53	1.45	23.38	15.06	1.55
Sample 2	23.96	14.44	1.66	23.96	16.52	1.45	23.35	15.12	1.54
Sample 3	23.93	14.41	1.66	23.93	16.44	1.46	23.35	15.10	1.55
Sample 4	23.85	14.57	1.64	23.85	16.60	1.44	23.28	15.29	1.52

The results presented on table 4 and 5, show that increasing the concentration of CO_2 in the shielding gases increases the concentration of C in the deposited metal. The results obtained suggest that with an increase in the concentration of CO_2 in the shielding gases, a decrease in the Cr_{eq} of the alloys occurs due to the selective oxidation of the elements Cr and Si. Figure 5 shows the contents of C, Si, Mn and Cr (% by weight) of filler metal ER 309L and welded chemical pads.

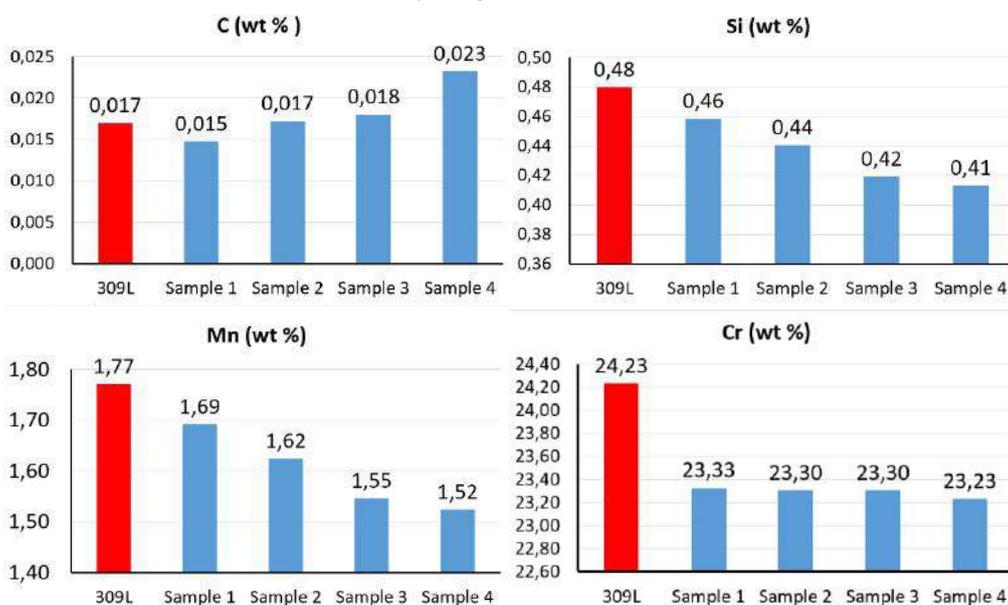


Fig.5: Contents of C, Si, Mn and Cr (% by weight) of filler metal ER 309L and chemical pads welded.

Despite the selective oxidation of Mn, the observed trend is of increasing of the Ni_{eq} . Figure 6 shows the variations of the Cr_{eq} and Ni_{eq} values (% by weight) and the Cr_{eq}/Ni_{eq} ratio of the filler metal ER 309L and the welded chemical pads according to the expressions of chromium and nickel equivalents proposed by Schaeffler, DeLongand Kotechi.

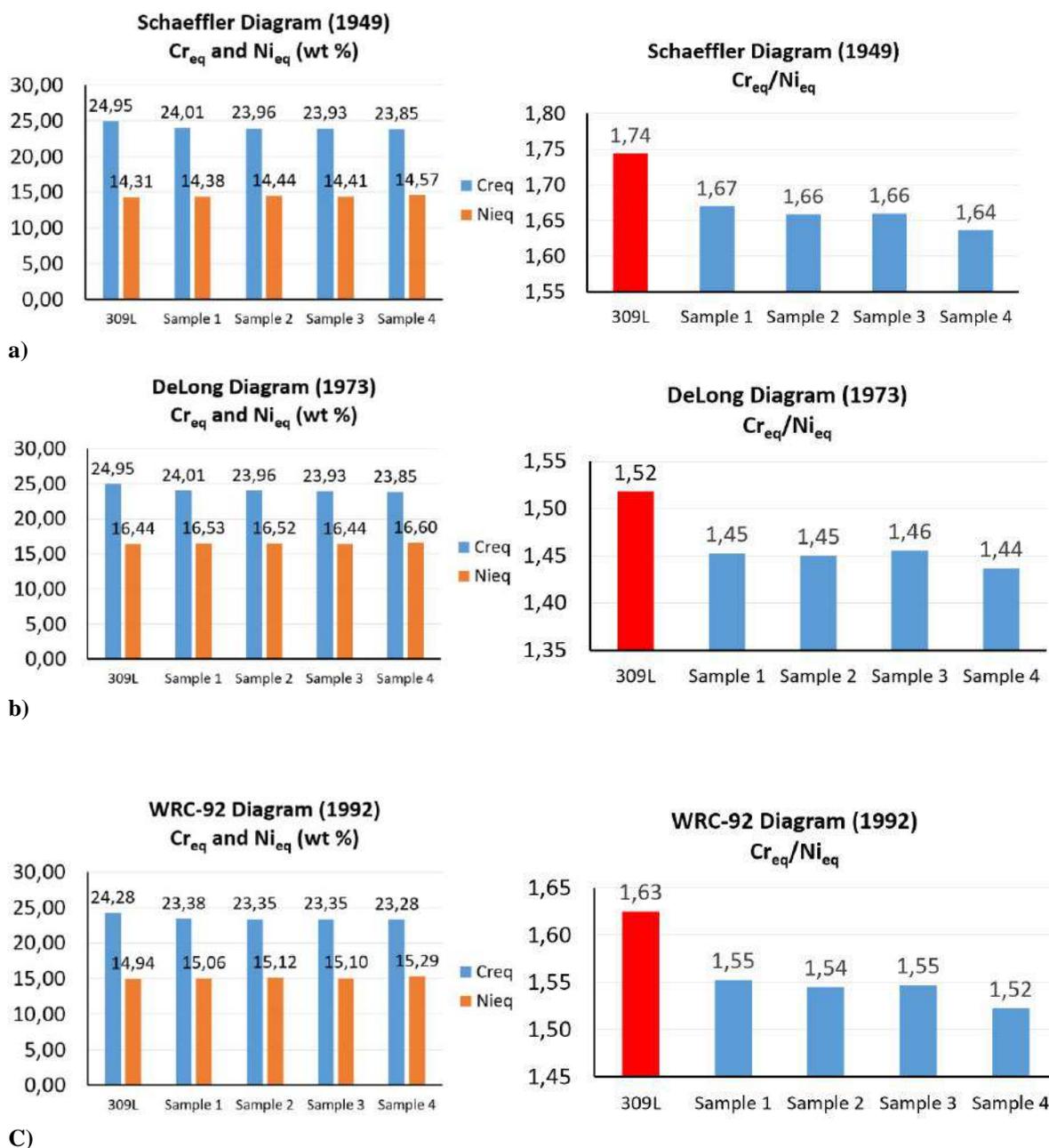


Fig.6: Cr_{eq} and Ni_{eq} values (% by weight) and the Cr_{eq}/Ni_{eq} ratio of the filler metal ER 309L and the welded chemical pads according to the expressions of chromium and nickel equivalents proposed by: a) Schaeffler, b) DeLongand c) Kotechi.

Table 6 presents the volume fractions of δ ferrite measured through metallographic analysis in 30 different regions per test piece.

Table.6: Volume fractions of δ ferrite measured optical microscopy.

Volume fraction of δ ferrite	Mean	95%CI	%RA
Sample 1 Transversal	13,1	1,5	13,6
Sample 1 Longitudinal	10,4	1,7	16,2
Sample 1 - Average	11,2	1,8	17,6
Sample 2 Transversal	12,6	1,3	13,3
Sample 2 Longitudinal	9,5	1,2	11,2
Sample 2 - Average	10,7	1,6	18,6
Sample 3 Transversal	11,5	1,5	18,5
Sample 3 Longitudinal	8,7	1,3	11,2
Sample 3 - Average	10,4	1,5	17,3
Sample 4 Transversal	10,9	0,9	13,2
Sample 4 Longitudinal	8,3	1,2	12,6
Sample 4 - Average	9,9	1,6	19,3

Figure 7 shows the micrographs obtained approximately 20 mm from the base metal in the transversal direction of the welded specimens.

Metallographic analysis revealed austenitic-ferritic microstructures for all welded specimens, with austenite being the light phase and ferrite being the dark phase in the grain boundaries.

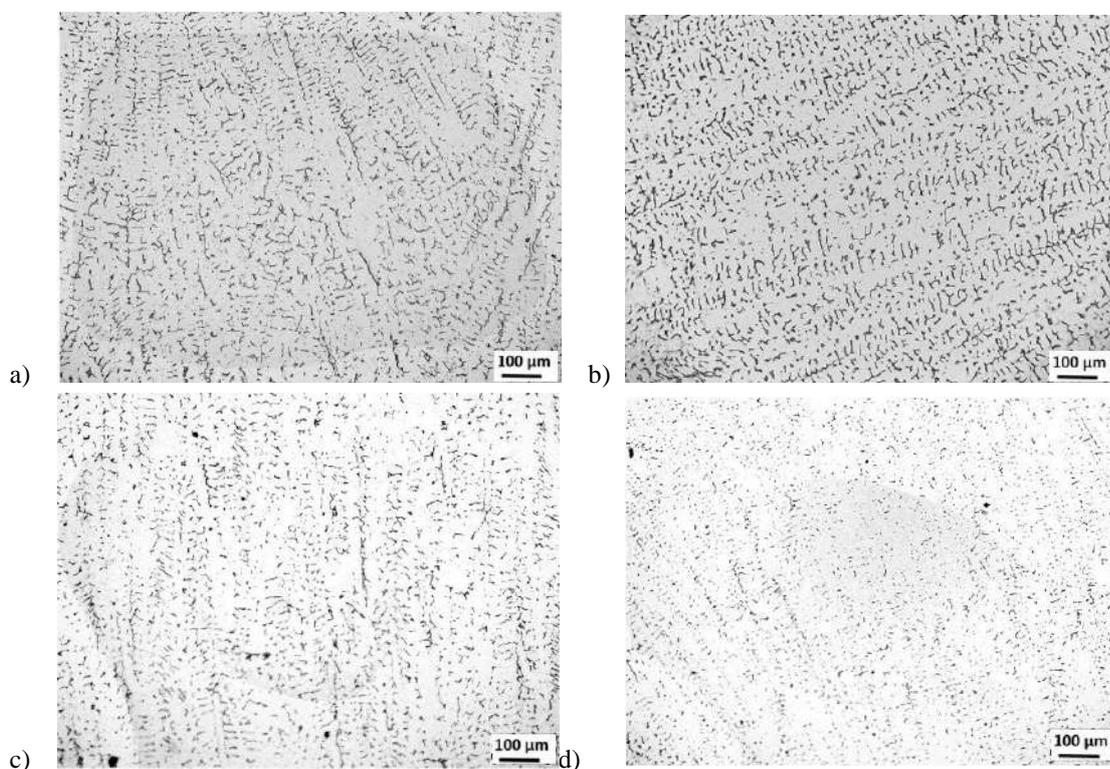


Fig.7: Cross-sectional micrographs of welded specimens. a) Sample 1, b) Sample 2, c) Sample 3 and d) Sample 4. Electrolytic attack with 20% NaOH with 6.5 V for 1.5 minutes.

The volumetric fractions of δ ferrite verified in the longitudinal direction are smaller than those verified for the transversal direction in the four welded specimens.

The metallographic analysis of the welded specimens revealed that the increase in the concentration of CO₂ in the shielding gases decreases the volume fraction of δ ferrite in the deposited metal.

As discussed earlier, these results are consistent with chemical analysis of chemical weld pads. In Figure 6, it can be seen, that with the increase of the CO₂ concentration in the shielding gases, there is a decrease in Cr_{eq} and an increase in Ni_{eq}, resulting in a decrease in the Cr_{eq} / Ni_{eq} ratio of the alloys.

IV. CONCLUSIONS

The increase in the concentration of CO₂ in shielding gases increases the Ni_{eq} of the alloys by increasing the content of carbon in the deposited all weld metal.

The results obtained suggest that increasing the concentration of CO₂ in the shielding gases decreases in the Cr_{eq} of the alloys due to the selective oxidation of Cr and Si elements.

Increasing the carbon content of the alloy decreases the volume fraction of δ ferrite in the deposited all weld metal.

The results obtained suggest that solidification of the studied alloys is ferritic-austenitic (mode III).

The increase in concentration of CO₂ in shielding gases decreases Cr_{eq} and increase Ni_{eq}, in the deposited all weld metal, resulting in the decrease in the Cr_{eq}/Ni_{eq} ratio of the alloys.

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Considerations on Characteristics and Improvements of Soft Soils

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Abstract — *This work is aimed at considerations of soft soils, their origin, behavior against applied tensions and the observation of methods that enhance their safety for civil constructions, such as roads, buildings and bridges on this type of soil, making its construction use. Therefore, case studies on soft soils will be presented, in order to understand their mechanical properties and data referring to some techniques that were developed in the study of geotechnical engineering, for the improvement - stabilization - of these soils, such as landfills on: geosynthetics and enriching of soft clays with Deep Soil Mixing (DSM). This article was based on rigorous bibliographic research, including considerations on the attributes, origin and performance of soft soils, generalized display of some improvement methods. Synthetically, a description of two improvement methods was carried out, observing the case studies of both, commenting on how an application of these best cases is made in a legitimate case and in a virtual simulation, with a justification of having an understanding of solutions that uses used, in order that the soft soil masses are useful.*

Keywords — *Soft Soils. Stabilization of soil. Geotechnical engineering.*

I. INTRODUCTION

The relationship between man-made buildings and the soil on which they were built is as old as the beginning of civilizations. Be it the pyramids in Egypt, the Great Wall of China, the Tower of Pisa or the sumptuous temples of the gods in Greece, man has, throughout history, developed large buildings, and with each new building, given the increase in population and the lack of expanding cities to more and more remote regions, be they small or large works, the man had to deal with the problems that the soil in question offered to the new constructions.

However, even with the appearance of pathologies in the structures, resulting from the soil where they were

found, the studies on soils, arose a short time ago, leading us to the 17th century, to the studies of Vauban (1687), Coulomb (1773), Rankine (1856), among others, who understood the soils as ideal masses of fragments, imputing them properties of homogeneous matter, that is, observing the soils more mathematically than physically, having been, at the time, of great contribution to the first studies on soils (CAPUTO, 1988).

Over time, it became clear that the behavior of soils was not under the same theoretical laws as the behavior of materials such as concrete or steel, due to the many types of soil, as well as the locations where they are found (PINTO, 2006). For this reason, with the great

constructions of the 20th century, and the countless failures accumulated in major works, such as the ruptures in the Panama Canal and the sliding of embankments in the canals under construction in Europe, the most in-depth study of soils through the perspective of Karl Terzaghi, the father of Soil Mechanics, who in 1925 published his book on soil research, the *Erdbaumechanik*, which was the north of soil mechanics, a discipline that at the time was still very nebula (CAPUTO, 1988).

In the case of soft soils, it is necessary to focus on understanding the main factors inherent to them, such as the fact that they are considered so, soils that have undrained resistance below 25 KPa or consistency index less than 0.5 per example. They have low mechanical resistance, high compressibility and little permeability (FUTAI, 2010), being, therefore, soils that offer little security in the laying of foundations, embankments for highways and social housing, presenting a great challenge to the engineer as to which the best path to take, whether it will be necessary to adapt the project, or whether it will be better to make use of improvements in the properties of the soil or whether it will be better to abandon the enterprise, in favor of finding a location with the most appropriate soil.

Thus, the objective of this study was to analyze case studies on soft soils carried out by other authors, in order to discuss the mechanical properties involved and the techniques related to geotechnical engineering that were applied in each situation to improve and stabilize these soils. , as landfills on: geosynthetics and geo-enrichment of soft clays with Deep Soil Mixing (DSM).

II. METHODOLOGY

The article was carried out through extensive bibliographic research, making through the research, considerations about the characteristics, the origin and behavior of the soft soils, as well as the generalized presentation of some methods of improvement of the same. A synthetic description of two improvement methods was also made, as well as the analysis of two case studies, where it was approached how these improvements are applied in a real case and in a simulation to better understand solutions that can be used to make these soil masses useful.

III. LITERATURE REVIEW

3.1 Geological formation

Hallal (2003, p. 25), highlights the influence of geological formation on the characteristics of soft soils:

“One of the main indications about the characteristics of soil deposits is their geological history, providing accurate information regarding granulometry, permeability, homogeneity, resistance and anisotropy, among other aspects. Geological history encompasses the source rock (or parent rock), the processes of alteration, transport, and deposition and the post-depositional processes.”

The soft clays of the quaternary period have the most diverse deposition environments, from the fluvial - the delta-lacustrine - to the coastal, also involving the lagoons and bays (CHRISTOFOLETTI, 1980). These environments are broken down by means of deposition activities (fresh, salt, or brackish water), which are fluvial or marine, or even by the characteristics of the deposition site - floodplains or floodplains, beaches or sea channels, among others.

Soils of fluvial origin are those that were formed by deposition of sediments on floodplains or river floodplains. In the poorly drained parts, that is, in the lower parts of the plain, sediments decant, especially the finer ones, such as clays and silts, and in many cases, stratification and intercalation with fine sands occur, becoming subject to dryness, and overdose may occur. (MASSAD, 2010).

In the context of soils of marine origin, it can be said that with regard to soft soils in Brazil, there were some sedimentation cycles, interspersed by a very intense erosion process, during the last glaciation of the globe, 15 thousand years ago and these cycles, according to Massad (2010, p.116): “[...] are directly related to the two episodes of sea entry towards the continent: the Canaanite Transgression, which occurred 120,000 years ago (Pleistocene), of the highest marine level (8 ± 2 m), and the Transgression Santos, started 7 thousand years ago (Holocene), of lower marine level (4 ± 2 m), which gave rise to two different types of sediments.”

Still according to Massad (2010, p. 116-118), these two sediments have their own characteristics, the Cananea Formation, is clayey or sandy at its base and sandy at the top. The Santos Transgression is formed by marine sediments, formed by reworking sediments from the Cananea Formation, sand, and clays, and sometimes by sedimentation of static or calm waters, also having been subjected to rapid and negative oscillations in the sea level.

The soft soils can also vary depending on the lithology of the erosion area, the way the sediment transport and the climate happened, so the sedimentary deposits have divergences between them, due to these variations in space and time under conditions environmental issues. Therefore, the formation of a

uniform deposit, depends on these conditions being stable (MASSAD, 2010).

Clay minerals are formed due to the chemical alteration of the rocks, forming microscopic particles, in a lamellar form, which perpetrates that reveal a large specific surface and, consequently, great sensitivity to the presence of water. The mineral present in its formation directly influences the behavior of the deposit, because the greater the presence of the clay particle, the weaker the geotechnical attributes of the soil (HALLAL, 2003).

3.2 Characteristics and composition of soft soils

Regarding the characteristics, we can mention the sedimentary soils that have low resistance to penetration, in an SPT that is less than 4 strokes, in which, the clayey part has the attributes of compressible and cohesive soil, in general, being soft clayey sands or soft clays (MASSAD, 2010). They are also defined as sediments from geologically newly formed soils, in the quaternary period, with dominance mainly of silt or clay particles. In general, they can be found in a dense or slightly pre-dense state, except for exceptions, especially on the surface of the soil, due to the dryness resulting from the oscillation of the water table, or because of the existence of landfills or overlying layers that increase the load. on these soils (HALLAL, 2003).

The methods for ascertaining the usual stability of these soils are based on the hypothesis that there is balance in a mass of soil, considering it as a rigid-plastic body and proximity to initiate a slide. Usually there are: circle of friction, Fellenius, Cunha, Morgenstern-Price, are some of the most common in this stability analysis, having, in most cases, in natural condition, safety factors in low condition or even less than those accepted for projects (MASSOCO, 2017).

Regarding the definitions presented, it is worth emphasizing that although they serve as a guide for understanding what soft soils are and their particularities regarding resistance, they are not used as a well-defined rule for detailing some sediment, so there are differences among the factors of undrained resistance, for example, due to the fact that there is no specific norm for this, which is also the reason that each terrain must be analyzed in a unique way, not assuming the design data.

3.3 Improvement methods for soft soils

According to Gerscovich (2010), a landfill based on compressible soils, implies in some phenomena, resulting from the loads applied on the soil, such as primary or densification settlement, a stage where the transfer of efforts between water and the solid framework occurs,

related to the expulsion of water from the void volume, thus generating large deformations in the soil. The secondary settlement, in turn, corresponds to deformations observed in the soil immediately after the primary, occurring with constant effective stresses, due to the fact that the voids index, together with the effective tension are a function of time, as shown in Figure 1.

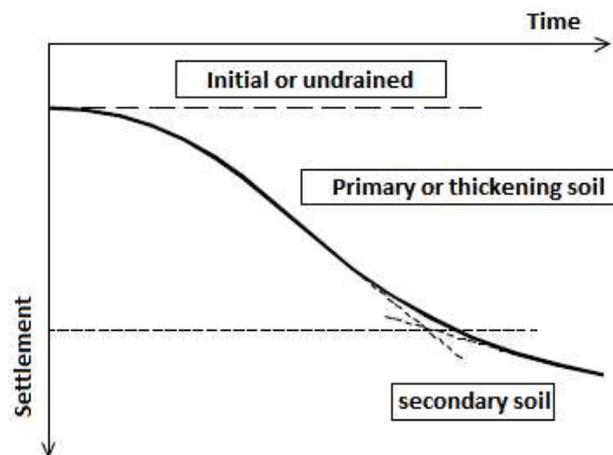


Fig.1: Evolution of settlements

Source: Gerscovich (2010), adapted.

In most soils, the secondary settlement is of little relevance when compared to the primary, however, in very plastic clays and more organic soils, it is significant. These settlements produce a density in the saturated soil, due to the transfer of water efforts to the solid framework, as previously mentioned, and this transfer is only possible by the dissipation of pore pressure surpluses, through water drainage (GERSCOVICH, 2010).

Soft soils present great difficulty for civil construction. Often, soil safety factors, applied directly in their natural condition, are small, and it is not possible to guarantee stability. With soil settlements, the same occurs, because the densification process takes time, as well as the settlement itself, needs a long time to be consolidated (MASSOCCO, 2017).

Many civil engineering projects involve this type of construction on very damp soils. Among them, road, and rail landfills for the construction of industries, earth dams, among others. And because of this need to build in areas with weak geotechnical characteristics, it is necessary to be very careful about defining the geotechnical parameters, how will the analysis of that sediment be done and what is the constructive sequence to be used, because if they are not taken into account these factors, the rapid and unthinkable construction, may cause the foundation soil to

rupture, under undrained conditions (FORMIGHERI, 2003).

One of the means used to alleviate the difficulties resulting from the presence of this type of material, is to completely remove the soft layer and replace it with granular material. However, this method is only economically viable, when there is only 3 m of soft layer, however, this substitution is expensive and inefficient. (DNER-PRO 381/98).

Formigheri (2003) states that landfill construction on soft soils, even if the necessary study has been done, may still surprise, due to the degree of stability that these landfills can achieve or not and the levels of vertical and horizontal displacement observed in the work. For this reason, it is necessary to analyze the soil in question, as well as to understand which type of landfill will be used, depending on which work is intended to be built on it. Then, we have the Class I landfill, which are landfills next to rigid structures, such as at the intersection of viaducts and bridges, and close to pipelines and other more sensitive structures. Class II landfills are not close to sensitive structures, however they are high, by definition, above 3 m. The Class III landfill, on the other hand, is low, that is, it has less than 3 m and is far from sensitive structures (DNER-PRO 381/98).

Massocco (2017) reports that there are many ways to make works on compressible soils feasible, and treatments can be done through measures to increase soil stability. Among the existing techniques, we can mention some of the best known, such as: construction in stages, application of temporary overloads, vertical geodrods to speed up settlement, side shoulders, piles, gravel columns, geosynthetics, among others.

3.3.1. Deep Soil Mixing (DSM) reinforced landfills

The Deep Soil Mixing technique, also known as soil-cement columns in Brazil, consists of making perforations in the soil in the form of columns, with the purpose of making controlled injection of humidified cement grout at low pressure, where this grout is mixed with the revolved soil during the excavation, thus enabling these soil-cement columns delineated in situ, of great resistance and low deformability. This method is widely used for the purpose of building landfills on soft soils, for the construction of roads that can even withstand the traffic of heavy equipment from the naval industry, for example (PINTO, 2016).

This method had its appearance around 1970, almost at the same time, in Japan, Sweden and the United States, due to the need to build in soils with poor geotechnical characteristics, especially in too soft clays,

soils with a high degree of saturation and a large amount of organic material (SANCHES, 2012).

The execution of the soil-cement columns, consists of a method of improving the soft soil, made in the deep regions of the land, without a previous excavation, that is, the machine that makes the drilling (drilling rig), also mixes the grout of cement (binder) with perforated soil, obtaining as a result, a soil with better mechanical characteristics than initially and with less permeability, giving the soil in question, characteristics such as improved resistance, deformability and permeability. (KITAZUME & TERASHI, 2001 apud PINTO, 2016). The stabilizing agents consist of one or two binders, which can also be in the dry state, the most common being lime and Portland cement, as shown in Figure 2.

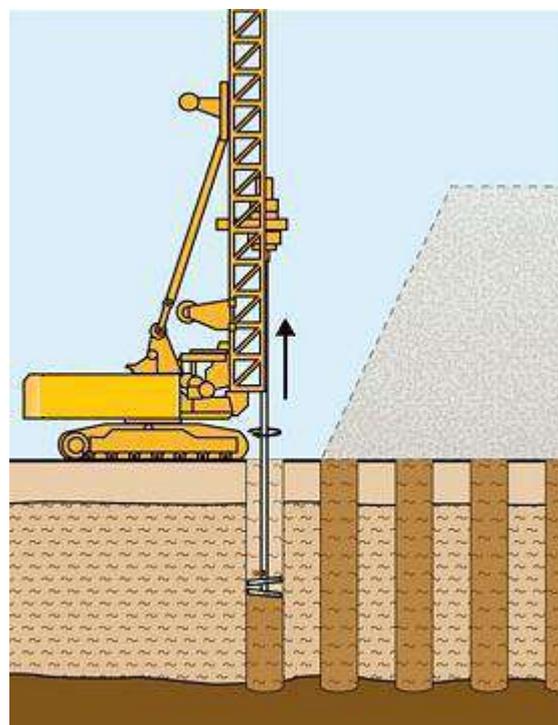


Fig.2: DSM application scheme

Source: Hayward Baker (2003) apud Sanches (2012), adapted.

In addition, it is possible to combine additives such as slag, fly ash, plaster, among others, thus enhancing the geotechnical characteristics of the applied soil (SANCHES, 2012).

Regarding the technique, according to Pinto (2016, p.17), we have two methods: Wet method: the wet method is more suitable for soft clayey soils, fine grained sandy soils with little moisture or stratified soils with soft and rigid layers interspersed. It usually uses cement grout. The inserted rod has a tip for drilling at its end and, next to it,

sets of blades that rotate to mix the soil-cement, as well as nozzles for launching the stabilizers. The diameter of these columns can vary from 40 cm to 2.4 m. The vertical drilling rod may eventually move up and down during the process to ensure the homogeneity of the mixture that will make up the soil-cement. The dry method: as a rule, the clay soils are strengthened with lime or cement with lime. Organic soils are stabilized with blast furnace slag. The dry method is only feasible in soils that are moist enough to react with the binders typical of this technique. The drill rod has a mixing blade at its end, near which is also the nozzle for launching the stabilizer. The columns executed in this method are normally 60 cm to 80 cm in diameter. The stem penetrates the soil, revolving it. After reaching the determined depth, it is collected and the stabilizer starts to be launched, while the mixing blade continues to rotate.

In Brazil, the DSM technique is still not widespread, however, in the countries where it developed, it has greater knowledge. According to Oliveira et al. (2012 apud Pinto 2016), there are several reasons for the expansion of the technique around the world, which are:

- i. DSM increases soil stability and simultaneously reduces settlement.
- ii. Faster execution.
- iii. Lower cost.
- iv. In recent years, there has been a development of machinery that allows DSM columns to run at greater depths in non-homogeneous soils, including soft soils, sands, over-densified clays, and even altered soft rocks, that is, rocks that have resistance to simple compression, in the healthy state, less than 2 MPa.

It is necessary to highlight one of the disadvantages of this method in Brazil, which is the fact cited above of not having extensive knowledge and dissemination of the technique. This is because, few companies have the necessary machinery for the execution, increasing the expense of its use, since they would have many costs with the transport of the specific machinery, as well as qualified labor for the execution, besides the cement having a high cost, due to the quantity to be used, and the work must have a large area to be treated to compensate the investment.

3.3.2. Landfills with geosynthetics

The lack of building in areas with soft soils requires many innovations to improve landfill works at the lowest possible cost and facilitated labor, without the need to remove the soft soil from the land to be built. For this reason, many studies have been done in the development of construction methods, aiming at soil improvement. Among

these methods, we have polymers, according to Vertematti (2015), such as plastic, elastomers, fibers, adhesives, coatings and geosynthetics. The use of polymers for the manufacture of geosynthetics began in 1960, and there were also records of use on a smaller scale in previous decades.

Geosynthetics have in their structure, polymers and to a lesser extent, some additives. These additives add improvements in the manufacturing processes and can change aspects of the polymer's behavior in the construction issue. In general, they are manufactured based on synthetic polymers, derived from oil, however, natural fibers such as sisal or coconut are also used, which are used in a variation of geosynthetics, the so-called geotextiles or biotextiles and geomantas. (VERTEMATTI, 2015).

A landfill work based on soft soil is a problem that requires a stabilization solution because of the possible problems that the construction of the landfill without some previous preparation of the soil can cause, for this, we can use a reinforcement in the soil with geosynthetics in base of that landfill. In this way, we increased its stability, allowing the land to be used for construction more quickly (VERTEMATTI, 2015).

Based on what Vertematti (2015) states, in the application of reinforcements on soft soil, geosynthetics are normally used: “geotextiles (GTX), geogrids (GGR), geotextiles and resistant geocomposites (GCO-R). Depending on the local conditions of the work and the materials available, one or more layers of geosynthetics can be used at the bottom of the landfill and separated by a layer of compacted soil.”

Figure 3 presents a simulation of the application of geosynthetic for separation of the foundation / sub-base of roads, showing the first image (a) without geosynthetic and the second (b) with geosynthetic.



Fig.3: Simulation of geosynthetic application

Source: LOPES (2005) apud FERREIRA (2010).

As we have as main advantage to the use of geosynthetics, the fact that they can simultaneously perform one or more functions as highlighted in NBR ISO 10318-1 - Geosynthetics - Terms and definitions (ABNT, 2018):

- Reinforces mechanical behavior.
- Limits the movement of soil or other particles on the surface due to the control of surface erosion
- Assists in draining rainwater, groundwater.
- Protection or prevention of local damage to a material.
- Can be used as a barrier, limiting fluid migration.

The most common forms of geosynthetics are geogrids, geocells, strips, wires, geomembranes, geoterrains, geomatres, geogrids and geocomposites. According to Sá (2000, p.10), among these, the most used as reinforcement are:

- Woven geotextiles: composed of two sets of perpendicular linear elements systematically interconnected to form a planar structure.
- Non-woven geotextiles: formed by filaments or fibers arranged at random to form a planar structure. This type of geosynthetic can withstand tensile forces, but because the filaments are misaligned, the loading causes much more elongation than an equivalent material with aligned elements.
- Geogrids: plastic grids that can be manufactured by different techniques and with a wide variety of geometric characteristics. Geogrids can be found in the form of strips or wires combined in two perpendicular directions to acquire a grid shape, but with different degrees of mechanical connection in the joints and protective sheaths. Another geogrid manufacturing process is the stretching of previously perforated blankets and Geocells: they are specially made materials so that, when stretched, they form elements like “honeycombs”, whose interior space is filled with soil. Most of the time, they are used to reinforce high embankments on foundations of soils with low support capacity.

The author also emphasizes that geosynthetics have many functions in engineering and various applications such as: improvement of soft soil, walls and embankments, reinforcements in foundations, for staked embankments, containments, drainages, among others. It can be cited as a disadvantage only the fact that they are solutions that can suffer some unforeseen in the execution if the calculations are not done correctly, from the question of the size of the

area that will be used, to the number of meshes and their thickness for a geogrid for example, but that is not restricted only to that geosynthetic. Thus, its execution requires a lot of care, so that the result is as expected in improving or strengthening the soil (VERTEMATTI, 2015).

IV. CASE STUDY ON SOFT SOIL

Soft soils have many problems regarding their usability and with that, it is necessary to use some method that makes the construction feasible, making an improvement of the soil to be used. Then, below, two case studies based on the two methods presented above will be presented, to exemplify in practice how these improvements occur.

4.1. DSM case study

Moretti (2012) developed a practical application of Deep Soil Mixing (DSM) on the coast of Pernambuco, close to the city of São Lourenço da Mata, in an area of 300 m in length in which many landfills built on soft soils are found in large quantities, because the region's soil is characterized by compressible and low resistance soils (FIGURE 4).



Fig.4: Photo of the place where the study was carried out.

Source: Moretti (2012).

4.1.1. Characterization of the geotechnical profile

In the area in question, according to Moretti (2012), three surveys were carried out, detecting which region has a subsoil formed by a layer of sandy-clay silt, about 1.0 m thick, with the next layer of organic clay being 12, 0 to 15.0 m, and after that, a silt clay of 2.0 m each and finally, a layer of clay silt. The water table level was detected at a depth of up to 1.60 m. The same author also informs that

three surveys were carried out, through which the geotechnical profile of the soil was traced, through these data, it was possible to determine the limits of liquidity (LL) and plasticity (LP), the plasticity index (IP), the compression (Cc) and recompression (Cr) coefficients, the moisture percentage (w%) and the specific weight (γ) of each soil layer. It was also possible to determine the granulometry of soils by means of sieving and the values of resistance obtained by means of UU triaxial tests (MORETTI, 2012). 4.1.2. Procedures adopted Moretti (2012) states, with regard to field procedures, DSM columns with a nominal diameter of 0.80 m and a spacing of 3 m between the axes were performed, using a triangular arrangement and workload to simple compression of 1MPa, these columns being seated at least 1.0 m deep in the firmer material, in a layer below the soft soil, executed according to DSM methodology.

Regarding the sampling of the columns with the rotary drilling equipment, Moretti (2012), says that some of the columns were selected on the job, in a random way, aiming to obtain a result that was more suitable, extracting unformed samples, from the inside of the columns using the equipment in question. Then, these samples were sawn, rectified and packaged in a laboratory in submerged curing, until laboratory tests were carried out. In the section studied, 52 columns of DSM were drilled, and columns were also drilled for testing cement consumption in the field, totaling another 4 columns. Figure 5 presents elements used in the study.

In section (a) we have the sample boxes collected on the spot. Section (b) has a planetary mortar used to homogenize the samples in the laboratory. Finally, in part (c) we have the execution of the compression test in a specimen molded in the laboratory.

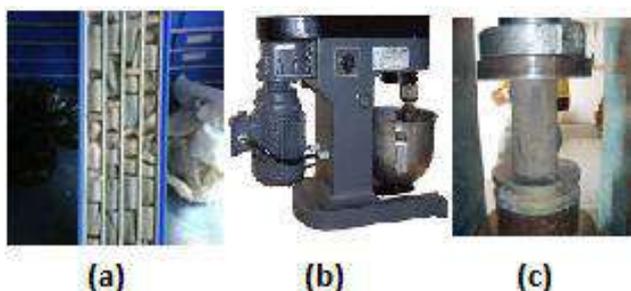


Fig.5: Elements used in the case study.

Source: Moretti (2012), adapted.

Among the laboratory procedures, the specimens for the study were made, mixing the local soft clay with water, until reaching the liquidity limit, and then, afterwards, these samples were homogenized with a planetary mortar,

after that, they were kept in full rest in a cool place, so that, knowing the specific weight and masses, they could calculate the volume (MORETTI, 2012).

Also according to the author, for the finalization of the specimens, a quantity of CP II-32 cement was added to the mortar, which quantity was obtained by means of dosing in terms of cement mass per volume of sample to be treated, the specimens were molded in metal cylinders and care was taken to prevent bubbles and discontinuities from forming through small blows on the outer wall of the molds, also protecting the cylinder ends, and finally, the compression tests axial, leading the specimens to ruin, in order to quantify how much there has been improvement in resistance (MORETTI, 2012).

4.2. Geosynthetic case study

Batista's case study (2007) describes three types of soft soils, with parameters for clays typical of the State of São Paulo, such as Sediments Flúvio Lagunares and Transitional Clays (MASSAD, 1999 apud BATISTA, 2007) and Argila Vermelha de Brasília (ALMEIDA et. Al., 1996 apud BATISTA, 2007). The author chose the soils of the places in question, because they cover cases of soils that have low, medium, and reasonably good resistance to soft soils. However, in this work, only the soil of São Paulo Transitional Clays will be approached.

4.2.1 Characterization of the geotechnical profile

Batista (2007) states that in the soil in question, an undrained resistance of about 14 kN / m² was shown in Table 1, with the soft soil layer being approximately 12.5 m deep. Related to the landfill, the following characteristics were adopted: Specific weight (λ) = 19 kN/m³, permeability (K) = 1 m / day, Young's modulus (E) = 60000 kN/m², Poisson (ν) = 0.3, cohesion (c) = 20 kN/m² and friction angle (ϕ') = 29 °.

Table 1. Undrained resistance varying with depth, adapted.

Depth (m)	Cu (kN/m ²)	Depth (m)	Cu (kN/m ²)
0,5	10,13	7,5	14,88
1,5	10,08	8,5	15,91
2,5	10,27	9,5	16,94
3,5	10,69	10,5	17,96
4,5	11,75	11,5	18,28
5,5	12,08	12,5	20,00
6,5	13,84	Média	14,17

Source: Batista (2007).

This layer of soil where the factors of undrained resistance were tested, was divided into 13 layers of 1 m, being able to observe a constant undrained resistance as we increase the depth. And yet for this characterization, the over-stressing stresses were considered, that is, effective vertical stresses added to a load increase of 9 KN / m² (BATISTA, 2007).

4.2.2. Procedures adopted

The German software GGU-Slope was used, which among its functions, allows to analyze the balance of embankments and embankments, being of paramount importance for safety to have these data, since, it is possible to avoid ruptures that interfere in the assessment of the rigidity of the reinforcement (BATISTA, 2007).

For comparative analyzes of soil displacement without reinforcement in the software, Batista (2007), said the landfill with 28 m of base and slope of 1V slope: 1.5H was arbitrated, being this loaded with 19 kN / m² each landfill layer, operating the load for 0.6 days, which is the shortest time accepted by the software for the case. After removing the static layer, the layer could thicken for 0.6 days, to imitate the rapid construction process, which is the most critical in an engineering work.

However, building the landfill directly on the soil without the reinforcement of geosynthetics, resulted in the rupture of the soil, generating numerical instabilities. The author also chose to execute landfills without balances, however, the fluvial lagoon soils have a low capacity to support, with a large amount of plastification in the soil, which made the study impossible, for this reason, it was used balance shoulders with the same material as the landfill, in order to better stabilize the settlements and plasticization that the soil would have (BATISTA, 2007).

4.3. Results and discussions

The study developed by Moretti (2012), makes some tests related to the increase of simple compressive strength of laboratory and field samples, however, this article will only address laboratory tests, in order to demonstrate this improvement through of one of the examples used by the author, who used different dosages of concrete, with 200 kg/m³, 400 kg/m³ and 600 kg/m³ with 7, 28, 56 and 120 days, however, according to Table 2, here it will be only the data referring to the cement consumption of 200 kg/m³ are presented.

Table 2. Resistance to simple compression (MPa). Cement consumption 200 kg/m³

Sample	Curing time (days)			
	7	28	56	120
1	1,30	2,90	2,90	4,00
2	1,10	3,00	3,30	3,60
3	1,00	2,70	3,00	3,70
4	1,20	2,50	3,50	3,70
Medium 200	1,15	2,78	3,18	3,75
Sd	0,13	0,22	0,28	0,17
COV	0,11	0,08	0,09	0,05

Source: Moretti (2012)

As shown in the table, it is possible to verify that as we increase the curing days of the sample, the resistance to simple compresses increases, as expected from curing the material, Moretti (2012) still makes comparisons with higher dosages of concrete, the which also shows that the higher the cement consumption, the greater the resistance of the DSM columns, as shown in Figure 6.

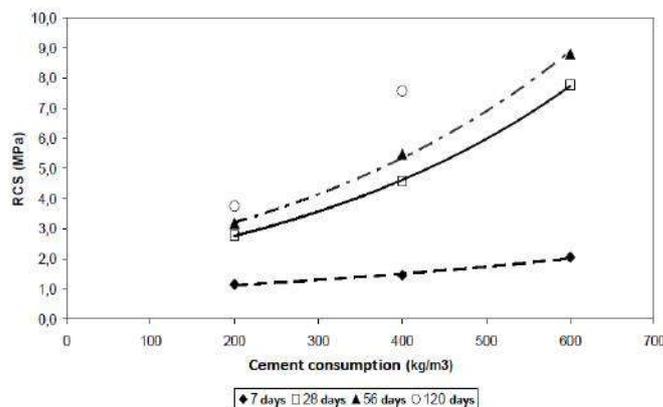


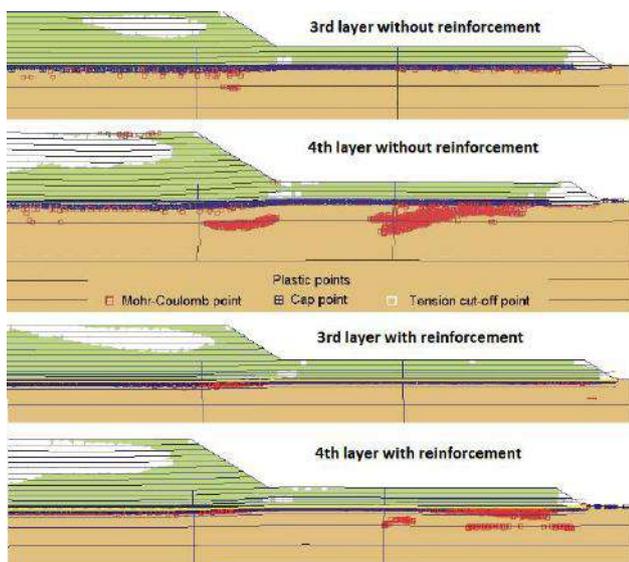
Fig.6: RCM x Cement consumption.

Source: Moretti (2012), adapted.

Batista's geosynthetics (2007) that were used, had nominal reinforcement of 1000, 4000 and 16000 kN/m, each being tested in the software and observing the behavior of the landfill with and without these reinforcements. For the 1000 kN/m and 4000 kN/m reinforcements, the results were similar. Figure 7 shows layers with and without reinforcement of 1000 kN/m.

Figure 7. Layers with and without reinforcement of 1000 kN/m.

Figure 8 shows layers with reinforcement of 16000 kN/m.



Fonte: Batista (2007), adapted.

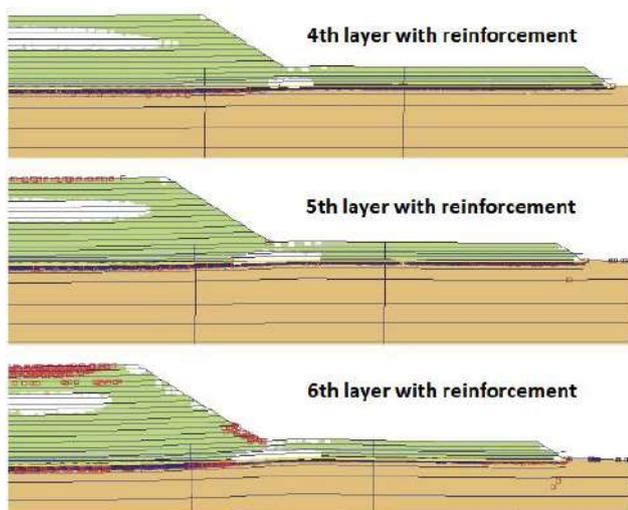


Fig.8: Layers with reinforcement of 16000 kN/m.

Source: Batista (2007), adapted.

In Table 3 it is possible to identify that, as we use geosynthetic reinforcement, less displacements occur in the soil formed by transitional clay, that is, it is clear that the reinforcement of geosynthetics contributes significantly to the improvement of a compressible soil in order to make it usable for civil constructions.

Table 3. Maximum total displacements (cm) for the AT soil.

Layers	Stiffness (kN/m)			
	Without reinforcement	1000	4000	16000
1	3,59	3,64	3,50	3,20
2	6,44	5,82	5,37	4,96
3	8,88	8,60	8,22	7,61
4	21,04	15,65	13,96	12,44
5	89,36	56,75	35,55	21,12
6	-	-	68,83	33,95

Source: Batista (2007).

Therefore, in relation to which method should be used or not, it is necessary to establish the type of work to be carried out, the client's budget, the facility to find the necessary materials and manpower necessary to use the method to be used to be employed. However, as previously mentioned, in Brazil, the DSM technique is still a little unknown and little practiced by companies at the national level, so for our reality the use of geosynthetics as a method of greater diffusion, knowledge and a large amount of skilled labor to use it, since in this sense, as Vertematti (2015) said, our country has a reference. In addition, it should be mentioned here that in the case of a soil with extremely poor properties in terms of its resistance, we can use the two methods together, in order to perform the geoenrichment of the soil and the mechanical reinforcement through some of the geosynthetics. Finally, we can summarize in Table 4, some of the advantages and disadvantages of both methods, as well as making some comparisons regarding the same.

Table 4. Advantages and disadvantages of DSM and Geosynthetics Methods.

Compared item	Method	
	Deep Soil Mixing (DSM)	Geosynthetics
Advantages	<ul style="list-style-type: none"> • Increased resistance inside the soil. • Decrease in differential settlements. • Makes the soil mechanically richer. 	<ul style="list-style-type: none"> • Increased resistance of the soil on its surface. • Decrease in differential settlements. • Protects the landfill from ruptures.

Disadvantages	<ul style="list-style-type: none"> • High cost. • In Brazil, it has little labor. 	<ul style="list-style-type: none"> • Material that can generate environmental impact in the case of materials made of polymers; • More superficial improvement, not foreseeing internal improvements in the soil.
Phases	<ol style="list-style-type: none"> 1. Soil drilling and cement mix plus additives. 2. Wait for the curing time of the columns. 3. Land the ground. 	<ol style="list-style-type: none"> 1. Drainage. 2. Leveling. 3. Application of geosynthetics on the soil to be used. 4. Land the ground.
Description	Improvement through geo-enrichment of the foundation soil, inside the soil.	More mechanical improvement than soil chemical characteristics, being carried out on its surface.
Application	Building or road works.	Building or road works.

Source: Vertematti, 2015.

V. CONCLUSIONS

Through all observations, it is clear that constructions on soft soils are a great challenge for engineering, taking into account all the obstacles that these soils can cause during a landfill work aimed at the construction of roads, foundations and works of social interest, since the characteristics inherent to soft soils such as high compressibility, high saturation level, low undrained resistance and low shear resistance, for example, make the execution of these works much more difficult, having to take into account many variables, aiming at the safety of buildings built on these soils.

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IOT Monitored Brushless DC Motor Speed Control Using Arduino

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Abstract— Brushless Direct Current motors are extensively used in many of the industries because of its low cost, high speed torque characteristics, noise less operation. Speed controlling is Very important. By using the Arduino Board interfaced with the Electronic Speed controller, Motor speed can be is controlled by varying the 10k pot. The parameters like Speed, Current and Voltage are Monitored on the LCD and the same parameters are monitored from remote access through the configured electronic gazettes by using the Internet Of things.

Keywords— ESC, IOT, LCD, DC motor.

I. INTRODUCTION

Brush less DC motors are excited with Permanent magnet are pretty largely used in a huge amount of applications because of decent performance profits like higher torque current ratio, less noise, more efficient, small size and inexpensive, lesser torque ripples, lesser supervision and well control characteristics on a huge range in torque speed period. Brushless DC motors which are used in ceiling fans are reduced in size and heaviness than AC fans which has Universal motors. As these motors have the capacity to work with the small supply source voltages. Commutation process of a Brushless DC motor in controlled by Electronic speed controller(ESC). ESC will energizes the stator windings and in a proper sequence ,which supports to rotate the Brushless DC motor. Brushless Direct Current motor speed can be controlled and other parameters are monitored on LCD display and on the registered android cell phones or tablet with the usage of Internet Of Things(IOT) technology. IOT is very helpful in industrial automation through remote access and also to monitor the different parameters.

II. BLOCK DIAGARAM

Hardware Consits of the following are

1. Microcontroller (Arduino Board)
2. Electronic Speed Controller
3. IOT Device
4. LCD Display

5. Power Supply
6. Sensors
7. BLDC Motor
8. 10k Pot

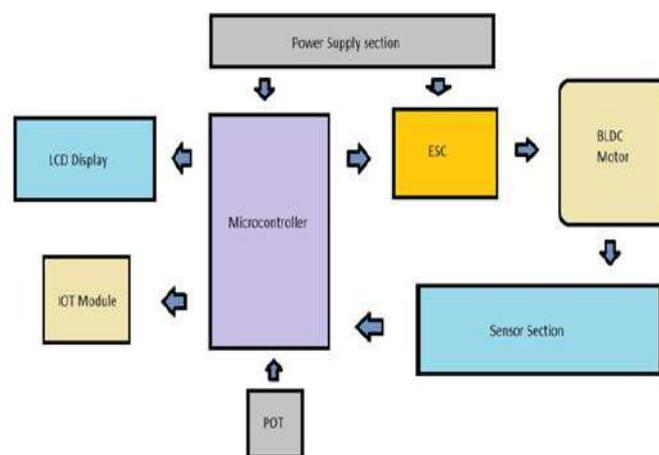


Fig. 1 Block diagram of the Proposed System

Arduino and ESC are two the main parts of the hardware, Arduino board is loaded with program written in embedded C language. When Supply of 12v is applied and by varying the 10K pot Arduino generates the PWM signals and depending the pulse width duration ESC will drive the Motor. As soon as ESC receives the pulses from Arduino it will energize the Phase wires of Brushless DC motor and motor starts rotating. Speed controlling of the Brushless DC motor is done by ESC. Sensors are used to sense the

different parameters like speed, current and voltage of the Brushless DC motor. IR sensor acts as a digital tachometer and measures the rotation of the speed in RPM. Rotation of the speed and other parameters can be visualized in the LCD display. The same output will be monitored on the IOT configured device.

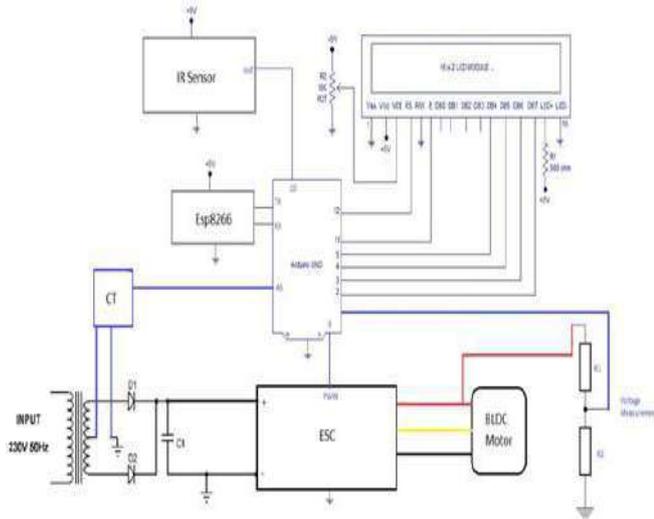


Fig.2 Functional diagram of proposed System

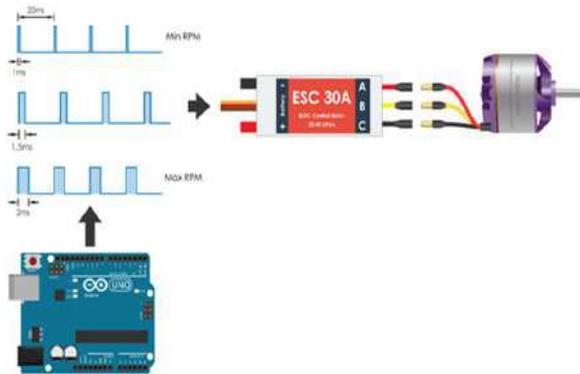


Fig.3 Arduino Board generating pulses to drive motor through ESC

III. FLOW CHART

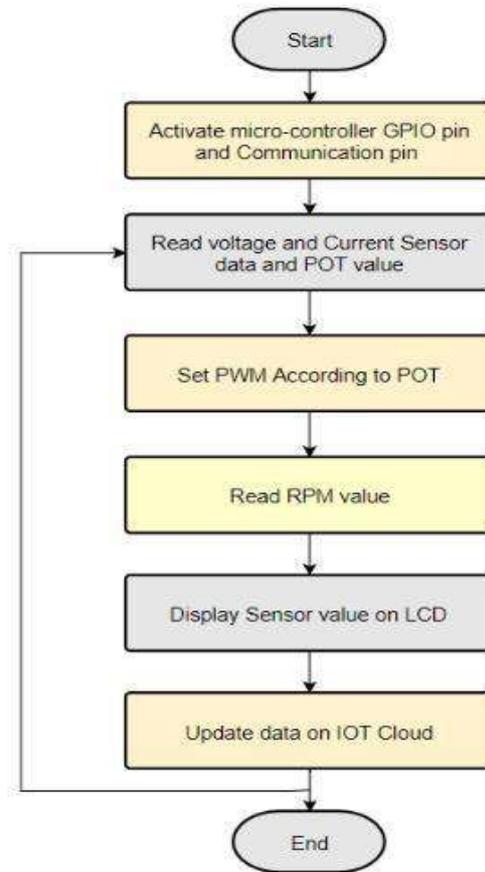


Fig. 4 Flow chart of the Proposed System

IV. HARDWARE ASSEMBLY



Fig.5 Hardware Assembly of proposed System

V. RESULT AND DISCUSSION

Brushless Direct current motor speed control is operated using the PWM system. The period of operation controls the output of the motor. By modifying the duty cycle, the appropriate pace can be identified. The modulation of the duty cycle of the direct current motor is used to manage the pulsed width

$$\text{Average voltage} = D * V_{in}$$

The average voltage achieved in a number of operating cycles is specified, while the voltage supply decreases with the duty cycle percentage, which decreases the average voltage.

$$\text{Duty Cycle} = 100\% \times \text{Pulse Width/Period}$$

Where,

$$\text{Duty Cycle in (\%)} = \dots$$

Pulse Width = Time period the signal is in the ON or high state (sec)

$$\text{Period} = \text{Time of one cycle (sec).}$$

The operating cycle regulates the speed of the Brushless Direct current engine. Different duty cycles can detect the required speed. The Arduino uno Pulse Width Modulation can be used to monitor the Brushless Direct Current motor working period to effectively adjust Brushless Direct Current motor rpm. Frequency and voltage can be displayed on the LCD16x2 Panel. The same parameters can be tracked from remote locations utilizing the IOT technology on installed computers. Speed for different voltages and current as seen in the table below.

Voltage in volts	Current in milliamps	Speed in RPM
7	362.48	10644
8	345.21	13193
9	310.69	16041

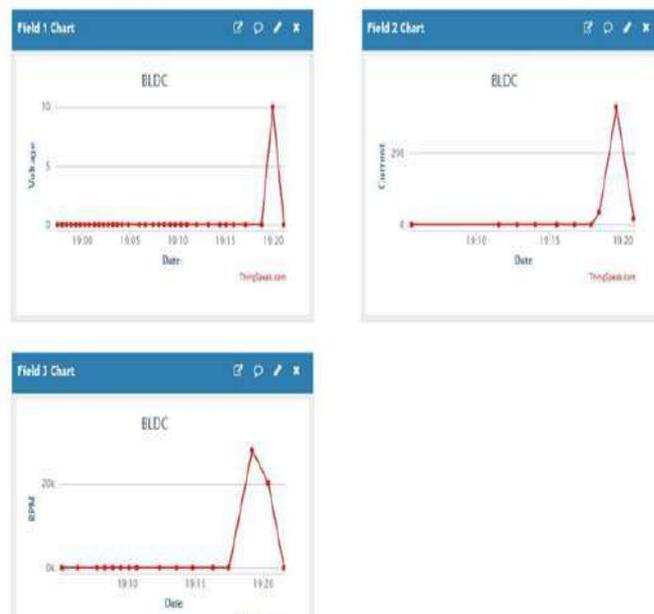


Fig. 6 Current, voltage and speed displayed on IOT application

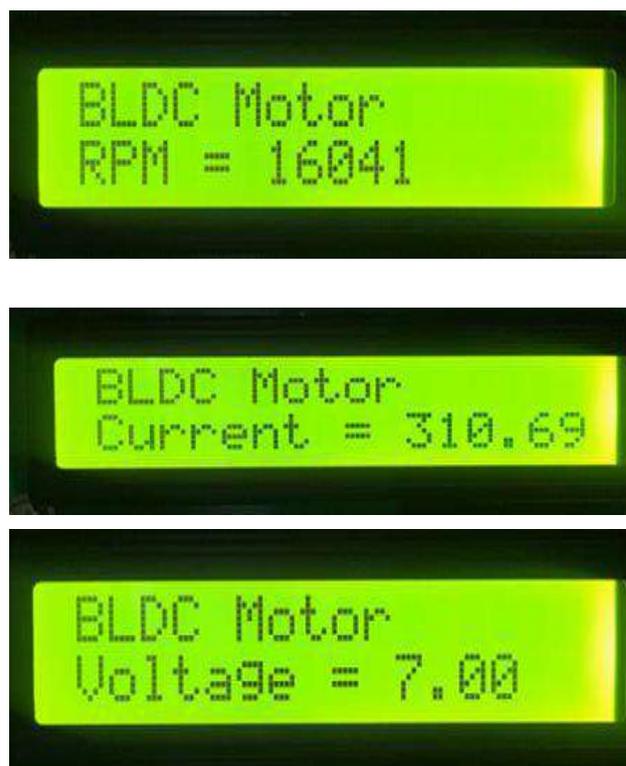


Fig.7 Current, voltage and speed displayed on LCD

VI. CONCLUSION

Brushless Direct current motor speed is controlled successfully by using Electronic speed controller (ESC) and parameters can be monitored on a LCD display and as well as on the configured electronic gazettes. This

proposed architecture uses the IOT technology in a web services for communication between remote user and source device. “Thingspeak” application can be launched in any browser using the credentials to monitor the parameters. This method of the proposed work provides a flexible and long distance connectivity between industrial environment and user. Speed of a Brushless Direct current motor is controlled successfully by using Electronic speed controller(ESC) and parameters can be monitored on a LCD display and as well as on the configured electronic gazettes.

VII. FUTURE SCOPE

Future we can implement Arduino wireless NRF communication in that, speed control is done by wireless technology.

Solar power can be used to run the Brushless Direct current motor.

We can add other sensors to monitor the other parameters like temperature, humidity near the motor etc.

ACKNOWLEDGEMENT

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Assessment of Discomfort and Strain among Floriculture Workers

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Abstract— *The floriculture sector generates employment opportunities for the uneducated, unskilled, poor and mainly people who are marginalized from other employment opportunities. Floriculture is considered as one of the hazardous occupation as it involves the repetitive nature of tasks, heavy workload, adverse environmental conditions and poor tools and equipments. The objectives of the present study were (1) Assessment of the working profile of workers engaged in different floriculture activities and (2) Assessment of discomfort and repetitive strain faced by the workers engaged in floriculture activities. The results from present study revealed that out of the total pooled sample, majority of the respondents were involved in flower picking activity. Approximate fifteen percent (13.24) of the respondents were working 7-9 hours per day in floriculture units. It was found that the maximum discomfort was faced by the respondents during flower picking activity (WMS 3.75) and the repetitive strain was also found highest for the picking activity (WMS 3.34) in Marigold farm units.*

Keywords— *Floriculture, Flower Picking, Pruning, Repetitive Strain, Working profile.*

I. INTRODUCTION

Floriculture work is physically demanding which includes activities that vary according to the seasonal needs for land preparation, planting, pruning, harvesting and transportation. Floriculture workers are exposed to a number of occupational health hazards that are potentially harmful to their health and well being. Occupational health hazards are also related to the activities which includes the repetitive nature of work and prolonged awkward posture of the workers. The floriculture operations need repetitive movements in awkward posture for longer duration which may cause severe health problems. Physical discomfort also affected by the working conditions such as working environment and working profile which impose additional stress on floriculture workers. Floriculture workers who maintain static awkward body postures with repetitive working movements and heavy lifting for prolonged periods can suffer from resulting muscle contractions and from alteration of the peripheral, vascular and nervous systems. Repetitive movements are more common in tasks that require manual dexterity (Henao and Samuel, 2011). Workneh (2007) conducted a study on working conditions of workers engaged in flower farm and revealed that due to long hours of standing

posture of workers leads to various health and safety problems such as headache, skin rashes, blood vein problems and respiratory problems. The National Research Council and Institute of Medicine (2001) defines work related illness or disease as being caused by aggravated, accelerated or exacerbated by workplace exposures, which results in impaired work capacity. Physical discomfort and repetitive strain are increasingly recognized as significant hazards of floriculture occupation. The knowledge about suitable working conditions, work posture, effective rest pause etc. are required for combating physical discomfort and enhancing the occupational health and safety of floriculture workers. Thus, the present study was undertaken with the following objectives (1) Assessment of the working profile of workers engaged in different floriculture activities and (2) Assessment of discomfort and repetitive strain faced by the workers engaged in floriculture activities.

II. METHODOLOGY

Six floriculture units were randomly selected from the district of Haryana state of India where floriculture was being done at large scale. All the floriculture workers

working in selected six floriculture units interviewed using the developed interview schedule for data collection. The data were suitably coded, tabulated and statistically analyzed to draw meaningful inferences.

III. RESULTS

1. Working profile of workers engaged in floriculture activities

Type of work performed by the respondents- Table 1 illustrates the type of work performed by the respondents engaged in different activities in floriculture units. It was revealed that out of the total pooled sample, majority (86.76%) of the respondents were involved in flower picking activity, 41.18 percent of the respondents were involved in planting activity and 30.88 percent of the respondents were involved in manuring activity. A same number (26.47%) of the respondents were involved in land preparation and pruning activities; 17.65 percent of the respondents were involved in packing activity. The involvement of respondents in irrigation as well as in transportation activity was 14.71 percent. More than ten (11.76%) percent of the respondents were involved in storage activity in floriculture units. Overall data as well as district wise data indicate that majority of the respondents were engaged in flower picking activity in floriculture units.

Mode of journey to go to floriculture unit- Majority (76.47%) of the respondents used to go to floriculture unit on foot while only 17.65 percent of the respondents were using bicycle to go to floriculture unit and very few 5.88 percent of the respondents were using bike to go to floriculture unit.

Distance traveled to go to floriculture unit- Table 1 reveals that one to two kms distance was travelled by the 41.18 percent of the respondents to go to floriculture unit followed by two to three kms distance (29.41%) and three to four kms distance (29.41%).

Working years in floriculture unit- Data in table 1 indicated that 51.47 percent of the respondents were working in floriculture units from one to three years followed by 35.29 percent of the respondents were working from four to six years and 13.24 percent of the respondents were working from seven to nine years. In Panipat district, maximum (64.29%) numbers of the respondents were working in floriculture units from one to three years while only 4.76 percent of the respondents were working from seven to nine years in Fatehabad district.

Working days- More than half (55.88%) of the respondents were working 25 to 30 days in a month, 33.82 percent of the respondents were working 20 to 25 days and only 10.30 percent of the respondents were working 15 to 20 days in a month. Maximum (64.29%) number of the respondents working 25 to 30 days in a month were from Panipat district and minimum (3.57%) number of the respondents working 15 to 20 days in a month were also from Panipat district.

Daily working hours- Findings in table 1 reveal that 66.17 percent of the respondents were working 4-6 hours per day, 20.59 percent of the respondents were working 7-9 hours per day and only 13.24 percent of the respondents working 7-9 hours per day in floriculture units. The maximum (78.95%) number of the respondents working 4-6 hours per day were from Hisar district and minimum (5.26%) number of the respondents were working 4-6 hours per day were from Hisar district.

Work shifts- Results in table 1 depict that 67.65 percent of the respondents were working in a single shift while 32.35 percent of the respondents were working in double shifts.

Length of work shifts- Data in table 1 also reveal the length of each work shift. In shift I, 69.12 percent of the respondents were working for 180-300 minutes and 30.88 percent of the respondents were working for 300-420 minutes while in shift II, 27.94 percent of the respondents were working for 120-240 minutes per day and only 7.35 percent of the respondents were working for 240-360 minutes per day.

Work period time- Majority (77.94%) of the respondents were working from 5a.m. to 9 a.m., 38.24 percent of the respondents were working from 9a.m. to 1p.m and 32.35 percent of the respondents were working from 2p.m. to 6p.m. District wise data also reveal that majority of the respondents were working from i.e. 5a.m. to 9 a.m.

Rest periods- Results in table 1 indicate that majority of respondents (63.24%) were allowed to take rest during work shifts and 36.76 percent of the respondents were not allowed to take rest during work. Majority (69.77%) of the respondents were taking only one rest period and 30.23 percent of the respondents were taking two rest periods in between the work. Overall data as well as district wise data indicate that majority of the respondents were taking only one rest period in between the work.

Length of the rest periods- In shift I, 48.84 percent of the respondents were taking rest for fifteen minutes and 20.93 percent of the respondents were taking rest for twenty

minutes in between work whereas in shift II, 16.28 percent of the respondents were taking rest for 90 minutes and 13.95 percent of the respondents were taking rest for 120 minutes while working.

Rest period time- Results in table 1 also indicate the time for rest periods. In shift I, 16.28 percent of the respondents were taking rest in time period of 7a.m. to 7.15a.m. followed by 13.95 percent in time period of 8a.m. to 8.15a.m., 11.63 percent in time period of 9a.m. to 9.15a.m. and 6.98 percent

of the respondents were not having any specified rest period time as they might take rest whenever they felt need to take rest. For 30 minutes rest period time in shift I, 20.93 percent of the respondents were taking rest in time period of 10am to 10.30am. In shift II, 16.28 percent of the respondents were taking rest in time period of 12noon to 2p.m. and 13.95 percent of the respondents were taking rest in time period of 12noon to 1.30 p.m.

Table 1 Working profile of workers engaged in floriculture activities (n=68)

Parameters	Fatehabad (n=21)	Hisar (n=19)	Panipat (n=28)	Total (n=68)
Type of work performed by the respondents*				
Land preparation	5 (23.81)	3 (15.79)	10 (35.71)	18 (26.47)
Planting	8 (38.10)	5 (26.32)	15 (53.57)	28 (41.18)
Manuring	7 (33.33)	3 (15.79)	11 (39.29)	21 (30.88)
Irrigation	2 (9.52)	2 (10.53)	6 (21.43)	10 (14.71)
Picking	19 (90.48)	17 (89.47)	23 (82.14)	59 (86.76)
Pruning	6 (28.57)	3 (15.79)	9 (32.14)	18 (26.47)
Packing	4 (19.05)	3 (15.79)	5 (17.86)	12 (17.65)
Storage	2 (9.52)	2 (10.53)	4 (14.29)	8 (11.76)
Transportation	4 (19.05)	3 (15.79)	3 (10.71)	10 (14.71)
Mode of journey				
On foot	11 (52.38)	16 (84.21)	25 (89.29)	52 (76.47)
bicycle	7 (33.33)	2 (10.53)	3 (10.71)	12 (17.65)
Bike	3 (14.29)	1 (5.26)	-	4 (5.88)
Distance traveled to reach floriculture unit (km)				
1-2	6 (28.57)	10 (52.63)	12 (42.86)	28 (41.18)
2-3	10 (47.62)	6 (31.58)	4 (14.28)	20 (29.41)
3-4	5 (23.81)	3 (15.79)	12 (42.86)	20 (29.41)
Number of working years in floriculture unit				
1-3	13 (61.91)	4 (21.05)	18 (64.29)	35 (51.47)
4-6	7 (33.33)	10 (52.63)	7 (25.00)	24 (35.29)
7-9	1 (4.76)	5 (26.32)	3 (10.71)	9 (13.24)
Average working days in a month				
15-20	2 (9.52)	4 (21.05)	1 (3.57)	7 (10.30)

20-25	8 (38.10)	6 (31.58)	9 (32.14)	23 (33.82)
25-30	11 (52.38)	9 (47.37)	18 (64.29)	38 (55.88)
Average working hours daily				
2-3	8 (38.10)	1 (5.26)	-	9 (13.24)
4-6	9 (42.85)	15 (78.95)	21 (75.00)	45 (66.17)
7-9	4 (19.05)	3 (15.79)	7 (25.00)	14 (20.59)
Number of work shifts/day				
One	17 (80.95)	7 (36.84)	22 (78.57)	46 (67.65)
Two	4 (19.05)	12 (63.16)	6 (21.43)	22 (32.35)
Length of each work shift period (Minutes)				
Shift I				
180-300	18 (85.71)	14 (73.68)	15 (53.57)	47 (69.12)
300-420	3 (14.29)	5 (26.32)	13 (46.43)	21 (30.88)
Shift II				
120-240	3 (14.29)	10 (52.63)	4 (14.29)	19 (27.94)
240-360	1 (4.76)	2 (10.53)	2 (7.14)	5 (7.35)
Time of work shift (period)*				
5am to 9 am	17 (80.95)	13 (68.42)	23 (82.14)	53 (77.94)
9 am to 1pm	11 (52.38)	6 (31.58)	9 (32.14)	26 (38.24)
2pm to 6 pm	4 (19.05)	12 (63.16)	6 (21.43)	22 (32.35)
Rest in between each work shift				
Rest period allowed				43 (63.24)
Rest period not allowed				25 (36.76)
Number of rest periods/day				
One	9 (69.23)	15 (78.95)	6 (54.55)	30 (69.77)
Two	4 (30.77)	4 (21.05)	5 (45.45)	13 (30.23)
Length of each rest period (Minute)				
Shift I				
15	6 (46.15)	11 (57.90)	4 (36.36)	21 (48.84)
30	3 (23.08)	4 (21.05)	2 (18.18)	9 (20.93)
Shift II				
90	3 (23.08)	2 (10.526)	1 (9.09)	6 (13.95)
120	1 (7.69)	2 (10.526)	4 (36.36)	7 (16.28)
Time of rest periods				
Shift I (15min)				

7am to 7.15am	3 (23.08)	3 (15.79)	-	6 (13.95)
8am to 8.15am	2 (15.38)	5 (26.32)	-	7 (16.28)
9am to 9.15am	-	-	3 (27.27)	3 (6.98)
Not specified	1 (7.69)	3 (15.79)	1 (9.09)	5 (11.63)
Shift I (30min)				
10am to 10.30am	3 (23.08)	4 (21.05)	2 (18.18)	9 (20.93)
Shift II (90min)				
12noon to 1.30 pm	3 (23.08)	2 (10.526)	1 (9.09)	6 (13.95)
Shift II (120min)				
12noon to 2pm	1 (7.69)	2 (10.526)	4 (36.36)	7 (16.28)

Figures in parenthesis indicate percentage

*Multiple responses

2. Assessment of discomfort and repetitive strain of workers engaged in floriculture activities

The discomfort and repetitive strain of workers engaged in floriculture activities was presented in table 2.

Table 2. Discomfort and repetitive strain faced by the workers in different floriculture activities (n=68)

Sr. No.	Activities	Marigold farm		Rose farm	
		WMS	Rank	WMS	Rank
Discomfort rating*					
1.	Land preparation	2.00	VII	2.75	V
2.	Planting	2.58	IV	2.89	IV
3.	Manuring	2.60	III	2.64	VI
4.	Irrigation	2.17	VI	2.00	VII
5.	Picking	3.75	I	3.63	II
6.	Pruning	NA	NA	3.67	I
7.	Packing	2.43	V	3.00	III
8.	Storage	3.00	II	2.00	VII
9.	Transportation	3.00	II	2.00	VII
Repetitive strain rating**					
1.	Land preparation	3.10	III	2.25	V
2.	Planting	2.79	IV	2.78	II
3.	Manuring	2.70	V	2.55	IV
4.	Irrigation	2.67	VI	1.25	VII
5.	Picking	3.34	I	3.44	I

6.	Pruning	NA	NA	3.44	I
7.	Packing	3.00	II	2.67	III
8.	Storage	1.50	VII	2.00	VI
9.	Transportation	1.50	VII	2.00	VI

*5= Very severe, 4= Severe, 3= Moderate, 2= Mild, 1= Very mild

**5= Very exhausted, 4= Exhausted, 3= Moderately exhausted, 2= Mildly exhausted, 1= Comfortable

Discomfort faced by the respondents- The finding in Table 2 highlights discomfort faced by the respondents engaged in Marigold farm units. The maximum discomfort was faced by the respondents during picking activity with weighted mean score of 3.75 followed by storage and transportation having weighted mean score of 3.00, manuring having weighted mean score of 2.60, planting having weighted mean score of 2.58, packing having weighted mean score of 2.43, irrigation having weighted mean score of 2.17 and land preparation having weighted mean score of 2.00. Table 2 further reveal that the respondents engaged in Rose farm unit were facing severe discomfort while pruning activity (weighted mean score 3.67) as the pruning activity required repetitive movements with high force for longer time. The discomfort rating in terms of weighted mean score in Rose farm units for picking activity was 3.63 followed by packing (weighted mean score 3.00), planting (weighted mean score 2.89), land preparation (weighted mean score 2.75) and manuring (weighted mean score 2.64). The least (2.00) weighted mean score was found in irrigation, storage and transportation which indicates that mild discomfort was faced during these activities by the respondents working in Rose farm units.

Repetitive strain faced by the respondents- The repetitive strain of the respondents in terms of weighted mean score was presented in table 2 and it was found that the repetitive strain was maximum (WMS 3.34) for picking activity in Marigold farm units followed by packing (WMS 3.00), land preparation (WMS 3.10), planting (WMS 2.79), manuring (WMS 2.70) and irrigation (WMS 2.67). The weighted mean score (1.50) of storage and transportation indicates that the respondents working in Marigold farm units in these activities were mildly exhausted in terms of repetitive strain. Respondents engaged in Rose farm units were facing maximum repetitive strain in picking and pruning activities with weighted mean score of 3.44 followed by planting (WMS 2.78), packing (WMS 2.67), manuring (WMS 2.55) and land preparation (WMS 2.25). In storage and transportation, respondents engaged in Rose farm units were

mildly exhausted in terms of repetitive strain as weighted mean score for both activities was 2.00.

IV. DISCUSSION

Working profile of workers engaged in floriculture activities: Flower picking was the activity in which maximum percentage (86.76%) of the respondents were as compared comparing to the other activities in floriculture farms. Thippaiah (2005) reported that among all floriculture activities, maximum number of employment was found in harvesting activity. When compared to other field crops and horticultural crops, used to the higher employment generation was found in the cultivation of flowers and flower picking activity accounted the continuous requirement of labour. In the present study, majority (76.47%) of the respondents were go to floriculture unit on foot and the minimum distance travelled by the respondents (41.18 %) was one to two kms and maximum distance travelled by the respondents (29.41%) was three to four kms. Workers were working in floriculture units from one to nine years. Most of the respondents (55.88%) were working 25 to 30 days in a month and the daily working hours of respondents (66.17%) in floriculture units were 4-6 hours whereas 13.24 percent of the respondents were working for 7-9 hours per day in floriculture units. There were two work shifts and 67.65 percent of the respondents were working in a single shift while 32.35 percent of the respondents were working in double shifts. In shift I, respondents were working for 180-420 minutes while in shift II respondents were working for 120 -360 minutes per day. Majority (77.94%) of the respondents were working in morning time as flower picking activity was done mainly in morning time and majority of the workers were engaged in flower picking activity. Thippaiah (2005) also reported that the flowers were plucked between 6 am and 12 noon. In present study, majority of the respondents (63.24%) were allowed to take rest during work shifts but 36.76 percent of the respondents were not allowed

to take rest while working. Overall data as well as district wise data indicated that majority of the respondents who were allowed to take rest were allowed to take only one rest period in between the work. In shift I, rest periods were allowed for fifteen and twenty minutes in between work whereas in shift II, rest periods were allowed for 90 minutes and 120 minutes while working.

Assessment of discomfort and repetitive strain of workers working in floriculture activities: Results highlighted that in Marigold farm units, the maximum discomfort was faced by the respondents during picking activity followed by storage and transportation, manuring, planting, packing, irrigation and land preparation. It was further revealed that the respondents engaged in Rose farm units were facing severe discomfort during pruning activity as the pruning activity required repetitive movements with high force for longer time followed by packing, planting, land preparation, and manuring. Repetitive strain faced by the respondents in different floriculture activities was maximum for picking activity in Marigold farm units followed by packing, land preparation, planting, manuring and irrigation. Respondents engaged in Rose farm units were facing maximum repetitive strain in picking and pruning activities. Reason behind the same could be that picking and pruning activities required either forward bending or standing with raised arms for longer duration. The repetitive nature of picking and pruning activity lead to repetitive strain problems.

V. CONCLUSION

Overall data as well as district wise data indicate that majority of the workers were engaged in flower picking activity in floriculture units. Majority (76.47%) of the respondents used to go to floriculture unit on foot. One to two kms distance was travelled by the 41.18 percent of the respondents to go to floriculture unit and more than half of the respondents were working 4-6 hours per day. Floriculture workers were working in single shift as well as in double shifts. A large number of workers (36.76%) were not allowed to take rest during work. Overall data as well as district wise data indicate that majority of the workers were taking only one rest period in between the work while 48.84 percent of the workers were taking rest only for fifteen minutes. The maximum physical discomfort and repetitive strain was faced during picking and pruning activity by the workers.

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Analytical Practices to Obtain Efficient Concrete Grade in Outrigger Walls below Plinth Level in Multistorey Building

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Abstract— To make the structure that would be free from lateral effects, some of the additional components should be implemented to it to make it safe. Some of the supplementary components are shear wall, bracing elements, belt supported system, outrigger wall system etc. These supplementary components when added to the multistoried fascinating and high rise structure can make it stiffer that ultimately fulfill the living needs. These add-ons make the structure safer for various horizontal and vertical irregularities. In this study outrigger system is taken for analysis by implementing the outrigger walls below the plinth level. Previous studies shows the outrigger system used at a particular height, but none of the researches shows this kind of the structural stability research approach. The main objective of the current theme is to prove the optimum grade of concrete that can be used when this kind of approach is adopted. Total 8 cases were selected, analyzed and compared among each other to select the optimum one. Building case OT8 observed and obtained as efficient case and should be recommended when this type of stability in building will be provided.

Keywords— *Efficient Concrete Grade, Lateral load capacity, Outrigger Walls, Plinth Level Stability, Shear wall.*

I. INTRODUCTION TO STABILITY ENHANCEMENT CRITERIA

The tall structures needs firm stable ground to achieve lateral stability with lesser ground area for living and commercial purposes. The stabilization of the structure has done when using the current guidelines of the Indian Standardization. The dual structural configurations are now the main criteria for current tall structures. Since the construction an industry expand day by day and follows the financial customs that operates cost effective structures.

The only view in this industry matter is financial along with reallocation and liquidity of funds for operation and maintenance of the construction. With this financial operation in this industry, structural engineers needs to do a very tough task to make the stability of the structures at each part or at each stages when design steps has going on. When construction work on site is going on, it sometimes loses the financial trend when the structural stability is there to make the structure heavy that sustain the hazardous seismic activities.

To make the structure more sustainable in these seismic activities, some supplementary stiffening structural members are needed like heavy weight R. C. C. components, belt supported systems, outrigger systems, dual structural systems, truss belt systems etc. These supplementary components on one hand, it stabilizes the structure more effectively, but on the other hand, it increases the mass of the structure that ultimately increases the base shear. Hence it is essential to make the structure more light and stable, subsequently it lessen the financial trend in the project.

As per the generalized theory of stability, many research activities are going on numerous researches done in this field established many things in terms of stability of the structure by means of and without adding the supplementary components. Practices that stability escalates could be achieved by:-

1. By implementing some stability improvement structural components that resist the lateral and vertical loads.
2. Altering the size of the structural elements.

3. By elimination of the structural elements.
4. By decreasing the bulkiness of the structure.
5. By changing the grade of concrete in overall or in the part of the structure.

II. OBJECTIVES OF THE CURRENT STUDY

The current study consists of providing the outrigger wall system below the plinth level to increase the lateral load handling capacity in multistoried building. A complete analytical procedure has followed to obtain the each parametric result, compared among all eight cases to obtain most efficient case. As per Indian standard under earthquake Zone III, the following objectives selected in this study:-

1. Determination of effective case among general and Outrigger Wall supported system provided below plinth level.
2. To determine Base shear response when seismic forces are applied in X and Z direction to the structure.
3. To find member Shear Forces values in Beam with efficient case among all eight cases.
4. To examine Bending Moment values in Beam with efficient case among all eight cases.
5. To determine and compare member Torsion values in Beam.
6. To examine column Axial Forces for total eight cases with efficient case to determine minimum axial force.
7. To find member Shear Forces values in Column with efficient case among all eight cases.
8. To examine Bending Moment values in Column with efficient case among all eight cases.
9. To determine and compare member Torsion values in Column.
10. To analyze the maximum nodal displacement case in X direction with most efficient case that provides more stability among others.
11. To obtain the maximum nodal displacement values in Z direction with most efficient case among all eight cases.
12. To demonstrate and recommend the efficiency of wall belt below plinth level with optimum concrete grade to stabilize the structure.

III. PROCEDURE AND 3D MODELING OF THE STRUCTURE

A semi commercial (G+16) storied apartment is supposed to be situated at seismic zone III and rested on medium soil. This apartment has both vertical load along with horizontal loads acting over it and this seismic load creates the maximum deflection at the top of the structure. With 900 sq. m. area, Dimensions and different input parameters of the building are selected and applied over the structure and then seismic load is applied over it with various seismic parameters as mentioned in Table 1 and Table 2 respectively.

For the analysis of the optimum grade of outrigger, a total of eight different cases have chosen for the parametric analysis, its description shown below. Dead loads, Live loads, Response spectrum loads and load combinations as per Indian Standards are applied on the apartment. M20, M25, M30, M35, M40, M45 and M50 grade of concrete used with Fe 500 grade of steel is used.

Figures 1 to Figure 4 shows typical floor plan of the apartment, its front view without wall outrigger at plinth, with wall outrigger at plinth and finally last figure shows the description of different components of apartment with Wall Outrigger below plinth level.

Table 1: Dimensions and different input parameters of the building

Parameters	Values
Building configuration	G + 16
Building type	Semi-commercial apartment
Total plinth area	900 m ²
Building Length	6m @ 5 bays
Building Width	5m @ 6 bays
Height of building from Ground level	64.5 m
Height of each floor	3.5 m
Depth of footing	4 m
Beam dimensions	550 mm x 350 mm
Column dimensions	600 mm x 550 mm
Slab thickness	165 mm
Staircase waist slab	150 mm
Shear wall thickness	140 mm
Outrigger wall thickness	135 mm
Material properties	Concrete (M20), (M25), (M30), (M35), (M40), (M45), (M50) Steel (Fe 500)

Table 2: Seismic parameters applied on the structure

Parameters	Values
Importance factor I	1.2
Fundamental natural period (Ta) in X and Z direction	1.1256 seconds
Response reduction factor R	4
Zone factor	0.16
Structure Type	RC frame Structure
Zone	III
Soil type	Medium soil

Different building model cases selected for analysis using analytical software

1. **Case OT1** = Outrigger Stability Case – Regular Building without Wall Outrigger below Plinth.
2. **Case OT2** = Outrigger Stability Case – Wall Outrigger of M20 grade Connection below Plinth level.
3. **Case OT3** = Outrigger Stability Case – Wall Outrigger of M25 grade Connection below Plinth level.
4. **Case OT4** = Outrigger Stability Case – Wall Outrigger of M30 grade Connection below Plinth level.
5. **Case OT5** = Outrigger Stability Case – Wall Outrigger of M35 grade Connection below Plinth level.
6. **Case OT6** = Outrigger Stability Case – Wall Outrigger of M40 grade Connection below Plinth level.
7. **Case OT7** = Outrigger Stability Case – Wall Outrigger of M45 grade Connection below Plinth level.
8. **Case OT8** = Outrigger Stability Case – Wall Outrigger of M50 grade Connection below Plinth level.

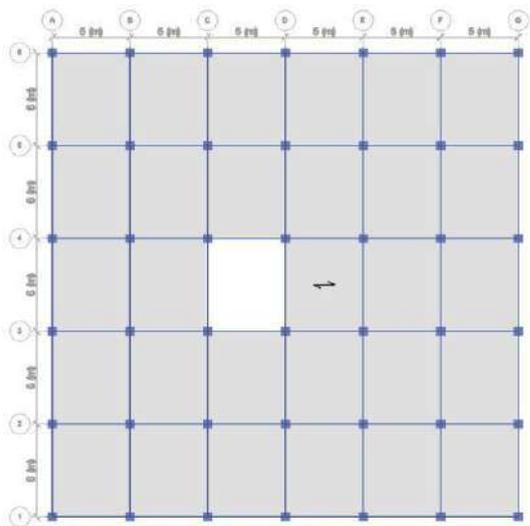


Fig. 1: Typical floor plan

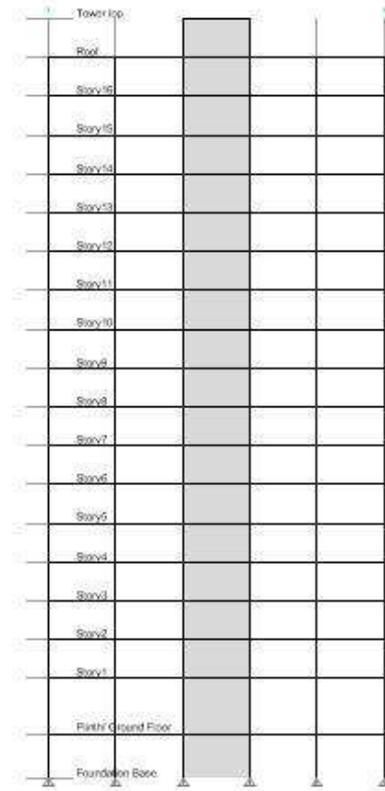


Fig. 2: Front View of the Structure without Wall Outrigger

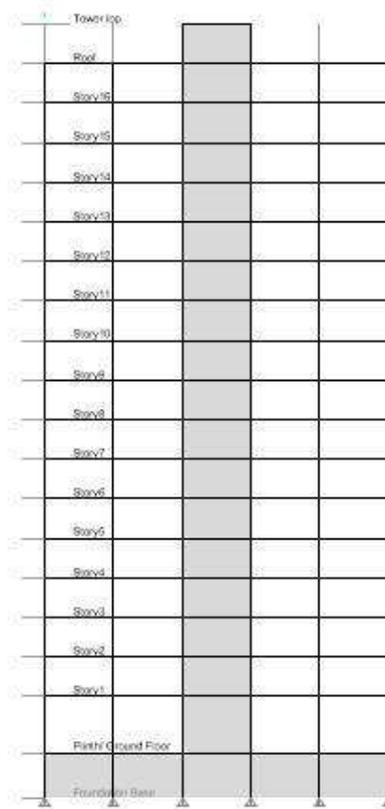


Fig. 3: Front View of the Structure with Wall Outrigger

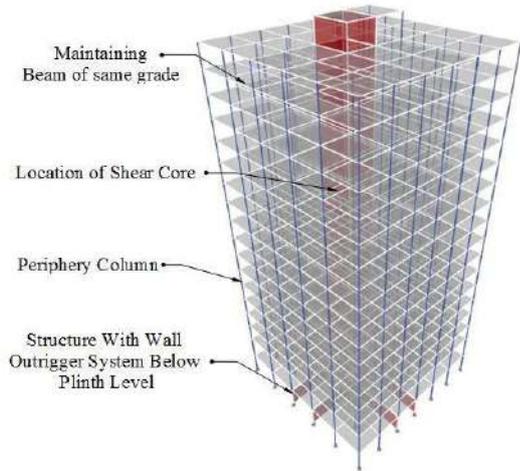
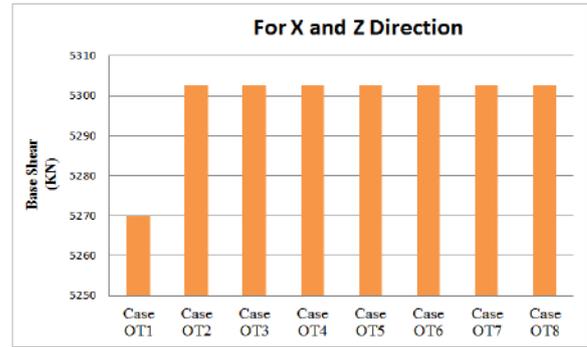


Fig. 4: Description of different components of Structure with Wall Outrigger below Plinth Level

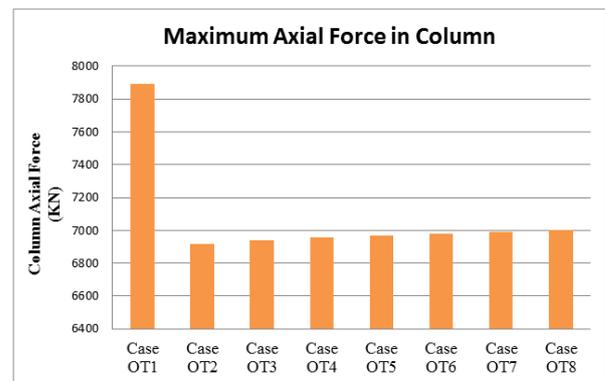
IV. RESULT ANALYSIS

As per Indian Standard 1893: 2016 code of practice, the stability of the building criteria by changing the grade of concrete in outrigger walls below the plinth level by fulfilling all the objectives.

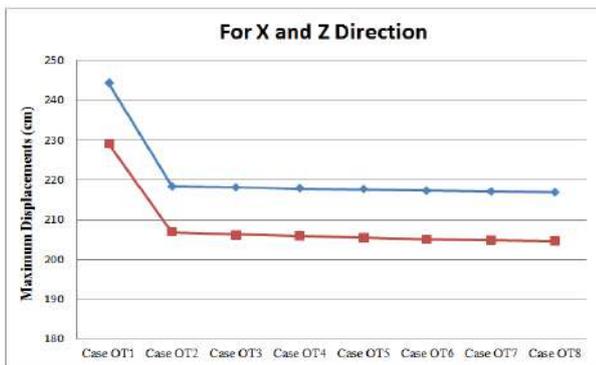
Graphical representation of each result parameters has discussed as per different wall outrigger case shown below:-



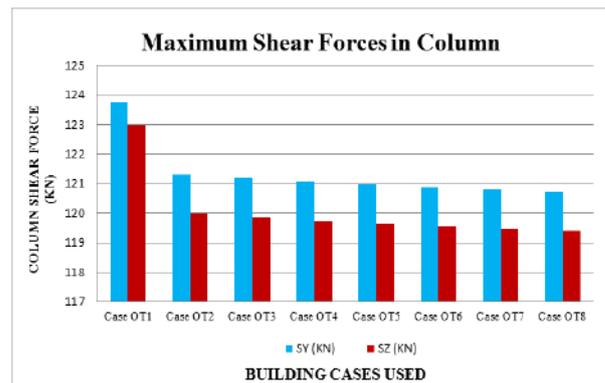
Graph 2: Graphical Representation of Comparison of Base Shear in X and Z direction for all Outrigger Wall Cases below Plinth Level



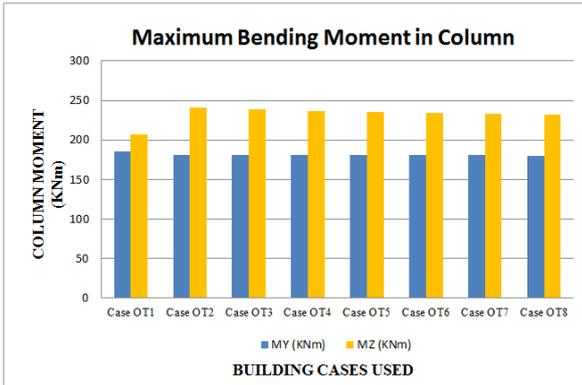
Graph 3: Graphical Representation of Comparison of Maximum Axial Forces in Column for all Outrigger Wall Cases below Plinth Level



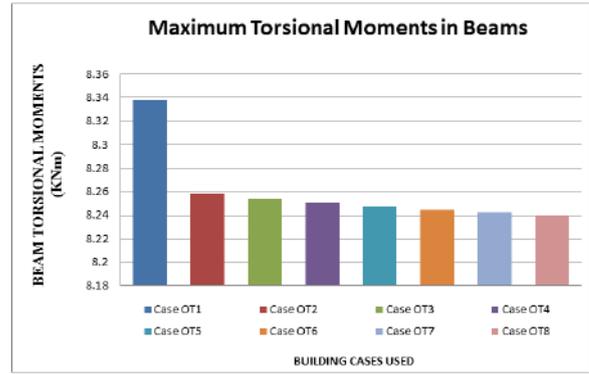
Graph 1: Graphical Representation of Comparison of Maximum Displacement in X and Z direction for all Outrigger Wall Cases below Plinth Level



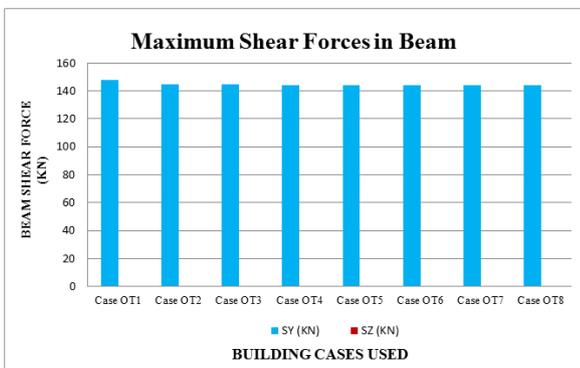
Graph 4: Graphical Representation of Comparison of Maximum Shear Force in Column for all Outrigger Wall Cases below Plinth Level



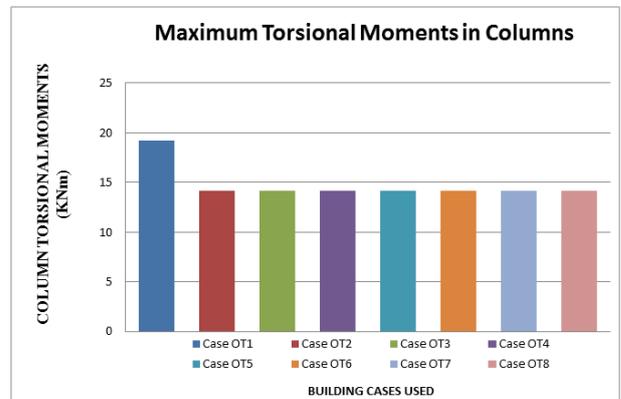
Graph 5: Graphical Representation of Maximum Bending Moment in Column for all Outrigger Wall Cases below Plinth Level



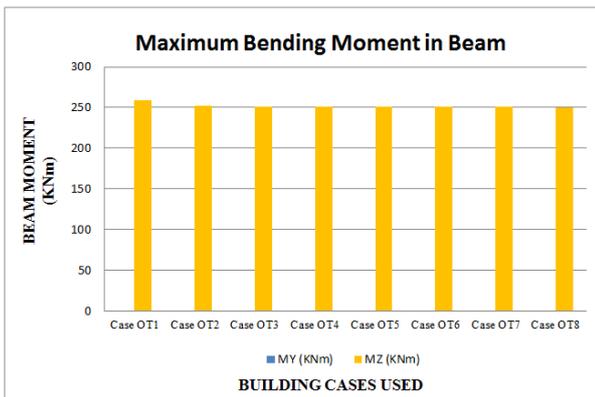
Graph 8: Graphical Representation of Comparison of Maximum Torsional Moments in Beam for all Outrigger Wall Cases below Plinth Level



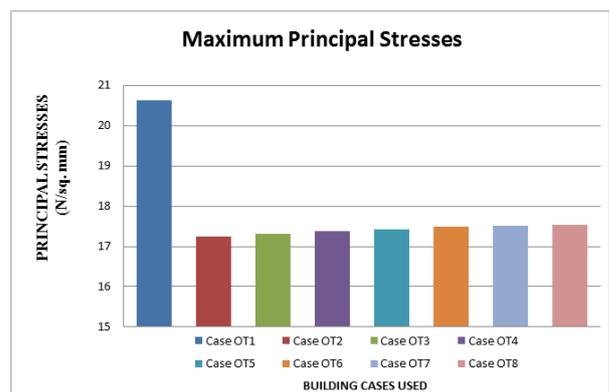
Graph 6: Graphical Representation of Comparison of Maximum Shear Force in Beam for all Outrigger Wall Cases below Plinth Level



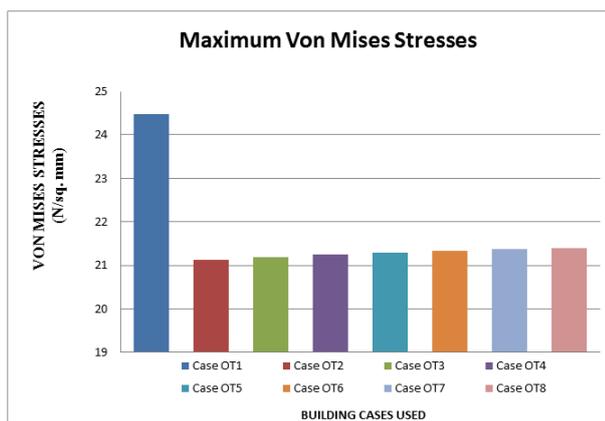
Graph 9: Graphical Representation of Comparison of Maximum Torsional Moments in Columns for all Outrigger Wall Cases below Plinth Level



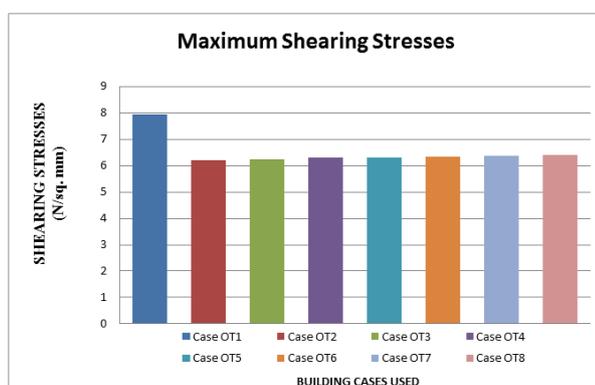
Graph 7: Graphical Representation of Comparison of Maximum Bending Moment in Beam for all Outrigger Wall Cases below Plinth Level



Graph 10: Graphical Representation of Comparison of Maximum Principal Stresses for all Outrigger Wall Cases below Plinth Level



Graph 11: Graphical Representation of Comparison of Maximum Von Mises Stresses for all Outrigger Wall Cases below Plinth Level



Graph 12: Graphical Representation of Comparison of Maximum Shearing Stresses for all Outrigger Wall Cases below Plinth Level

V. CONCLUSION

The conclusion can be pointed out are as follows:-

1. With a minimum value of 216.978 mm in X direction and minimum value of 204.664 mm in Z direction, Maximum displacement values drastically decreases since stiffness is more when outrigger wall cases used below plinth level.
2. Due to an addition of a new structural component, the Base shear values increases with increase in additional member in a structure. Case OT1 seems less but due to addition of outrigger wall, it seems an equal value of 5302.53 KN for all cases in both the directions.
3. Maximum Axial Forces in Column seems lesser in Case OT2 with a minimum value of 6916.3613 KN for all Outrigger Wall Cases provided below plinth level.
4. Shear forces in column gradually decreases when Outrigger Wall Cases provided below plinth level. In

both moment along Y and Z axis (M_y and M_z), the column bending moment parameter also decreases gradually after the application of Outrigger Wall Cases provided below plinth level.

5. Shear forces in beams along both Y and Z axis (S_y and S_z), after the application of Outrigger Wall Cases provided below plinth level the values declines.
6. The pattern that created in shear forces in beam follows same in Bending Moment in Beam for both M_y and M_z . The values decreases to Building case OT8.
7. With a minimum value of 8.2402 KNm, the Torsion parameter in beams seems less in Building case OT8 after the application of Outrigger Wall Cases provided below plinth level. The same trend follows in Torsional cases in column.
8. A big drop has seen in Maximum Principal Stresses observed after the application of Outrigger Wall Cases provided below plinth level. The same trend follows in Von Mises stresses and Shearing Stresses respectively.

Observing all the parameters, after the application of Outrigger Wall provided below plinth level, the Building case OT8 observed and obtained as efficient case and should be recommended when this type of stability in building will be provided.

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The importance of the nurse in caring for the Kangaroo method: Integrative literature review

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Abstract— Aim: identify the importance of the nurse in the care of the kangaroo method. **METHOD:** It is an integrative literature review study, developed according to the production of the following steps: delimitation of the guiding question, establishment of inclusion and exclusion criteria, search and selection by primary studies in the databases, data evaluation and analysis, results presentation and interpretation. **Results:** the importance of the nurse's assistance in carrying out the kangaroo method, in consideration of he has an important role in this process, by the reason of he is responsible for promoting the care, encouraging the family to be present and acting during the stages of the kangaroo method. **CONCLUSION:** Therefore, the nurse's role in the kangaroo method is essential to conduct the teachings about the stages of the method at the moment the mother-child is going through this process, thus ensuring the effectiveness of this strategy.

Keywords— Nursing Care, Kangaroo Method, Newborn.

I. INTRODUCTION

Currently, there are 15 million premature births worldwide and approximately 1 million children die from complications of prematurity, which is the leading cause of

death in children under five (Araújo et al., 2018). According to the Brazilian Society of Pediatrics - SBP, Brazil is the 10th largest country in the world in the number of live premature births and the 16th in the number of deaths due to complications of prematurity (SBP, 2016).

Due to the high prevalence of infant mortality, the kangaroo method was initially conceived in Colombia in 1979 at the Instituto Materno Infantil de Bogotá by Dr. Reys Sanabria and Dr. Hector Martinez, as a proposal to improve the care provided to preterm newborns in that country (Brazil, 2015).

In this context, the policy of Humanized Attention to the Newborn of Low Weight - Kangaroo Method, which was regulated as Ordinance GM No. 693, on July 5, 2000, later revised as Ordinance No. 1,683, July 12, 2007 (Brazil, 2017), emerged. This policy brought the qualification of global care to the newborn, benefiting the integral development of the child, the family bond and, as a consequence, the reduction of neonatal mortality rates (Sales et al., 2018).

The Kangaroo Method (MC) is a strategy divided into three stages, aiming at the humanization and participation of parents in neonatal care; the first stage begins in the prenatal period of high-risk pregnancy, followed by admission of the newborn (NB) in the neonatal ICU; in the second stage the baby remains continuously with its mother and the kangaroo position is performed most of the time and; the third stage is characterized by monitoring the child and the family in the outpatient clinic and at home until reaching the weight of 2,500g (Heck et al, 2016; Brazil, 2015).

In the research presented by Balduino (2018), regarding the nursing that will be in charge of this assistance, being the mediator between caring and teaching the family members, so that they come to participate in these strategies, such as early skin-to-skin contact between the RNPT and their family, individualized care, partnership with the family and encouraging breastfeeding (Brazil, 2015).

The nurse has a primary role in caregiving assistance, making it possible to welcome and develop balance in the environment, where the kangaroo method will be carried out to introduce the strengthening of affective bonds between mother and child, guaranteeing integral and qualified care (Brazil, 2017; Sales et al., 2018).

The role of the nurse in the MC is essential to conduct the teachings about the stages of the method at the moment the mother-child is going through this process, thus ensuring the effectiveness of this strategy. In this context, the study of Tarcísio (2010), reinforces about the frequent training of the nurse in relation to the MC, the author still makes an observation that, by not passing on the training to the professionals, probably will contribute to the low rates of effectiveness of the second and third stages of the method.

The interest in the study is justified by the importance of the role of the nurse in relation to the practice of the MC, under its limits in the realization of the care of the method for the NT, emphasizing that the mothers have a fundamental role during the process of the stages of the method. In this sense, this study aims to identify the importance of the nurse in relation to the care of the kangaroo method.

II. METHOD

This is an integrative review study of the literature with a methodological approach to reviews, allowing the inclusion of experimental and non-experimental studies for a complete understanding of the phenomenon analyzed (Souza; Silva & Carvalho 2010). It was developed according to the production of the following steps: delimitation of the guiding question, establishment of inclusion and exclusion criteria, search and selection by primary studies in the databases, evaluation and analysis of data, presentation and interpretation of results (Crossetti, 2012 & Soares et al., 2014).

In the face of this, we tried to answer the guiding question: What is the importance of the nurse in the care of the newborn baby in the performance of the kangaroo method? The search for primary studies in the databases was developed in the period of September 2019, articles published in scientific health journals in the Scientific Electronic Library Online (Scielo), Virtual Health Library (VHL) and Latin American and Caribbean Literature in Health Science (Lilacs) databases, using the descriptors: nursing care, kangaroo method and premature newborn, follows in table 1 of the crossover performed to find as many articles as possible.

Table 1: Descriptor crossover

Database	Crossings	Full
Scielo	Nurse-AND-Method Kangaroo	500
BVS	Kangaroo-AND-born method	480
Lilacs	Method-OR-Kanguru- OR-Bornborn	11.437

Source: Authors, 2020.

In the inclusion criteria were used: articles with primary studies corresponding to the periods from 2014 to 2019, full text, Portuguese language, English and articles available in full without fees. The exclusion criteria used

were: publications prior to the established chronological period, articles with fees charged, studies focused on other themes and articles in Spanish or other languages, abstracts and incomplete texts.

The selection of primary studies in the databases was followed by reading and analyzing the studies found in accordance with the inclusion criteria, and was thus divided into three stages. In the first stage 1,032 articles were identified, of these 504 were duplicated and

eliminated. In the second stage, 528 articles with titles and abstracts available according to the filters used in the research, of which 289 can be chosen.

Only then, after this careful evaluation the full texts were read with 239 articles, 225 not used and discarded because they do not fit the inclusion criteria and because it is not in accordance with the guiding question of this work, so after all this process obtained a final sample of 14 articles. Figure 1 shows all this selection.

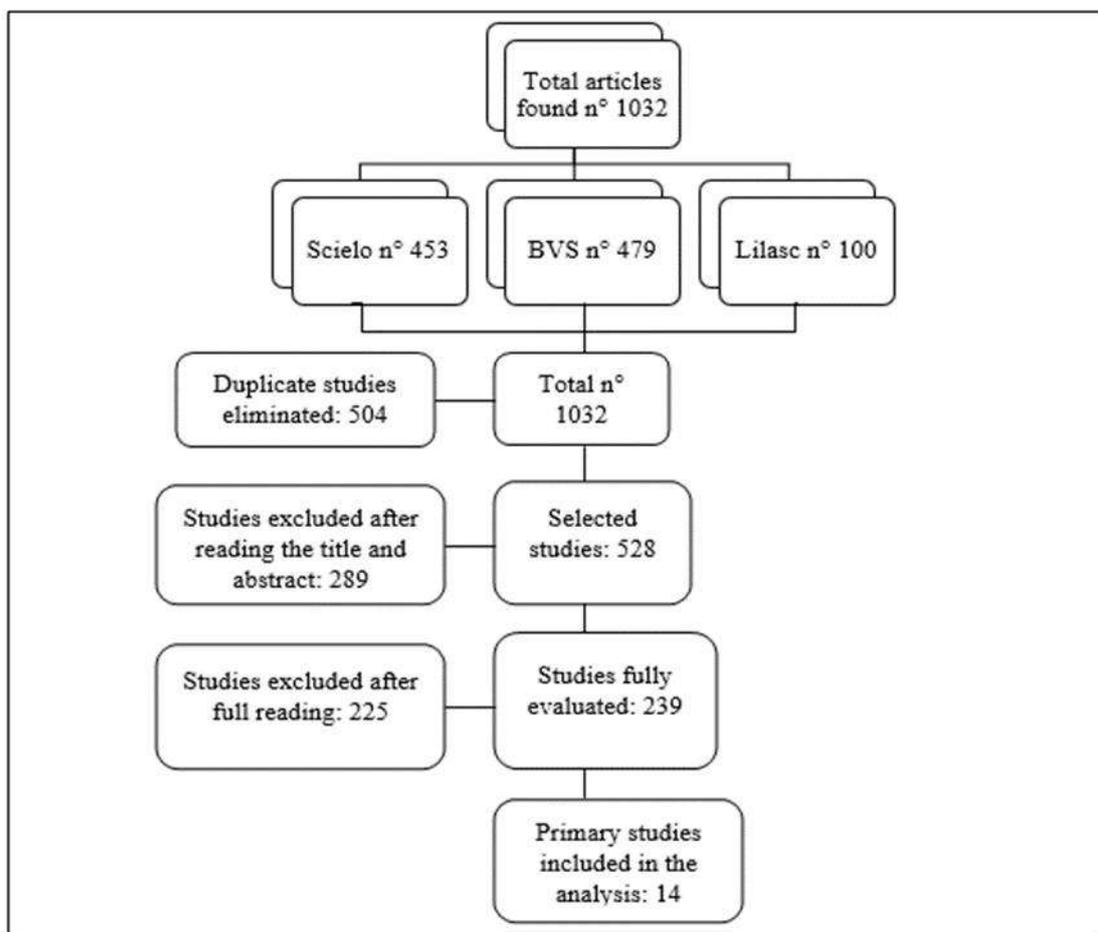


Fig.1: Flowchart of identification, selection and inclusion of Studies

Source: Authors, 2020.

III. RESULTS

Finally, with the final articles found in the literature after the data searches, in what concerns the nurse to be in charge of the care of the kangaroo method to the premature newborn, 3 categories were used for the analysis process: The importance of the benefits of the

kangaroo method for the recovery of the premature newborn; The assistance of the nurse in the care of the kangaroo method; The Reception carried out by the nurse in the accomplishment of the kangaroo method. The three categories are in tables 2, 3 and 4.

Table 2: The importance of the kangaroo method benefits for the recovery of premature newborns.

AUTHOR AND YEAR	ACADEMIC JOURNAL	ARTICLE TITLE	RESULTS
VIANA; CUNHA; LEÃO, 2018 ¹¹	Journal of Specialist Scientific Journal	Kangaroo Method: Efficacy Of Nursing Care For Newborn Infants With Low Birth Weight	The most benefits attributed to the kangaroo method include: reduction of hypothermia, sepsis, hospital stay and mortality risk, positive impact on cognitive and motor development of premature infants, maintenance of stability during transport of premature infants, as well as vital signs at physiological levels, even when performed in NB under mechanical ventilation and hemodynamically stable.
MENEZES, 2017 ¹²	Tiradentes University, International Nursing Congress	Benefits from the mother kangaroo method for low birth weight.	The kangaroo method brings numerous benefits, perceived and reported by the mothers themselves, such as the construction of the bond, the approach with the baby favors growth and development, allows quiet sleep, in addition to the security that the Method provides for mothers in the care of the baby and the pleasure in consolidating the maternal role.
ARAUJO <i>et al.</i> , 2016 ¹³	Rev. iberoam. educ. investi.	The experience of the kangaroo method experienced by mothers in a public maternity ward in Maceió / Alagoas	The low weight newborn will be caressed, touched and wrapped in the lap, will feel more welcomed and safe in the mother's lap, because through this method will contribute to the smooth transition to extrauterine life, having the mother as an indispensable role in the care and treatment of the baby in this process of the stages of the MC, especially when it is in the kangaroo infirmary.
BALDUINO, 2018 ¹⁴	Anhanguera of Santa Bárbara D'oeste College	Mother-Kangaroo Method in Premature: The Performance of the Professional Nurse.	The importance of the kangaroo method, because it encompasses the family and it will be stimulated to early contact with the baby, forming bond and all this is extremely relevant in the recovery of the newborn.

Source: Authors, 2020.

In summary, the several benefits of the Kangaroo Method for both mother and baby are shown in table 3, regarding the autonomy perceived by mothers about the Kangaroo Method, there was a strengthening of the mother-child bond and the family, improving the clinical

picture and its development, thus contributing to the hospital discharge and the nurse is always establishing an effective communication in all stages of the Kangaroo Method.

Table 3: The nurse's assistance in front of the kangaroo method care.

AUTHOR AND YEAR	ACADEMIC JOURNAL	ARTICLE TITLE	RESULTS
SALES et al., 2018 ⁵	Esc. Anna Nery, Rio de Janeiro	Contributions of the nursing team in the second stage of the Kangaroo-Mother Care Method: Implications for hospital discharge of the newborn.	The nurse should take special care to maintain the integrity of the baby's skin, to this end, the nurse should seek ways to implement strategies in the kangaroo ward and set goals that promote protection to the newborn
KLOSSOSWSKI et al., 2016 ¹⁵	Rev. CEFAC	Comprehensive care for the premature newborn: implications of practices and public policy.	Baby and family care promotion, promoting family participation and encouraging breastfeeding.
CRUZ, 2017 ¹⁶	Unime	Kangaroo Method: The importance of the family in skin-to-skin contact of the preterm newborn.	Promote a humanized and safe approach through skin-to-skin contact (kangaroo position).
SILVA; CRISPIM; FIGUEIREDO, 2017 ¹⁷	UniSALESIANO	Neonatal Intensive Care Unit: mothers' perception of lived experiences and the importance of nursing care and orientation.	Stimulate participation in all the activities developed during the stages of the kangaroo method.
ARAÚJO; RODRIGUES; PACHECO, 2015 ¹⁸	Rev enferm UERJ	The maternal care promotion to the premature newborn: the perspective of problematizing education in health.	To promote newborn care through the kangaroo method, the nursing team should establish effective communication with mothers in order to instrumentalize and empower them to participate in the care of their child in an autonomous way, with the mother being gradually introduced into the care process.

Source: Authors, 2020.

In relation to the results observed in table 4, as for the assistance of the nurse in the care of the premature newborn, this professional needs to promote the

participation of the family for the accomplishment of the process of the kangaroo method in all the stages.

Table 4: The Reception carried out by the nurse in the realization of the kangaroo method.

AUTHOR AND YEAR	ACADEMIC JOURNAL	ARTICLE TITLE	RESULTS
PEREIRA, Viana Magda Rogéria et al 2018 ¹⁹	Research Journal: Cuidado é Fundamental Online.	Experiences of Pre. mature Mothers Regarding the Kangaroo Method.	The conversation with mothers about the Kangaroo Method process is evident in the first stage they follow with special care: in the care of their family, guiding on the participation of the mother and father in the care of the Newborn, as well as stimulating the support of breastfeeding, discussing the experiences of mothers and the difficulties they face due to the health conditions of their Newborn

BEATRIZ Lelis et., 2018²⁰	Rev enferm UFPE	Motherly welcome in the context of prematurity	Nursing has the responsibility of welcoming relatives, focusing on the figure of fathers and special care for mothers.
NUNES et al., 2017²¹	Rev Paul Pediatr	Relationship of Kangaroo Position Duration and Mother-Child Pre-Term Interaction at Alta Hospital	The welcome during the kangaroo method, the interaction and communication of the team with the mothers are of fundamental importance so that the emotional experiences of this period are better elaborated and the suffering of the mothers minimized.
NUNES, Natália P., 2015²²	Rev Promoção Saúde Bras	Maternal perception of the experience in the neonatal intensive care unit.	The reception of the multidisciplinary team to the mother who suffers at this moment, should be considered as relevant by the professionals, because the problems experienced can interfere in the realization of the Kangaroo Method, often, due to lack of information, the mothers are dominated by feelings of distrust, despair, fear and incomprehension in relation to the clinical picture of the baby.

Source: Authors, 2020.

IV. DISCUSSION

In this research, specifically, the importance of the nurse in the care of the kangaroo method was identified, besides observing the benefits of this practice, since the mothers have a fundamental role in the realization of the method.

In a study by Viana, Cunha & Leão (2018), they stated that the benefits of CM in relation to the newborn were analyzed, where positive impacts on its cognitive and motor development could be identified, with an improvement in its weight gain and reducing its length of stay, thus avoiding hospital infections.

In this research it was possible to observe the benefits perceived by mothers about the Kangaroo Method, already in the studies of Menezes (2017), it positively points out about this perception of mothers that there was a strengthening of the mother-child bond, favoring the growth of this Newborn and provided their involvement in the care of their baby.

According to the author Araujo et al., (2016), if the newborn underweight is caressed, touched and wrapped in the lap, he will feel more welcomed and safe, because this tool is a technology that provides a smooth transition to extrauterine life, having the mother as an indispensable role in the care and treatment of the baby in the transition of the stages of the Kangaroo Method, especially when he is in the infirmary.

To reinforce this discussion, it is worth noting the statement of Balduino (2018), in this study it was observed that the method also contributes to include the family by encouraging early contact with the baby, increasing the bond and affection and improving the recovery of the newborn.

The results of the above approaches intensify that the importance of the nurse beside the mothers to direct the care to the newborn is notorious, because this professional needs to seek strategies that promote the well-being and protection of the baby, possess the technical capacity, based on scientific evidence to guide the care (Sales et al., 2018).

Therefore, the kangaroo method is intended to include family participation in this process and to guide the mothers on the importance of exclusive breastfeeding (Klossowski et al., 2016).

In this way promoting a humanized assistance stimulating the skin-to-skin contact by the kangaroo position (Cruz, 2017). Since the method brings challenges for nurses regarding the best way to teach mothers the care for their babies, these professionals should always demonstrate the importance of all stages of the process and seek to intermediate all these cares (Silva, Crispim & Figueiredo, 2017).

According to Araújo, Rodrigues & Pacheco (2015), the nursing team should promote newborn care through the kangaroo method, encouraging mothers as to the

importance of their participation in the recovery of their child in this care process.

The studies of Pereira et al., (2018), show that it is important to welcome the nurse to mothers and their premature newborn, because they are responsible for passing on relevant information related to the stages of the kangaroo method and the importance of each one for the effectiveness of this strategy, stimulating them about breastfeeding, discussing and sharing about the experiences experienced to overcome this stage (Lelis et al., 2018).

This welcome and interaction needs to be effective, because if the nurse does not pass on information about the process of the stages of the Kangaroo Method, they will be dominated by feelings of distrust and despair, since they will be sensitized when they see the clinical status of their children (Nunes et al., 2017; N. P. Nunes, 2015). But if they are correctly guided these feelings will not dominate them and they will understand that they are part of this bond of care.

Since there are countless attributions developed by nurses in front of all this assistance of the Kangaroo Method, in which they contribute to the success of this tool, guaranteeing the teaching-learning for the mothers by means of the appropriate guidelines about this strategy and its benefits.

V. CONCLUSION

The present study denotes the importance of the nurse's assistance in the care of the kangaroo method, because it has an important role in this process, since it is responsible for promoting the care, encouraging the family to be present and acting during the stages of the kangaroo method.

In addition to encouraging the practice of breastfeeding, improving the clinical condition, and strengthening the affective bond between mother and newborn, the researchers analyzed prove this importance of the nurse as a mediator to favor the care and benefits of the Kangaroo Method for mother-child contributing to hospital discharge.

Therefore, all the findings in this research are relevant for the performance of the Kangaroo Method mainly in relation to the reception, the way this professional will approach the mother, from the entrance until her discharge from hospital, passing on the important information for the realization of the Kangaroo Method strategy, thus they acquire the confidence in realizing the kangaroo position.

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Antimicrobial capacity of photodynamic therapy on apical debris of root canals instrumented with a reciprocating system

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Abstract— *Purpose: The aim of this study was to evaluate the antimicrobial action of photodynamic therapy (PDT) on apically extruded debris after root canal system (RCS) instrumentation using WaveOne Gold (WOG) files. Methods: Thirty mesial roots from permanent mandibular molars were selected. The mesiobuccal canal of each root was contaminated with standard-strain Enterococcus faecalis ATCC29212 for 21 days and randomly divided into two groups (n=15): WOG, canals instrumented with WOG file; WOG + PDT, photodynamic therapy performed after instrumentation with WOG. The parameters used for PDT were: low power laser with a wavelength of 660 μm, power of 100 mW, energy of 9.6 J, irradiation time of 96 seconds, and fiber diameter of 600 μm. E. faecalis samples, as well as apical debris, were collected before and after each procedure. Descriptive analysis was performed and the Kruskal-Wallis (Dunn) nonparametric test was applied, with a significance level of 5%. Results: Significant reductions in E. faecalis were observed after instrumentation in both groups (p<0.05). Regarding debris, microbial reduction occurred only in the group in which PDT was performed after instrumentation (p<0.05). Conclusion: The combination of PDT and reciprocating instrumentation effectively reduced Enterococcus faecalis burden in apically extruded debris.*

Keywords— *debris, endodontic treatment, enterococcus faecalis, photodynamic therapy.*

I. INTRODUCTION

The persistence of microorganisms within the root canal system (RCS) is the main cause of endodontic treatment failure, and is associated with persistent or new-onset periradicular lesions [1,2]. The high prevalence of Enterococcus faecalis in endodontic infection has been attributed to its ability to survive in adverse conditions [3-7].

During mechanical and chemical root-canal preparation, extrusion of material beyond the root apex occurs. The presence of bacteria in this extruded debris may result in postoperative complications such as pain and inflammation, of varying intensity depending on host

immune response and virulence of the microorganisms involved. Even when appropriate technique is followed, treatment failures can occur due to the restricted access of instruments and substances to certain regions, which may hinder diffusion of chemical agents into the RCS. New technologies are required to overcome this [3,8 -13].

Photodynamic therapy (PDT) is a treatment modality based on the interaction of low-intensity visible light with a nontoxic photosensitizer in the presence of oxygen, resulting in reactive oxygen species (singlet oxygen and hydroxyl radicals) capable of penetrating microorganism cells. PDT can destroy microorganisms without damage to adjacent tissues and with no risk of bacterial resistance

[2,14-18]. Several studies have proven the efficacy of PDT in intracanal microbial reduction [1,3,8,10,12,15,19-27].

The aim of this study was to evaluate the antimicrobial action of PDT on apical debris when combined with reciprocating instrumentation. The null hypothesis was that there would be no significant microbial reduction in apically extruded debris with this combination as compared with reciprocating instrumentation alone.

II. METHODS

The present study was approved by the local research ethics committee (protocol no. 2.431.557)

Sample Selection and Preparation

Thirty permanent lower first molars were selected. Sample size was calculated by analysis of variance (ANOVA) for $\alpha=0.05$ and $\beta=0.80$; six repetitions per treatment were deemed necessary. The inclusion criteria were:

- Morphologically similar mesial roots, with independent and formed foramina;
- No history of previous endodontic treatment;
- No canal calcifications or obliterations;
- Absence of internal/external and apical resorption;
- Absence of root caries, lacerations, or cracks;
- Root canals with a master apical file size compatible with a #10 K-file;
- Mesio Buccal canal curvature of 10–20° as determined by Schneider's method [28].

Digital radiographs of all teeth were obtained in the buccolingual direction to evaluate the aforementioned criteria and to determine the degree of mesial root curvature. The selected teeth had their root surfaces scraped with a #13/14 McCall universal curette (Trinity Indústria e Comércio Ltda, São Paulo, Brazil). The specimens were then stored in 0.1% thymol (A Fórmula, Salvador, Brazil) for 24 h for disinfection. The teeth were decoronated near the cemento-enamel junction to obtain a standard root length of 13 mm. The orifice of the mesiolingual canal was sealed with light-curing resin (Z350 XT, 3M ESPE, Minnesota, USA) in accordance with standard dental restorative technique [5], and the distal root discarded. To facilitate contamination of the RCS with *Enterococcus faecalis*, all canals were instrumented manually with a #20 K-file (Dentsply Maillefer, Ballaigues, Switzerland) down to working length [5,14]. The working length was established through the visual method by inserting a #10 K-file (Dentsply Maillefer,

Ballaigues, Switzerland) into the root canal and advancing it until the file was visible at the apical foramen under the operating microscope. The instrument was withdrawn and 1 mm subtracted from the measurement thus obtained.

The roots were numbered and attached to the cap of an Eppendorf tube (Eppendorf do Brasil, São Paulo, Brazil), which was used to collect any debris extruded through the foramen after instrumentation. The tubes and their caps with roots attached were then sterilized by the moist heat method in an autoclave (Digitale, BS Equipamentos, Indústria e Comércio Ltda., Varginha, Brazil) at 121°C for 15 min.

The roots were randomly divided (www.random.org.br) into two groups of 15 each. Root canals were contaminated with the ATCC29212 standard strain of *E. faecalis*, reactivated in sterile Brain Heart Infusion (BHI) broth (Sinergia, Campinas, Brazil), and incubated for 24 h at 37°C in a 5% CO₂ atmosphere. The 24-h culture was seeded onto a Petri dish containing BHI agar and incubated for a further 24 h at 37°C in a 5% CO₂ atmosphere. Once microbial growth was observed, a suspension was prepared in a tube containing 10 mL sterile normal saline solution and adjusted to match a McFarland turbidity standard of 2 (Probac do Brasil, Produtos Bacteriológicos Ltda, São Paulo, Brazil). In a sterile test tube, 5 mL of the prepared solution was added to 5 mL sterile BHI broth to obtain the final suspension. A 20- μ L aliquot of the final suspension was injected into each root canal. Specimens were stored in 24-well cell culture plates (Costar, New York, NY). Sterile cotton pellets moistened in sterile distilled water were added to four wells in each plate to ensure a moist environment. The plate lid was closed and sealed with adhesive tape, and the preparation incubated for 21 days at 37°C in a 5% CO₂ atmosphere. Every 2 days, 20 μ L sterile BHI broth was added to the root canals and the cotton pellets were replaced with freshly moistened ones. The viability and purity of the microorganisms within the canals were checked weekly by random sampling of two teeth using #15 sterile paper points (Endpoints, Rio de Janeiro, Brazil), which were placed and kept inside the canals for 1 min, seeded onto sterile BHI broth, and incubated for 24 h at 37°C in a 5% CO₂ atmosphere. After microbial growth, smears and Gram stains were prepared for morphological and stain-based confirmation of bacterial identification.

After 21 days, baseline microbial count and bacterial viability were checked in both groups by the paper points method described above. Subsequently, instrumentation was performed in each group as follows:

- WOG: root canal instrumented with WaveOne Gold files (Dentsply Maillefer, Ballaigues, Switzerland) (n=15). The canals were instrumented with a WaveOne Gold reciprocating system using a single 25.07 (primary) file powered by an X-Smart Plus electric motor (Dentsply Maillefer, Ballaigues, Switzerland) in WaveOne Gold mode. Instrumentation always took place with three inward and three outward motions (average amplitude 3 mm), performing wall brushing as the instrument exited the canal, with preparation proceeding preferably by thirds until the working length was reached. The irrigating solution employed during preparation was sterile saline, at a volume of 5 mL per root third (total volume 15mL per canal). Between cycles, the tooth was instrumented to its actual length with a #10 K-file (Dentsply Maillefer, Ballaigues, Switzerland), simulating the clinical protocol. At the end of the instrumentation process, final irrigation was performed with 2 mL of sterile saline.

WOG + PDT: WaveOne Gold instrumentation combined with PDT. The RCS was instrumented with WaveOne Gold files (Dentsply Maillefer, Ballaigues, Switzerland) following the same protocol as described for the WOG group. Subsequently, PDT was performed in every third (cervical, middle, and apical) at 4 mm, 8 mm and 12 mm of working length.

PDT protocol

The root canals were filled with 0.5 ml of photosensitizing solution (0.005% methylene blue, Chimiolux, DMC Group and Aptivalux Bioengenharia Ltda., São Carlos, Brazil), with the aid of a syringe. The pre-irradiation time was 2 minutes. Subsequently, the channel was irradiated with a conical optical fiber tip (DMC Group and Aptivalux Bioengenharia Ltda., São Carlos, Brazil), diameter 600 µm, coupled to a diode laser (Therapy XT; DMC Equipamentos Ltda., São Paulo, Brazil; wavelength 660 nm, power 100 mW). The energy deposited in each third of the root from cervical to apical (4 mm, 8 mm and 12 mm) was 3.2 J, for a total energy of 9.6 J [8,15,20]. Spiral movements were performed for 32 seconds in each third.

Microbial collection after instrumentation was performed by inserting #25 absorbent paper points (Endopoints, Rio de Janeiro, Brazil) into the root canal for 1 minute. Subsequently, each root was irrigated with 1 mL of sterile saline to collect residual debris.

Eppendorf tubes containing the absorbent paper points used for baseline and post-instrumentation microbial sampling, as well as tubes containing suspended debris, were shaken for 30 seconds in a tube shaker (Vortex AD 56; Phoenix, Araraquara, Brazil). Serial dilutions were

prepared from this suspension to a concentration of 10⁻⁵; then, 0.1-mL aliquots of the suspension and each dilution were seeded onto Petri dishes containing BHI agar incubated in a 5% CO₂ atmosphere at 37°C for 24 hours. Subsequently, the number of colony forming units (CFU) per plate was counted and the concentration in CFU/mL calculated.

Statistical Analysis

The results were analyzed in Biostat 4.0 software. The Shapiro-Wilk test rejected the assumption of normality; therefore, a descriptive analysis was performed, and the Kruskal-Wallis (Dunn) nonparametric test was applied with a significance level of 5%.

III. RESULTS

There was a significant reduction in microbial counts after instrumentation in both groups (p<0.05). Reductions in microbial burden in extruded debris occurred only in the group undergoing PDT after instrumentation (p<0.05, Table 1 and Fig. 1).

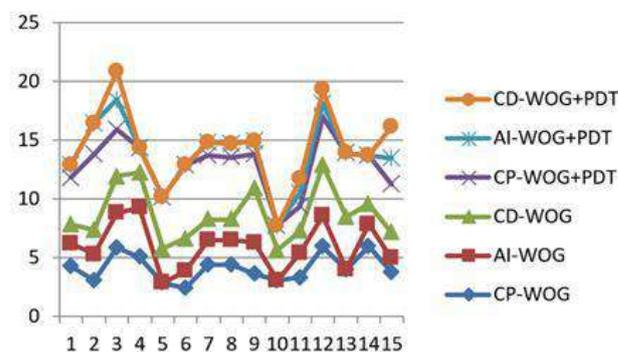


Fig. 1: Microbial count of samples in each group

CD, microbial counts in apical debris; AI, microbial counts in the root canal system after instrumentation; CP, microbial counts in the root canal system at baseline.

Table 1. Medians, interquartile ranges, and Kruskal-Wallis (Dunn) statistic of microbial counts before instrumentation, after instrumentation, and in debris between experimental groups.

Microbial count	WOG	WOG+PDT	(p)
Before instrumentation	3.97 (1.51) ^{a,1}	4.12 (2.60) ^{a,1}	p > 0.05
After instrumentation	2.12 (1.17) ^{b,1}	1.14 (1.14) ^{b,1}	p > 0.05
In debris	2.60	0.00	p < 0.05

	(1.27) ^{ab,1}	(0.57) ^{b,2}
(p)	<0.05	<0.05

WOG. Wave One Gold instrumentation; WOG + PDT, WOG instrumentation and photodynamic therapy.

Different lower-case letters along the same column and different numbers along the same row denote $p < 0.05$.

IV. DISCUSSION

E. faecalis is considered an opportunistic pathogen. It is strongly associated with persistence of root-canal infection and failure of endodontic treatment [7,17,26,29-32]. In an attempt to reproduce the real-world clinical situation of persistent intracanal contamination, we selected *E. faecalis* for this experiment due to its ability to penetrate the dentinal tubules and known resistance to antimicrobial agents [15,16,25,27,33-35]. *E. faecalis* was cultivated for 21 days, sufficient time for formation of a mature biofilm [5,10,27,36,37], which tends to be associated with even greater resistance to the action of antimicrobial agents and PDT due to the high cell density and presence of an extracellular matrix which blocks drug diffusion and absorption [38].

Pre-enlargement of the root canals was performed manually with #20 K-files in order to standardize the initial diameter, facilitate bacterial contamination, and allow bacteria to reach the dentinal tubules [5,25,32,36].

All instrumentation techniques cause extrusion of material beyond the apical foramen, but studies have shown that WOG files extrude less debris [31,37,39-41]. In the present study, the canals were prepared by thirds, always in a smooth crown-down fashion, in order to avoid apical extrusion. Sterile saline solution was used as an irrigant to avoid interference of agents with antimicrobial activity on the results [5,37].

Although chemical-mechanical debridement of the RCS is effective, adequate preparation of areas that are difficult to reach may be impossible due to anatomical complexity and microbial resistance [12,32]. New approaches have been researched to reduce the incidence of biofilm on the infected root canal wall; in this context, several studies have proven the efficacy of PDT as an aid in RCS disinfection [1,3,5,8,10,12,15,16,19,20,22-27,38].

The most commonly used light sources are low-power lasers, which have a specific wavelength for photosensitizer activation that, in addition to having an antimicrobial effect, facilitates rapid repair of periapical tissues and reduces post-instrumentation discomfort [4,6,9,15,38]. The photosensitizer used in this study was

methylene blue, due to its ability to absorb light at the wavelength emitted by 660 nm laser, as demonstrated in previous studies [2,5,14-17,33,35,36,38]. The pre-irradiation time used was 2 minutes, which is sufficient to allow the dye to accumulate in the target tissues but not so long as to allow its effect to decline before light application [8,14,20,25,33,38]. Pre-irradiation time is important because Gram-positive bacteria (such as *E. faecalis*) have a porous outer membrane, allowing faster diffusion of the photosensitizer into the cell [15,16].

Laser was applied within the root canal with the aid of a fiberoptic tip. In most studies, the irradiation protocol involves spiral motions of the fiber, starting from the apical region and moving towards the cervical direction [8,14,15,17,20,25,33,38]. There are no previous studies reporting PDT application by thirds, from cervical to apical, as performed in this study. Several studies have confirmed the efficacy of PDT in intracanal microbial reduction after instrumentation or in combination with irrigating substances, despite the wide range of PDT protocols adopted [1,2,5,6,16,17,20,22,27,33-35,38].

There was a significant difference in microbial count in extruded debris between the WOG and WOG + PDT groups, in favor of the latter. This result suggests that the photosensitizing agent penetrated the dentinal tubules and hard-to-reach areas when activated by the laser, corroborating the findings of Ramalho et al. [9] Use of a fiberoptic tip for intracanal irradiation is an important aid in PDT because it promotes a homogeneous distribution of light along the root canal, allowing the irradiation beam to reach the full length of the RCS and the root apex [2,5,12,15,20,27,33,34,38]; this facilitates greater formation of reactive oxygen species within the dentinal tubules, which enhances microbial reduction [6]. Sabino et al. [38] suggested that the spiral movement of the fiber inside the canal may contribute to reoxygenation of the photosensitizer, allowing a greater formation of reactive oxygen species; in addition, spiral movements can help displace the biofilm and facilitate dye diffusion into deeper dentinal tubules, thus improving PDT efficacy.

PDT was applied by thirds until the working length was reached, a procedure that, to the best of our knowledge, had not been adopted in previous research, and which may have contributed to the reduction of bacteria in the apical debris.

The presence of microorganisms in apical debris may result in worsening of periapical inflammation, causing postoperative pain and flare-ups, hindering the healing process in periapical tissues, and negatively affecting the clinical outcome of endodontic treatment [37,40,41].

V. CONCLUSION

We conclude that adjunctive use of PDT after reciprocating instrumentation of the root canal system reduced bacterial burden in debris extruded beyond the root apex. This finding provides new perspectives in the field of endodontics.

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Parasitological analysis of vegetables sold in supermarkets and fairs in the city of Araguaína, state of Tocantins, Brazil

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Abstract— *The consumption of fresh vegetables has become more commonplace, thus, the occurrence of parasitic structures in these food causes several pathologies, between them, intestinal diseases, once helminths, protozoa and other pathogens may be present in these vegetables. The objective of this study was to identify the incidence of parasites in vegetables sold in supermarkets and fairs of Araguaína-Tocantins. A total of 80 samples were collected and analyzed, 40 samples of curly lettuce (*Lactuca sativa* L.) and 40 samples of arugula (*Eruca vesicaria*). The analysis was performed at the food quality control laboratory of UNITPAC. There were found, *Entamoeba coli* cysts, *Iodamoeba butschili*, on lettuce, and larva and eggs of *ancylostomids*, also the presence of *Strongyloides stercoralis* present in both lettuce and arugula. In this perspective, the results expressed, demonstrate the need for more effective hygienic-sanitary measures, aiming at an improvement in the population's quality of life.*

Keywords— *Vegetables. Parasites. Pathologies. Food. Hygienic-sanitary.*

I. INTRODUCTION

The current scenario has brought several changes in the eating habits of Brazilians, especially when talking about a more nutritious and healthier diet. Due to these changes, vegetables have been gaining more space in the lives of citizens, since these food possesses a low caloric content and also present nutrients which bring benefits to the body.[1]

In this perspective, lettuce and arugula are the most popular leafy vegetables, also the most consumed in Brazil and around the world, as they are used mainly in the form of salads, due to their convenience. Lettuce (*Lactuca sativa* L.) is a vegetable that has an Asian origin and belongs to the Asteraceae family, this vegetable has several benefits, such as vitamins A, B1, B2, B5 [2], whereas arugula (*Eruca vesicaria*) is rich in folic acid and antioxidant.

However, they represent a vehicle for the transmission of parasites, mediated by biological, social and cultural factors, since their cultivation occurs mainly through the use of water, and it may be related to contamination with fecal material of human origin, thus, the use of irrigation with water and soil contamination by the use of organic fertilizer with fecal residues, is a relevant factor for the cultivation of vegetables. [3]

Therefore, intestinal parasites (helminths and protozoa) reflect a problem for public health. Brazil, for example, has a high prevalence of parasites in less favored communities and with precarious basic sanitation and sewage systems. Thus, the conditions of personal, environmental and sanitary hygiene in which these populations live determine the cycle of parasites. [2]

Some studies have shown a high frequency of protozoa and helminths in vegetables sold in supermarkets, fairs and restaurants [4]. In this context, the confirmation of the presence of parasites in vegetables is of a great importance for public health, since it provides data for health surveillance about the sanitary hygienic status of these products, allowing the optimization of control in the cultivation of vegetables. [5]

In addition, the population's eating habits of consuming fresh vegetables make it possible the exposure to a large portion of the people to the most varied forms of transmission of these parasites. From this perspective, it is essential to control the quality of fresh food, since they are directly and indirectly linked to infections in individuals. With this, it is necessary to guide the population on the correct consumption and hygiene of these food, as it is of great importance to preserve and maintain the population's food quality.

Thus, we see the need to conduct this study in order to review the relationship of parasites with public health, as well as the importance of quality control in parasitic contamination of vegetables and identification of the incidence of parasites in vegetables sold in supermarkets and fairs in the city of Araguaína, state of Tocantins.

II. MATERIALS AND METHODS

The research was carried out from August to September 2019, where 80 samples of vegetables were collected and analyzed, 40 of lettuce (*Lactuca sativa* L.), 40 of arugula (*Eruca vesicaria*), in a supermarket and in an open market (in the city center) in Araguaína - Tocantins.

The collection of samples was carried out during a period of eight weeks, in the morning shift on five days of the week, from Monday to Friday, and a sample of fresh lettuce and arugula was collected randomly, *in natura*, whole, from the lot of vegetables to sale in a supermarket in Araguaína – Tocantins. Moreover, fresh samples of the studied vegetables sold at weekly opening fairs were collected during one day each week.

Establishments with a large flow of customers were selected and for the selection of samples, the criterion used was that each sample unit had its own visual organoleptic characteristics, being composed of a set of stems and leaves tied with a bow.

The samples were individually packed in polyethylene bags for first use and in a styrofoam box soon after, duly identified, were sent to the Quality Control Laboratory of the Centro Universitário Presidente Antônio Carlos - UNITPAC. The time elapsed for the collection of the

samples and the preparation of them was of 2 hours, yet for the beginning of the exam, it was expected the sedimentation of 24 hours.

The samples were analyzed using the Hoffman parasitological method (spontaneous sedimentation). Each type of vegetable was washed twice with 600 mL of distilled water, in a plastic bowl, with each unit separately in the same water. This washing liquid was captured in 150 mL conical cups, the liquid remaining for 24 hours in rest to perform the spontaneous sedimentation technique. Then, 0.1 mL of the obtained sediment was removed, which was analyzed by optical microscopy, directly on a slide stained with lugol solution. The 10X objective blade scanning technique was adopted to identify parasites or free-living larvae and the confirmation of parasitic structures was performed using the 40X objective.

III. RESULTS AND DISCUSSION

The contamination levels of the two vegetable variations showed that the percentage of helminths and protozoa found in the samples of vegetables sold in open markets and supermarkets in the city of Araguaína, state of Tocantins is significant, since it was found that 95% (76/80) of the vegetable samples showed contamination with some type of helminths and that 2.5% (2/80) are contaminated by some type of protozoa from a total of 80 samples analyzed, as shown in Chart 1.

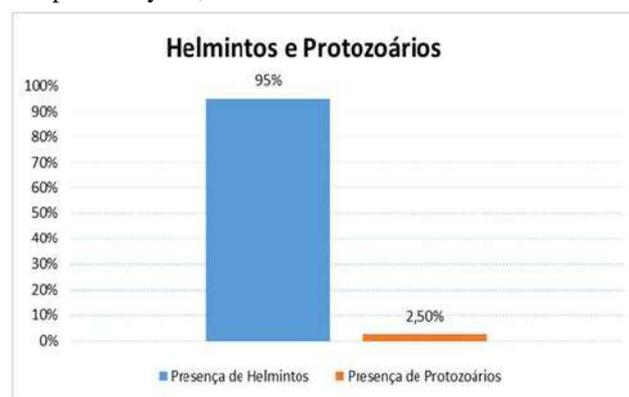


Fig.1: Frequency of helminths and protozoa in lettuce and arugula samples

Similar results were found by Medeiros et al. [6], where after optical microscopy analysis of arugula and green onion samples from markets in the city of Vitória da Conquista, state of Bahia, reported that 100% (10/10) of the arugula samples and 80% (8/10) of green onion were positive for the presence of parasites.

Falavigna et al. [7], in the city of Maringá, state of Paraná, by analyzing samples of curly and iceberg lettuce from fairs, also found expressive results, with a percentage

of 70% and 76% of the samples, respectively, positive for parasitological research.

Other studies carried out also demonstrated the presence of parasites in the analyzed vegetables. According to França et al. [8], in 2009, in the city of Uberlândia, state of Minas Gerais, it was found that 100% (96/96) of lettuce analyzed, of the curly variety, which were marketed by producers at a fair, presented some evolutionary form of parasites. The same result was obtained by Nomura et al. [9], where in the analysis of 8 samples of lettuce from a fair and a supermarket analyzed in the city of Londrina state of Paraná, all were positive for some species of parasite.

It was possible to observe the presence cysts of *Iodamoeba butschili* and *Entamoeba coli* appearing in smaller proportions, with a prevalence of 1.25% (1/80) for both parasites and being present only in lettuce, as shown in Table 1. These data are lower than those detected by Medeiros et al. [6] who found contamination rates in the range of 44.82%. Even though the presence of *Entamoeba coli* in food samples is not considered pathogenic, it is indicative of low hygienic-sanitary conditions. [10]

Table 1: Frequency of enteroparasites found in lettuce and arugula samples.

	Parasita	Local da Coleta			
		Supermercado		Feira	
		Alface	Rúcula	Alface	Rúcula
Cisto	Cisto de <i>Iodamoeba butschili</i>	1			
	Cisto de <i>Entamoeba coli</i>			1	
Larva	Larva rhabditóide ancilostomídeo	1	19		10
	Larva filarióide ancilostomídeo	6	4	1	17
	Larva filarióide Strongyloides Stercoralis		9	5	3
Ovo	Ovo de ancilostomídeo		1		
Total		8	33	7	30

When comparing the group of helminths, we can highlight the presence of larvae and eggs, however, the highest prevalence was rhabditoid Ancilostomid larvae reaching a frequency of 37.5% (30/80) among all samples examined. Higher data than those found by Neres et al. [11], who reported rates of 5.41% for lettuce samples from supermarkets and 16.67% for samples from open markets, in the city of Anapólis - Goiás.

The pathology known as larva migrans can be acquired in contact with larvae of Ancylostomids (parasitic hookworms), however, it is worth mentioning that despite the fact that it penetrates the skin of man, this larva infects dogs and cats, being caused by the species of *Ancylostoma caninum*, however in contact with the skin, the larva penetrates the skin making an erratic cycle leaving a path through which it passes, causing common symptoms such as intense itching. [12]

Thus, the presence of rhabditoid and filarioid larvae in lettuce and arugula, can cause various symptoms, such as bronchitis / alveolitis, when installed in the lungs. The intestine is mainly affected by the formation of intestinal ulcers caused by the hematophagous activity of the parasites, which can favor the occurrence of microcytic and hypochromic anemia and even hypoproteinemia. [12]

Thereby, the possibility of contamination of these vegetables may be associated with various forms of contamination, which may be through the practice of using organic fertilizer, the use of contaminated water for irrigation, transportation made in open crates and the lack of personal hygiene in moment of food handling, such practices were seen as possible forms of contamination. [13].

IV. CONCLUSIONS

The occurrence of parasites in food consumed *in natura* is an alert, due to the possibility of transmission of viable organisms that can invade them causing diseases. Therefore, it is important to know how the vegetables offered in fairs and supermarkets are presented so that quality control measures and possible interventions are adopted in order to obtain a reliable product.

According to the data obtained in this study, it is pointed out that the samples of lettuce (*Lactuca sativa* L.) and arugula (*Eruca vesicaria*) *in natura*, which are sold in supermarkets and street markets in the city of Araguaína-Tocantins, showed a low quality in the hygienic-sanitary question, according to the microscopic analyzes performed. In addition, structures of parasites that cause disease in humans have been shown in most samples, especially in arugula samples, thus, vegetables marketed in these establishments, become inappropriate for consumption according to the standards established by ANVISA.

The results expressed in this study represent a need for greater understanding about the quality control methods of these vegetables from planting to arrival at supermarket fairs.

In this perspective, it is necessary to know and act for control actions in the production of food that are consumed fresh, especially lettuce and arugula bought in fairs and supermarkets. Surveillance measures can be taken to control the vegetable production process. As well as in the domestic environment, asepsis of vegetables and fruits for consumption can be performed by immersion in a chlorine solution prepared from commercial bleach.

Therefore, reinforcing the hygiene of vegetables. This study aims to alert health professionals so that they can play their roles with the community and public health

agencies, acting effectively in orienting the stages of the production, transport and hygiene process of these food, as well as prioritizing measures that allow the treatment of infected individuals.

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Commercial relations in global value chains: Potentials and limitations of ports

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Abstract— *The competitiveness of seaports is affected predominantly by several dimensions and variables present in areas outside the limits themselves. However, decisions made in these areas directly reflect port objectives and strategies. Due to the commercial relations linked to globalization, hinterlands have emerged, others have changed location, and there are also infrastructure changes, due to port congestion and scarcity of land use, as well as the development and emergence of intermodal corridors, among others, causes pointed out in the literature. However, this issue has been addressed relatively moderately in the literature on port operations. In particular, there are gaps to be studied to answer the question of how to know and understand port hinterlands and optimize supply chains. For this reason, this work describes a methodological approach to diagnose, map and define hinterlands of brazilian container seaports. The proposed approach allows researchers, managers and institutions (public and private) to have a resource to assist them in mapping, planning and managing current situations, as well as in analyzing port opportunities, potential and limitations.*

Keywords— *Strategic Resource Management, Hinterland connections, Sea transport chains, Relationship management, Importance-performance analysis.*

I. INTRODUCTION

The world economy has advanced significantly in recent decades, especially in the areas of international trade and industrial organization (Gereffi, Humphrey & Sturgeon, 2005, Reuber *et al.*, 2018). And, within this context, in the course and operational unfolding of activities in these areas, there has been a growing demand for better performance in the global logistics chain (Rodrigue, 2020).

As an alternative to meet the demands of productivity in cargo handling, Bird (1963) and Shintani *et al.* (2020), mention that the ports have stood out over time, as it is one of the oldest forms of interaction between businesses and, that up to the present day they have proved to be efficient in the transportation of bulk cargo.

According to Chen, Jeevan and Cahoon (2016), after decades of adaptation in the ways in which this type of transportation is operationalized and, based on an increasing demand for unitization of cargo, there was a need to create a compartment that met this expectation,

appearing from there the containerization. For these authors, as a consequence of this emergence, there has been a growth in new relationships between countries, regions and port cities, supported among other dimensions, to a large extent, in the dimensions related to transport costs and commercial alliances.

As a result, cargo distribution on the continent (inland or hinterland) has become an important dimension of the globalization / maritime transport / goods distribution paradigm (Notteboom & Rodrigue, 2005, Behdani *et al.*, 2020). For this reason, according to these authors, the transport of goods in contêiner (brazilian portuguese), contentor (european portuguese), container (english), has grown excessively, due to the mobility of handling and, differentiated total logistical cost in relation to other options on the market. And, according to Talley and Ng (2017), this growth implies demands for efficiency improvements in logistics - each product has a different logistics chain -, mainly, in the handling and transport of containers, something that, essentially, is largely derived

part of cargo distribution inland and between port hinterlands, within the economic impact zone.

In this context, this work analyzes the connectivity of Brazilian container seaports from the perspective of their hinterlands, with the objective of diagnosing, mapping and delimiting them.

II. THEORETICAL REFERENCE

The movement of containerized cargo is related to the maritime transport chain through shipowners, ports and transporters, so that the choice of operation and use of this chain needs to be joint, say Talley and Ng (2017). According to these authors, shipowners seek to maximize the profits of this chain, as well as, ports seek productivity and, carriers seek ways to minimize logistical costs.

In the opinion of Notteboom and Rodrigue (2005), knowing the geometric and operating characteristics of a port are preponderant for the performance of port cargo handling, intermodal, and its relationship with the hinterlands. Within this context, Talley and Ng (2017) highlight that in order to choose a port, attributes such as geographic location, oceanic distance between origin and destination, availability of berths, volumetric cargo capacity, value of fees, available services are considered, efficiency, physical and technical infrastructure and availability of transport links between ports and hinterlands. For these authors, these attributes are decisive for selecting a port and, from different users analyze their profitability with the possible capacity of handling containers.

For Kramberger *et al.* (2015) the choice of a port is related to the performance of its operating capacity. According to these authors, this performance is directly influenced by shippers, dispatchers, shipping companies and terminal operators.

In the opinion of Gamassa and Chen (2017), the transport system between a port and its hinterland plays an essential role in connectivity with inland regions. Expanding this view, Nasanjargal, Gamassa and Chen (2018) assure that in order to guarantee an additional cargo flow, the optimization and expansion of connections with inland regions (dry ports) has become preponderant, and as important as the port facilities themselves.

For this reason, Gereffi and Lee (2016) believe that the global value chain is fundamental in helping the management and operation of the industrial sector, allowing, in some cases, to maximize revenues and reduce negative impacts on corporate business. For these authors, another important characteristic of the global value chain is

the opportunity for the chain to link leading companies in the market, with small and medium businesses and suppliers in different local contexts.

Due to the multiplicity of data, information and different operational contexts contained in a value chain, Backer and Miroudot (2014) emphasize that from this view it is possible to plan and manage projects, production, marketing, unitary distribution of products and, also, perform support to the final consumer. However, these activities can be carried out within the same company or divided between companies from different countries and continents, these authors point out.

The rise of global value chains in recent decades - in part, according to Amador and Cabral (2014), is linked to the expansion and development of international trade. These authors point out that this development leads to an increase in investment patterns in cargo transportation, affecting business competitiveness and also in regional macroeconomic developments.

For this reason, Notteboom and Rodrigue (2008) point out that the hinterland is an essential component in strategic and operational planning of a port and for its economic impact on land, due to commercial considerations. This perception of these authors is justified by the contributions that come from reflections related to these plans, such as, for example, in enabling optimized interconnections to stakeholders and supply chain components, which can help reduce costs, improve operational availability and decrease load distribution time.

Thus, as the economy and handling operations become increasingly specialized and globalized, according to Bergqvist and Egels-Zandén (2012), the importance of logistics activities in the interior also increases. However, these authors emphasize that this importance goes beyond regional limits, and it is important to consider port hinterlands in global transport systems. This consideration is based on seaports, which play a key role as transshipment hubs. Because of this, cargo movement flows must be diagnosed, monitored and managed, with measurement in hinterlands that reconciles transport demand and supply (Notteboom & Rodrigue, 2008).

According to Rodrigue and Notteboom (2010), the delimitation of hinterlands allows the understanding of the market, of specific niches and of potential situations to be explored by a port or by the authorities, which allows the development of port development plans (Pizzolato, Scavarda, & Paiva, 2010). Highlighting this argument, Degraffi (2001) suggests that, for a port to remain competitive, it is necessary to constantly review its cargo handling network, having in the hinterlands an important

contribution of knowledge, which allows to understand the current situation, of expansion and, of possible investments outside the administrative boundaries of the geographical limits. In this author's view, this contribution of knowledge can be acquired at different levels of flows, such as primary hinterland - intense cargo handling (from 50,000 tons); secondary hinterland - median movement (between 15,000 and 50,000 tons); and marginal hinterland - small movement (below 15,000 tons).

III. METHODOLOGICAL APPROACH

As a research unit, the main Brazilian public maritime port complexes were used. These units were selected due to their operational efficiency presented in the reports of ports that operate containers between the years 2010 to

2019 of the National Waterway Transport Agency (ANTAQ, 2020). Thus, the analysis carried out was composed of the five selected Brazilian ports (Santos, Paranaguá, Rio Grande, Itajaí and Rio de Janeiro) that showed high efficiency and availability of data in the analyzed period (Rodríguez, 2020).

The methodological approach was established through three steps (Fig. 1), based on the principles: diagnose, map and delimit port hinterlands (Rodríguez & Notteboom, 2010). In addition, a survey was used using secondary data obtained from the waterway statistical yearbook, prepared by the National Waterway Transportation Agency (ANTAQ, 2020), for the time period from 2010 to 2019.

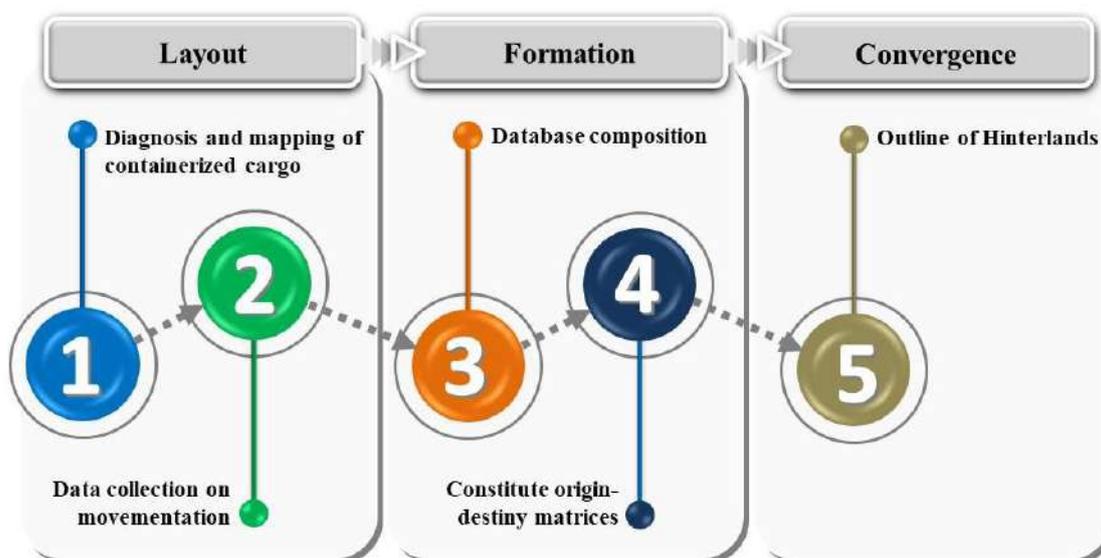


Fig. 1: Summary of the methodological approach used.

In the Scheme (Step 1) a diagnosis and mapping of the containerized cargo handled in Brazilian ports was carried out, taking into account the ANTAQ database (2020). Then, container movement data were collected from all selected Brazilian ports, completing Step 1.

Subsequently, Stage 2 (Formation), started with a composition of the Database (DB). However, for this selection the efficiency and availability of data were verified and, also, according to Bird (1963) and Guerrero (2019), a minimum representation of 3 ports was considered for the mapping of the interior. Then, considering the selection made, it was composed of DB, based on the categorization of hinterlands proposed by Degraffi (2001). From the port movements, these were categorized and classified in order of decreasing efficiency and, later, source-destination matrices were structured.

Finally, Step 3 (Convergence) delimited the primary hinterlands of the selected ports (Degraffi, 2001), with the preparation of thematic maps of containerized cargo (Notteboom & Rodríguez, 2005, Notteboom & Yang, 2017, Guerrero, 2019). The establishment of thematization considered a centrality of primary cargo in the country of origin and, also, for the destination of the cargo. It is important to mention that to assist the processing, mining, intelligence and data analysis activities, electronic spreadsheets and also Tableau software Trial version were used.

IV. RESULTS

In the Scheme (Step 1) a diagnosis and mapping of the containerized cargo handled in Brazilian ports was carried out, taking into account the ANTAQ database (2020).

Then, container movement data were collected from all selected Brazilian ports, completing Step 1.

Based on data from ANTAQ (2020), shipment and disembarkation data were collected from the defined federal ports, analyzing and classifying them according to cargo occurrences by country (second phase). This procedure was necessary due to the consolidation of data in the Waterway Statistical Yearbook (ANTAQ, 2020).

From the classification of cargo occurrences by country, the data analyzed were synthesized, and with this, the origins and destinations of cargo were structured (third phase). For example, when preparing Table 1 below, it was possible to rank the 2010 commercial partners in the port of Santos, located in the State of São Paulo. This port in 2019 corresponded to 48.3% of all container shipments in the country and in previous years it has always remained the main port.

Table. 1: Loading of containerized cargo in 2010.

Destiny	Spain	United States	Singapore	Not identified	Germany	Hong Kong	China	Belgium	Italy
Qnt. (ton)	1.522.380	1.484.438	1.103.659	960.351	877.488	828.881	729.568	725.223	623.260
%	10,43	10,17	7,56	6,58	6,01	5,68	5,00	4,97	4,27
Accum. %	10,43	20,60	28,17	34,75	40,76	46,44	51,44	56,41	60,68
Destiny	Colombia	Netherlands	Maroccos	Argentina	Dominican Republic	South Africa	Mexico	Venezuela	Panama
Qnt. (ton)	556.266	535.480	427.561	410.177	361.947	359.694	355.405	346.370	242.477
%	3,81	3,67	2,93	2,81	2,48	2,46	2,44	2,37	1,66
Accum. %	64,49	68,16	71,09	73,90	76,38	78,85	81,29	83,66	85,32
Destiny	United Kingdom and Ireland	Chile	Peru	Angola	Jamaica	South Korea	France	Bermuda	Senegal
Qnt. (ton)	209.374	197.018	186.428	167.625	147.070	140.073	111.569	105.858	93.519
%	1,43	1,35	1,28	1,15	1,01	0,96	0,76	0,73	0,64
Accum. %	86,76	88,11	89,38	90,53	91,54	92,50	93,26	93,99	94,63
Destiny	Iran	Congo	Malasya	Trinidad and Tobago	Japan	United Arab Emirates	Uruguay	Ecuador	Oman
Qnt. (ton)	91.009	79.011	77.590	71.689	63.258	57.487	48.895	44.289	35.009
%	0,62	0,54	0,53	0,49	0,43	0,39	0,34	0,30	0,24
Accum. %	95,25	95,80	96,33	96,82	97,25	97,65	97,98	98,28	98,52
Destiny	Sri Lanka	Pakistan	Nigeria	Malta	Russia	India	Portugal	Taiwan	Zimbabwe
Qnt. (ton)	30.055	28.429	28.150	27.145	23.070	18.944	10.062	9.125	8.178
%	0,21	0,19	0,19	0,19	0,16	0,13	0,07	0,06	0,06
Accum. %	98,73	98,92	99,12	99,30	99,46	99,59	99,66	99,72	99,78
Destiny	Bahamas	Cuba	Equatorial Guinea	Cape Verde	Ivory Coast	Egypt	Saudi Arabia	Qatar	Israel

Qnt. (ton)	7.946	7.570	7.105	4.858	1.859	1.702	562	441	78
%	0,05	0,05	0,05	0,03	0,01	0,01	0,004	0,003	0,0005
Accum. %	99,83	99,89	99,93	99,97	99,98	99,99	99,9955	99,9986	99,9991
Destiny	Lebanon	Greece	Dominica	Philippines	---	---	---	---	Total
Qnt. (ton)	58	34	31	9	---	---	---	---	14.592.804
%	0,0004	0,0002	0,0002	0,00006	---	---	---	---	---
Accum. %	99,9995	99,9997	99,9999	100	---	---	---	---	---

Source: ANTAQ (2020).

It is observed that the composition of the hinterlands for landing in 2010, according to Degrossi (2001) indicates: primary hinterland: Spain, United States, Singapore, Germany, Hong Kong, China, Belgium, Italy, Colombia, Holland, Morocco, Argentina, Dominican Republic, South Africa, Mexico, Venezuela, Panama, United Kingdom, Great Britain and Ireland, Chile, Peru, Angola, Jamaica, South Korea, France, Bermuda, Senegal, Iran, Congo, Malaysia, Trinidad and Tobago, Japan and the United Arab Emirates; secondary hinterland: Uruguay, Ecuador, Oman, Sri Lanka, Pakistan, Nigeria, Malta, Russia and India; and marginal hinterland: Portugal, Taiwan, Zimbabwe, Bahamas, Cuba, Equatorial Guinea, Cape Verde, Ivory Coast, Egypt, Saudi Arabia, Qatar, Israel, Lebanon, Greece, Dominica and the Philippines.

Based on the data collected, when comparing the years 2010 and 2019, it is possible to note that there was an increase of 117.24% in the number of commercial partners, as well as an increase of 20.84% in the amount of tons shipped.

There is a decrease from 33 (thirty-three) to 29 (twenty-nine) in the number of primary partners, with only 25 (twenty-five) countries repeated in the two years, such as the United Arab Emirates and the United Kingdom of

Great Britain. Brittany and Ireland, which became secondary hinterlands. While Japan, Venezuela and Trinidad and Tobago, they became marginal hinterlands. Iran has no cargo transportation records for Santos after 2018, and Bermuda has not received containerized cargo after 2017 from the port. Also, four countries entered as primary hinterland, with Uruguay, Ecuador and Malta moving from secondary hinterlands to primary and Bahamas from marginal hinterland.

Between the years 2010 and 2019, it is observed that the port of Santos has three shipment sequences (Fig. 2), with important fluctuations in productivity. The first oscillation consists of a reduction in 2013, when compared to the previous year, there was a decrease of 3.68%. However, compared to 2010, there was an increase of 2.31%. The second reduction occurred in 2016, when compared to 2017 there was a reduction of 3.1%. However, when compared to the first reduction, there was an increase of 11.95%. The next reduction occurred in 2019, when compared to the previous year, its decrease was 1.66%, and in 2016 the increase was 5.09%.

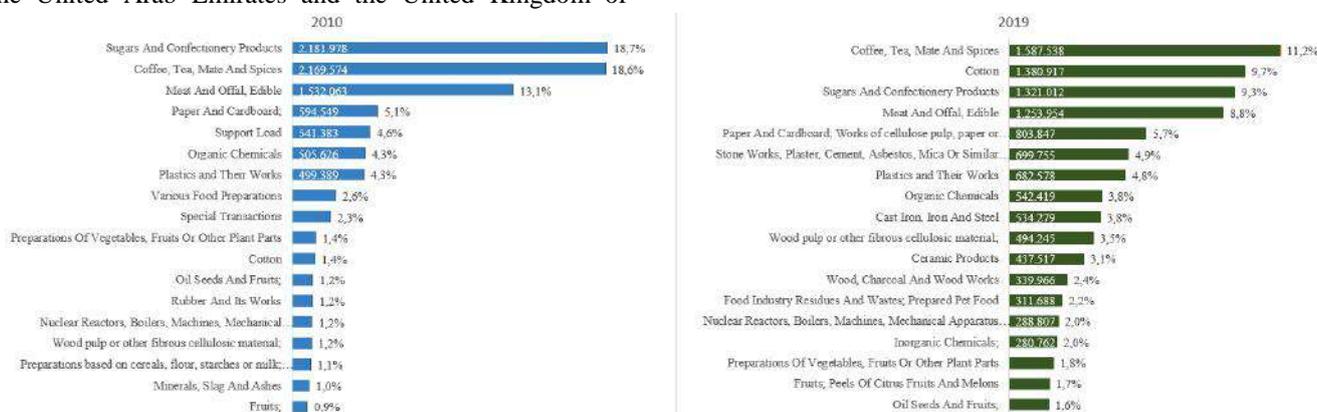


Fig. 2: Analysis of the variation between products shipped (2010 and 2019). Source: ANTAQ (2020).

Thus, from Fig. 2 there is a decrease in sugar, coffee and meat transported, as well as its percentage of participation in the loading of containerized cargo, highlighting materials such as cotton, which now represents 9.7% of the products transported and stone works with 4.9% participation.

Concluding the analysis of the main port observed, there are four other remaining ports (Fig. 3), for which the shipping data will be discussed and analyzed, based on the data collected in ANTAQ (2020).

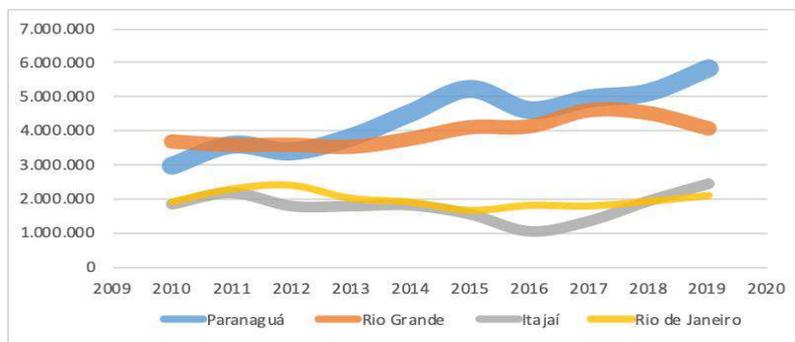


Fig. 3: Shipment history of the chosen ports related to the quantity transported (2010 and 2019). Source: ANTAQ (2020).

Seaport Paranaguá

The seaport Paranaguá, is located in the state of Paraná and in 2019 corresponded to 16% of the containers shipped in the country and in previous years it has always been among the three main ports. When comparing the years 2010 and 2019, a decrease in the number of partners is observed, from fifty-one to thirty-three, which is equivalent to a loss of 35.3%. However, there is a 96.34% increase in the amount of tons transported and a considerable increase in transport to countries that were already part of the primary hinterlands. An increase of 87.96%, in addition to the inclusion of six countries as primaries, of which only Jamaica became a new partner, and there was a change in hinterlands in five other countries. Of these, the United Kingdom, United States, Mexico and Morocco were marginal hinterlands and Angola was a secondary hinterland.

Based on Fig. 3, it can be seen that in the period from 2012 to 2015, there was a growth of about 54%, with this increase becoming a 5.36% drop in containerized transport in the years 2015 and 2016. The decrease in the transport of meat and offal (-8.42%), paper and cardboard (-19.68%), waste and waste (-44.97%), among others, is attributed. As a consequence, an increase of three consecutive years ended. In 2019, there was a significant increase in transport, recovering losses definitively and becoming the year with the highest quantity in tons of shipments in the last ten years.

Seaport Rio Grande

Located in the state of Rio Grande do Sul (RS) and in 2019 it accounted for 11.2% of all container shipment

movements in the country and in previous years it has always been among the top three. It is also observed that there was an increase of thirteen commercial partners, adding to this an increase of 10.8% in the cargo transported during the analyzed period. Even with the decrease of seven primary partners, there was an increase of 16.81% in transport within the primary partners. For example, the United Kingdom and Ireland, the Dominican Republic, Germany and Italy became secondary hinterlands, Argentina and Venezuela became marginal hinterlands, and Jamaica began to export less over the years, with a hiatus in the years 2018 and 2019, returning to export in 2020 (ANTAQ, 2020).

It is also observed that there were slight drops in exports during the years 2010 to 2013, and from 2013 onwards the port had increasing exports until the year 2017 (31.28%). Subsequently, there were two falls, the largest in 2019, where the fall compared to the previous year was 10.14%. Products such as plastics, meat and tobacco, increased compared to 2018, however, the drop in cargo handling can be evidenced by chemicals (-66.76%), wood pastes (-51.32%), fish and crustaceans (-75.8%), while the other products had small falls or, remained proportionally with the same amount of cargo transported.

Seaport Itajaí

Located in the state of Santa Catarina, this port in 2019 corresponded to 6.7% of all container movements in the country and in previous years it has always remained among the main ports. It is observed that there was a reduction in the number of partner countries, however, there was an increase of 32.8% in the transport of

containerized cargo. Involving the primary hinterland, this increase was much greater, as in addition to increasing the number of partners, the amount of cargo transported increased by 42.32%. Regarding the primary trading partners, Germany, the United Arab Emirates and Venezuela ended the commercial partnerships in the years 2017, 2014 and 2012, respectively, while Holland became a secondary hinterland and Panama became a marginal hinterland. While in 2019 the countries Malta, Angola and Mexico, which in 2010 were not trade partners, became in 2017, 2012 and 2013, respectively.

It can also be noted a fall between the years 2014 to 2016 (43.22%), reaching the worst year of cargo transportation in the last ten years. The main item was wood transportation (74.5%), which recovered in 2019; meats remained even in the drop in transport, increasing in 2019 by 69.6%. However, after the event, there was a rise for three years, reaching its peak in 2019 and reaching the highest amount transported in the last ten years (138.6%).

Seaport Rio de Janeiro

Located in the state of Rio de Janeiro, in 2019 it accounted for 5.8% of all container movement in the country and in previous years it has always remained among the main ports. There was an increase of 9.74% in

shipments, despite the decrease in four commercial partners between the years studied. It is worth mentioning the exchange of four primary partners: Hong Kong, China, Singapore and the Dominican Republic. Of these, only the last mentioned became secondary, and the others became marginal and the new partners entered: Italy, Morocco, Panama and Chile, the first two coming from secondary hinterlands and the last two from marginal hinterlands.

The seaport of Rio de Janeiro grew for two years, in the years 2010 and 2012, after which three consecutive falls occurred, which represented 31%, when comparing the years 2012 to 2015. Subsequently, there were four consecutive increases, which demonstrated a gain of 26.5% in cargo transportation. In 2012, the main cargo was miscellaneous cargo, with a reduction of 71.9%, not being included among the main products of the subsequent cargo. Based on data obtained by ANTAQ (2020), there is a diversification in cargo transportation over the years.

The Fig. 2 below shows the analysis of landings from the selected ports, first illustrating the hinterlands of the port of Santos for the year 2010, to rank its commercial partners. In 2019, this port accounted for 48.3% of all container landings in the country and in previous years it has always remained the main port.

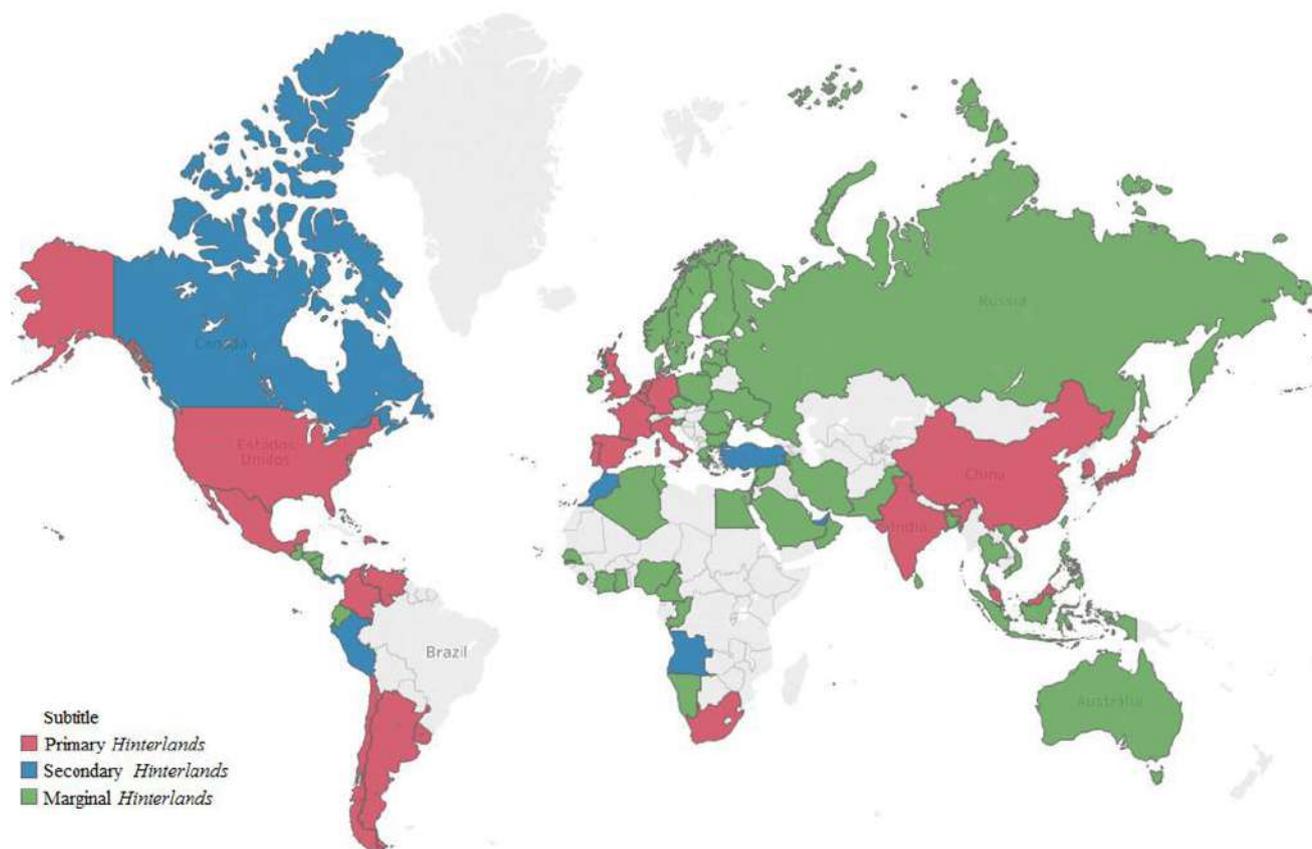


Fig. 4: Landing of containerized cargo in 2010. Source: ANTAQ (2020).

The composition of the hinterlands of the year 2010, as established by Degrassi (2001) were: primary hinterland: United States, China, Belgium, Germany, Singapore, Spain, Hong Kong, Italy, Mexico, South Korea, Malaysia, Argentina, Netherlands, Colombia, Dominican Republic, Jamaica, South Africa, United Kingdom and Ireland, France, Chile, India, Venezuela, Uruguay, Portugal and Japan; secondary hinterland: Panama, Morocco, Angola, Cape Verde, Turkey, Bermuda, Mauritius, Peru, United Arab Emirates, Canada, Malta and Trinidad and Tobago; and marginal hinterland: Finland, Taiwan, Russia, Sweden, Ecuador, Iran, Senegal, Bahamas, Indonesia, Ukraine, Israel, Congo, Poland, Saudi Arabia, Thailand, Ivory Coast, Norway, Oman, Egypt, Guatemala, Algeria, Romania, Saint Lucia, Estonia, Pakistan, Greece, Qatar, Nicaragua, Latvia, Ireland, Ghana, Denmark, Honduras, Gambia, Vietnam, Puerto Rico, Sierra Leone, Bangladesh, Bulgaria, Cameroon, Nigeria, Syria, Tunisia, Lithuania, Costa Rica, Sri Lanka, Slovenia, Australia, Philippines, Lebanon, Namibia, Cyprus and the Czech Republic.

Based on the ANTAQ (2020) document, time data were compared and there was an increase of 33.3% in the number of commercial partners in the port of Santos. However, the increase in cargo landed did not match the

proportion of the increase in the number of commercial partners (2.59%). It is also important to comment that there was an increase in the number of primary hinterlands, which increased from twenty five to thirty five countries. Among them, only Jamaica, the Dominican Republic and Venezuela are no longer part of the primary hinterland, with the Dominican Republic becoming a secondary hinterland, while the other two countries are now classified as marginal hinterlands.

Regarding the countries that entered the primary hinterland, the three that came from the secondary hinterland were Morocco, Turkey and Peru, while the countries that came from the marginal hinterland were Finland, Taiwan, Russia, Sweden, Indonesia, Israel, Saudi Arabia, Thailand, Norway and Vietnam.

Between the years 2010 and 2019, regarding the volume of disembarkation from the Port of Santos, it was observed that in 2012 there was a decrease in relation to the previous year. This fall was 10.68%, showing a recovery in 2013, however there have been drops in landing in the following three, coming to decrease by 26.6%, when comparing the years 2013 to 2016, with recovery of falls in the years 2017 to 2019, in the order of 25.8% (Fig. 5).

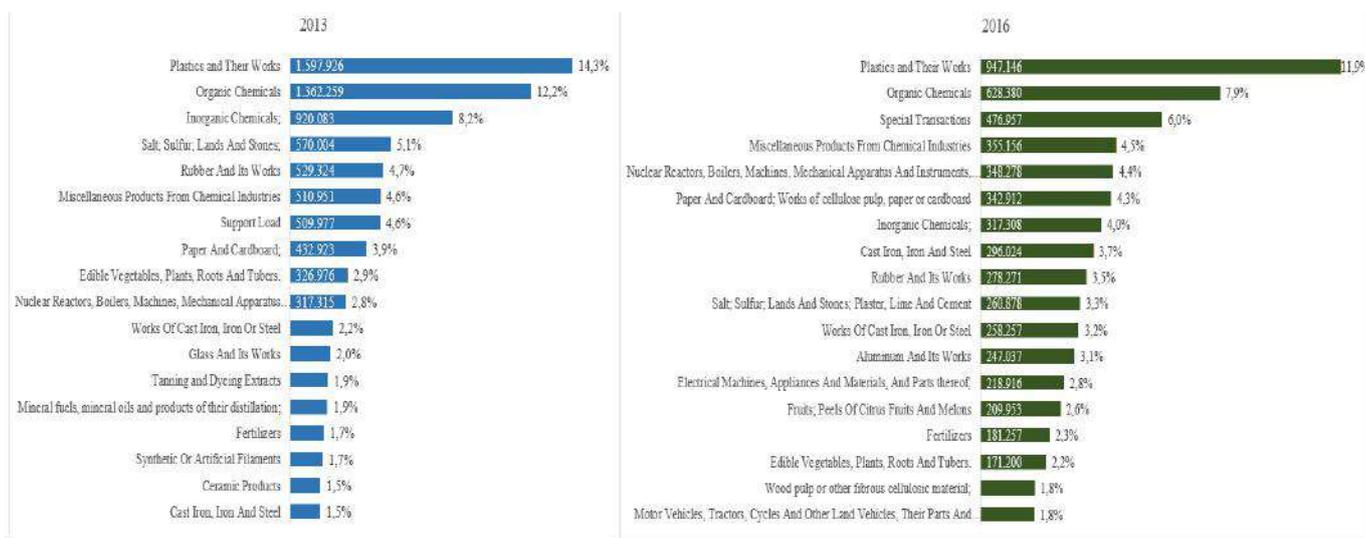


Fig. 5: Landed products. Source: ANTAQ (2020).

There is a drop in the almost unloading of practically all products, with the only product showing growth Special Transactions, which in 2013 represented 0.03% and in 2016 started to represent 6% of the entire volume of cargo landed. With regard to products that suffered falls, it is

noteworthy that for plastic with 40.72%, organic chemicals with 53.87% and inorganic chemicals with 65.51%. This behavior can be seen from the movement history of the other ports (Fig. 6).

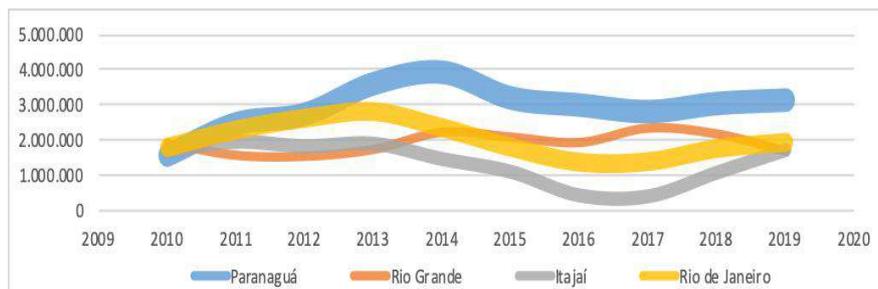


Fig. 6: Landing history of the chosen ports. Source: ANTAQ (2020).

Seaport Paranaguá

Paranaguá seaport in 2019 corresponded to 12.5% of the containers landed in the country, and in previous years it was always among the three main ports. When comparing the years 2010 and 2019, it can be reported that there was a decrease in the number of partners, which were 70 (seventy) and became 35 (thirty-five), which is equivalent to a loss of 50% in number of partners. However, there was an increase of 101.2% in the quantity of tons landed, showing productivity. There is also a considerable increase in transport to countries that were already part of the primary hinterlands (82.7%), in addition to the insertion of eight countries as primary ones, with emphasis on Italy that became a new partner, and the occurrence of a change in hinterlands from seven other countries. Of these Colombia, Singapore, Morocco and Malta were marginal hinterlands and Germany, Hong Kong and France were secondary hinterlands.

Still based on Fig. 6, there is a drop of 28.7% in container transport between the years 2014 and 2017, ending an increase of four consecutive years. According to ANTAQ (2020), it was found that a large part of the economic sectors had drops in transport in 2015 compared to 2014, in the order of 18.78% in the volume of shipment.

Comparatively, in the years 2010 and 2014, the port of Paranaguá grew approximately 152.5%. Subsequently, there was a continuous fall, and only in 2017, after three consecutive falls, there was a slight increase of 3.26%, represented by products such as meat, wood and paper that had not fallen between 2014 and 2015.

Seaport Rio Grande

This seaport in 2019 corresponded to 6.8% of all container movement in the country, a position maintained comparing the previous years and the five main Brazilian ports. There was an increase in the number of seven trading partners, however, there was a decrease of 11.38% in the quantity of tons shipped. It can also be observed that there was a decrease in the number of primary trading partners, decreasing from ten to seven, of which, Germany became a

secondary hinterland, while Hong Kong and Jamaica became marginal hinterlands.

Another consequence of this decrease in the number of commercial partners was a fall in imports within the primary hinterland (26.57%). It can be seen, based on Fig. 6, that the port has a characteristic of oscillation over the years, however it is worth noting the fall from 2017 to 2019 (27.37%). It can be concluded that, even with the growth of cargo shipped from plastics (14.63%), the other products transported presented significant falls, with emphasis on chemical products (81.01%) and cereal transportation (40.24 %).

Seaport Itajaí

This seaport in 2019 corresponded to 7% of all container movements in the country, a position maintained in relation to previous years among the main Brazilian ports. It is possible to state, according to ANTAQ (2020), that there was a reduction of 58.44% in the number of partners, however, there was an increase of 2.65% in the amount of cargo transported. Another important factor was the increase in the number of primary hinterlands, with four in 2010 and ten in 2019. Only China and South Korea remained primary hinterlands.

Based on Fig. 6, it can be seen that the port of Itajaí suffered a reduction in the volume of transport for four consecutive years (2013 to 2017), reaching a decrease of up to 79.1% in the volume transported, and recovering in the years of 2018 and 2019, with a recovery of 334.5%.

When analyzing the last two years, based on ANTAQ (2020), there is a decrease in most of the products transported, with emphasis on plastic, which had been showing leadership in 2013 and suffered a decrease of 78.6% with respect to the year 2017, pulled by cast iron with a fall of 86.96%, contrasted with fish and crustaceans with an increase of 12.9%.

Seaport Rio de Janeiro

In 2019 it corresponded to 7.8% of all container movements in the country, a position maintained in relation

to previous years among the main Brazilian seaports. Even with a 7.7% increase in the volume of cargo transportation, there was a 13.6% decrease in the number of commercial partners (2019).

The increase in primary partners stands out, rising from six to eleven. As a consequence, there was an increase in landings made from these countries (33.16%). Comparing the period from 2010 to 2019, five new countries that were secondary hinterlands were registered: Argentina, Spain and France, and countries that were of marginal hinterlands: Chile and Singapore.

In 2010, 11.77% of the cargo landed had no record of the countries of origin, and in 2019 all had the record. Fig. 6 shows that growth in the years 2010 to 2013 of 54.1%, followed by three years of decrease, resulting in a drop of 49.8% in the volume of cargo unloading, until 2016. From 2016 there was a growth of 39.2%, remaining below the main peak of the last ten years.

Similar to the volume shipped, the main landing product was general cargo. This product in the years 2013 to 2016 decreased by 75.1%, and in 2019, there are no data among the main products of the port of Rio de Janeiro. Increases are noted in landings of plastics, other products and miscellaneous cargo, in the years 2016 to 2019.

Construction of Origin-Destination Matrices (Fourth Phase - Stage 2)

Therefore, based on the data for mapping the hinterlands of the chosen ports, considering the mapping and structuring of the origins and destinations of cargo (fourth phase), a correlation of data was made when analyzing the countries with which the ports related. For this, the electronic spreadsheet and the georeferenced database were used, made available by the Tableau software, with the aid of a tool available in the Gallery Alteryx.

From the elaboration of this database, matrices of origin and destination were designed to support the creation of thematic maps "Destinations" (Fig. 7) and "Origins" (Fig. 8). From these elaborations, the five ports,

their cargo and countries joined, to identify the concentration of cargo flows from primary hinterlands (fifth phase - Stage 3).

Thus, in addition to the current commercial partners, the main Brazilian ports studied have the capacity to prospect opportunities, as well as to propose commercial relations with countries that present possibilities to operate transactions, thus increasing their market share. For example, to provide better conditions with commercial partners for the consolidation of cargo flows, depending on the type of logistics (inbound or outbound). All of this should be done based on strategic planning with integration of information between the origins and destinations of the cargo.

Rodrigue (2020) reports that regionalization is a process that can take place both in the vicinity and around the hinterlands of a port. Thus, it was found that this statement may have practical application for the chosen ports, which, based on the knowledge of higher cargo movements, such as China, can offer conditions for planning operational continuity between intermodals and maritime transport systems and terrestrial.

The relationship between ports, their trade flows and trade policies is increasingly complex, given that trade flows change, not only through their own reforms, but also through the reforms of their trading partners (Rodrigue & Notteboom, 2010). It is noted, when comparing the results of the research carried out based on the years 2010 to 2019 that the ports, allowed to obtain information that presents possibilities of commercial expansion. Many secondary hinterland countries have the ability to switch from secondary and marginal hinterlands to be part of the primary hinterland group.



Fig. 7: Destination Map of Containerized Cargo. Source: Authors (2020).



Fig. 8: Map of Origin of containerized cargo. Source: Authors (2020).

Thus, from the methodology proposed in this work, port administration, government agencies and the private

sector, among other actors, can simulate market scenarios, as well as, throughout the supply chain and in the value

chain, global value chain to interconnect market-leading companies, with small, medium and large businesses and suppliers in different local contexts, in order to plan and evaluate the implementation of possible improvements in the logistics infrastructure of the main Brazilian ports, which may result in an increase in the volume of movement containerized cargo.

V. FINAL CONSIDERATIONS

Brazilian container seaport terminals have been experimenting in recent years with a new concept of performance in handling the unit volume of transported cargo, including shipments and landings. Consequently, there is a demand for planning, strategies and actions on the part of government officials, port authorities, intervening and consenting bodies and, other stakeholders. Within this context, this work, after diagnosing, mapping and delimiting Brazilian containerized cargo movements, in five Brazilian ports, found the existence of several hinterlands, which lead to the elaboration of foreign trade agreements and strategies, at national and / or regional level to encourage port cooperation, or even the formation of clusters.

The delimitation by categorization of the hinterlands allowed the visualization of commercial and potential partners, as well as countries that have become a reference in cargo handling, thus indicating markets and possibilities for action or expansion.

By analyzing the research units (port of Santos, Paranaguá, Rio Grande, Itajaí and Rio de Janeiro) that showed high efficiency and availability of data in the analyzed period, it was possible to carry out the analysis in relation to current and potential commercial partners, and so, underline decision-making processes. With this, it is possible to verify which factors and sub-factors that support to influence the choice of a port. Thus, for a port to be competitive within the logistics corridors, it must first be able to identify and know its hinterlands, and from there, increase its own level of connectivity for specific logistics networks (shipping companies, logistics service providers and end customers), and potential users.

In the studied regions, the main users of the ports showed a regularity in terms of cargo handling, in the analyzed period, leading to the conclusion that their commercial partners are being served efficiently. On the other hand, issues of inefficiencies, expected performance or under expected infrastructure and the quality of transport services along with cultural and behavioral reasons can be some limitations of the work.

The cargo handling market requires constant review of plans, in addition to intense monitoring of port market share. And, based on an efficient management of these issues, the level of specialization in the port tends to increase.

The findings verified from the results show movement relationships (ports and hinterlands) between Brazilian origins and global destinations, and also in the opposite direction. These connections allow important reflections on commercial relations, shipping lines, supply chains, among other elements, dimensions and variables that influence the daily handling of inland and foreland containers.

From the methodological approach of this work, maritime stakeholders have one more tool to understand the Brazilian handling of containerized cargo and, with this, expanded conditions and parameters to carry out reflections, projections, plans and actions in dry ports, and can even carry out integrated activities, between ports that are interconnected. Thus, if a port or terminal has congestion, and can rely on tools such as the approach of this work, it becomes possible to plan and manage cooperation with a dry port located nearby.

The results still provide the visualization of scenarios, as well as the possibility of simulations, from that, and countermeasures can be carried out, avoiding waste and optimizing efforts and resources.

In this study, the issue of cargo migration between ports and terminals was not considered. Thus, as a continuity, it is suggested the use of tools and / or techniques that contribute to the understanding or indication of ways to balance the benefits of each port / terminal involved in handling containerized cargo. For example, the use of multivariate data analysis to understand occurrences of interrelationships between dimensions and variables that act in one or in the hinterlands.

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Monitoring System of Fisheries Water Quality Based on Microcontroller

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Abstract— A prototype of the water quality online monitoring system with Temperature, DO, Ph and ATmega 328 microcontroller-based salinity monitoring has been made. Initial detection of water quality, through (a) sensor integration to the ATmega 328 microcontroller system and (b) ATmega 328 microcontroller programming for system operation. Integration of the sensor into the microcontroller system, in the form of: (i) utilization of pins on the microcontroller board for conductivity sensors only 4 of the 8 pins are available, each of which is used for data (pin-1), clock (pin-3), ground (pin -4), and +5 volt dc power supply (pin-8); (ii) the port on the microcontroller board for the thermistor, namely C-port (PC) with PC0 for reading and writing data, while PC1 is used to synchronize the communication process router to the website and (iii) the five main ports on the ATmega 328 microcontroller board used, namely for: (i) 5 volt dc power supply at ATmega 328, (ii) conductivity and temperature sensors, (iii) pH sensors, (iv) DO sensors, (v) turbidity sensors, (vi) 2x16 LCDs and (vii) output. Programming the ATmega 328 microcontroller for system operation, planting C-language programs is carried out in eight stages, namely: (i) pin configuration, (ii) variable declaration (variable), (iii) declaration of constants (constants), (iv) initialization, (v) initialization, (v)) main program, (vi) display, (vii) retrieve and send data, and (viii) output: Measurement of system performance in the form of a validation test by displaying Temperature, DO, pH and salinity values on the website with the lab-android.com page. Website pages are equipped with database, SQL, block diagrams and export and import data. Website can be accessed from a PC / laptop or mobile phone.

Keywords— water quality, microcontroller, ATmega 328, website, data.

I. PRELIMINARY

The development of science and technology in this era is an important and inseparable factor in efforts to improve technology and the welfare of every society. As is the case with the level of community needs for tools that can work automatically, efficiently and save energy nowadays. Not only in large industries, medium industries, small industries, but also in households who want convenience and cost-effective in meeting their needs and completing work (Oktariawan, 2013).

Cultivation is greatly influenced by various factors such as land area, feed, stocking density and water quality. One factor that will be discussed is water quality. This water quality is very important to guarantee a healthy period of shrimp life from aquaculture (usually 100 days from vaname

type shrimp). Water quality for aquaculture activities is affected by many factors, including temperature, pH, conductivity and Dissolved Oxygen (DO) parameters. In this study an online water quality monitoring system has been designed for aquaculture. Water quality monitoring in aquaculture is usually only done manually by taking water samples and then brought to the laboratory for analysis. The periodic monitoring process tends to be impractical, requires expensive labor costs, and a high level of human error. Another drawback is the limitation in storing large data, so it cannot be used as a prediction to study water quality characteristics in the area of cultivation. To overcome the problem of monitoring water quality manually, an online monitoring system was designed. (Kusrini, Wiranto, Syamsu, & Hasanah, 2016).

In the online monitoring system that will be made this will include websites and android applications. By using the Android application will be easier because it can be monitored anytime, anywhere, and by anyone with an application that has been installed on his smartphone. Water quality monitoring data is obtained by using an Arduino microcontroller that will be connected to computers and mobile phones. The data generated can be recorded in a computer so that it produces an effective curve to see the development of water quality elements such as PH, DO, temperature and water salinity.

This tool is expected to reduce pond operational costs and is also expected to simplify pond management by adding a control system that will work automatically.

II. METHODOLOGY

This study consists of several stages of the procedure following the general pattern of scientific research

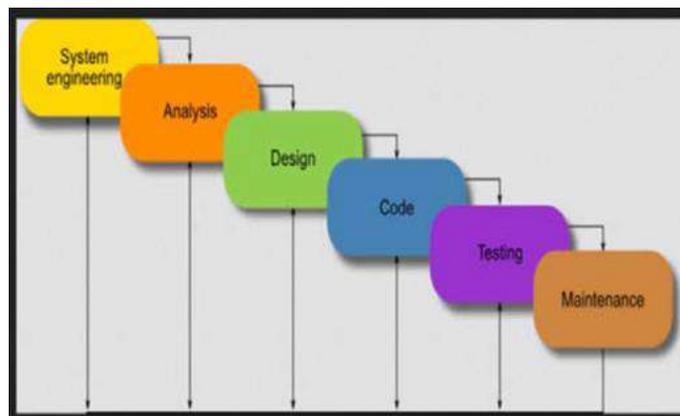


Fig.1: Research procedures using the Waterfall Method

III. TOOLS AND MATERIALS

Arduino Uno

Arduino Uno is a microcontroller based board on ATmega328. This board has 14 digital input output pins (of which 6 pins can be used as PWM outputs), 6 analog inputs, 16 MHz crystal oscillator, USB connection, power jack reset button. These pins contain everything needed to support a microcontroller, only connected to a computer with a USB cable or a voltage source can be obtained from the AC-DC adapter or battery to use it. The top view of ATmega 328 can be seen in figure.



Fig.2: Board Arduino Uno

as follows:

Literature review

This stage is carried out by tracing various sources on the internet and scientific journals to obtain data that supports and reinforces issues regarding the ATmega 328 microcontroller and sensors relating to this research. Connecting Arduino and data generated from sensors to the website.

Data collection

To collect data, the author conducted a field assessment to see how the conditions in the shrimp ponds and see if later this application can be compatible with existing field conditions.

System planning

In this case the system design method used the Waterfall method. The reason for using this method is the system used to design a system that consists of:

DS18B20 temperature sensor

Water temperature is very important to know the level of pollution experienced by water, because it can affect the life of organisms that are in it, because if the factory waste is carelessly discharged the temperature around the river tends to rise from normal limits, but the temperature of this water depends on the climate in the place itself and divided based on its deviations, to measure the temperature of this water using the DS18B20 shown in the figure.



Fig.3: Physical form of DS18B20 & Waterproof Probe

The DS18B20 temperature sensor is the latest series of digital temperature sensors from Maxim Integrated Products. This sensor is able to read temperatures with a precision of 9 to 12-bits, a range of -55°C to 125°C with accuracy ($\pm 0.5^{\circ}\text{C}$). Each sensor produced has a unique 64-Bit code embedded on each chip, allowing the use of sensors in large numbers through only one cable (single wire data bus / 1-wire protocol). This is an extraordinary component, and is a benchmark for many temperature-based data logging and control projects.

PH Meter Sensor

A pH meter consists of an electrode (measuring probe) connected to an electronic device that measures and displays the pH value. The main working principle of the pH meter is located on the sensor probe in the form of a glass electrode by measuring the amount of H_3O^+ ions in solution. The tip of the glass electrode is a 0.1 mm thick glass layer that is round (bulb). This bulb is paired with a non-conductor glass cylinder or an elongated plastic. The pH sensor core is located on the surface of the glass bulb which has the ability to exchange positive ions (H^+) with a measured solution.

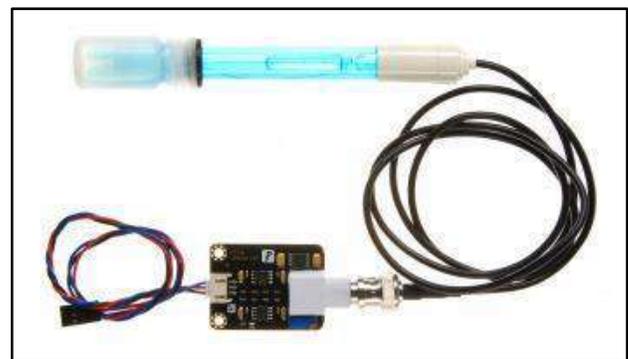


Fig.4: pH sensor

In the use of a pH sensor a calibration method is needed so that the sensor can be measured its level of accuracy, and can be accounted for, therefore a calibration powder is needed which has a level of accuracy ± 0.1 pH, which is mixed with aqua dm ie water that has been distilled twice as much 250 milli liters entered in the measuring cup, calibration powder has varying pH degrees of 4.00, 6.18 and 9.18.

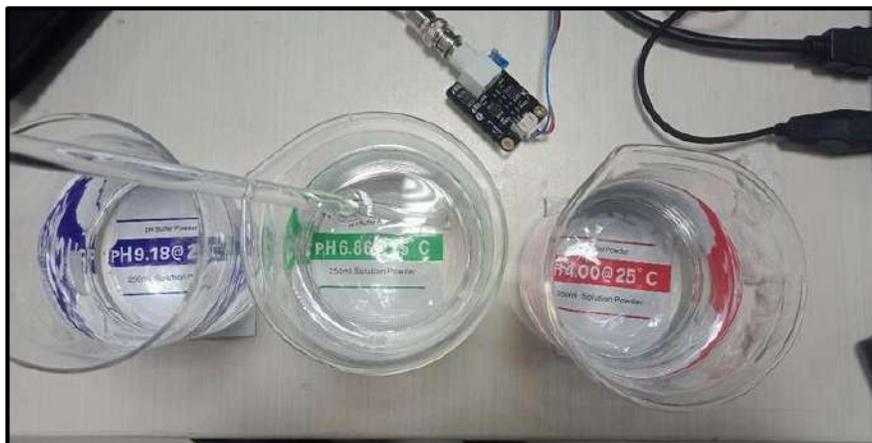


Fig.5: pH sensor calibration powder

TDS Sensor (Total Dissolved Oxygen)

In measuring the TDS level, a TDS sensor module circuit is used. This module consists of a sensor module circuit and a TDS sensor signal conditioning circuit as shown in figure.



Fig.6: DFRobot Analog TDS Sensor Arduino

The workings of the circuit are started with the sine wave generation by the Wien Bridge Oscillator circuit with a 5.3 kHz oscillation frequency and then amplified by a large non-reversing amplifier whose gain is based on the magnitude of the resistance value obtained from the conductivity sensor output. The AC signal that occurs is converted into a DC signal to be processed by a microcontroller through the AC to DC signal converter circuit.

Router

TL-MR3020 allows users to directly setup their security by simply pressing the WPS button on the router and automatically establishing a secure WPA2 connection, which is more secure when compared to WEP encryption. Not only is it faster and safer than normal security setups but it is more convenient for users so there is no need to remember passwords. Compatibility is the most important aspect to consider when choosing a 3G / 4G router. To ensure the best compatibility between the router and modem you will use with the router, TP-LINK has made a 3G / 4G Router that is compatible with ISPs wherever they are used.



Fig.7: Router TP-Link MR3020

IV. RESULTS AND DISCUSSION

Hardware design and assembly (Modeling and System Engineering)

The device designed in this study was divided into four main parts, namely the sensor section, the processor section, the data sender section, and the output section. This device is also part of the processor consists of ATmega 328 which will regulate the work functions of the sensor system and give commands to the output device. A router is a device that functions to send data and connect to a computer network. While the output part consists of a PC / Laptop and LCD as a monitoring and control device that will display the results of data processing from the sensor readings.

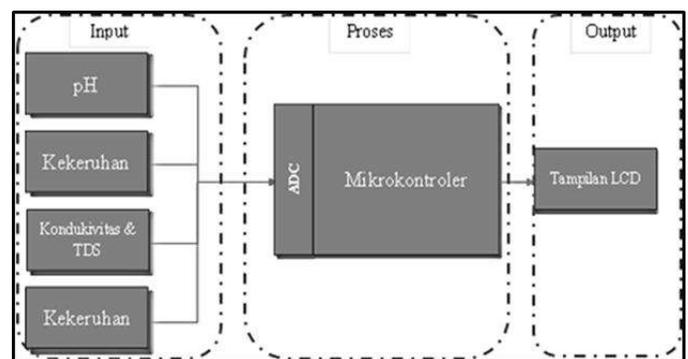


Fig.8: Hardware block diagram

4 sensors are connected to the ATmega 328 microcontroller. All of them require several connecting circuits because they are current-output sensors. ATmega 328 collects measurement data periodically, obtains GPS coordinates, and

uploads data bundles into the database using data links via results.
TP-links to the website. Users can visit the website to see the

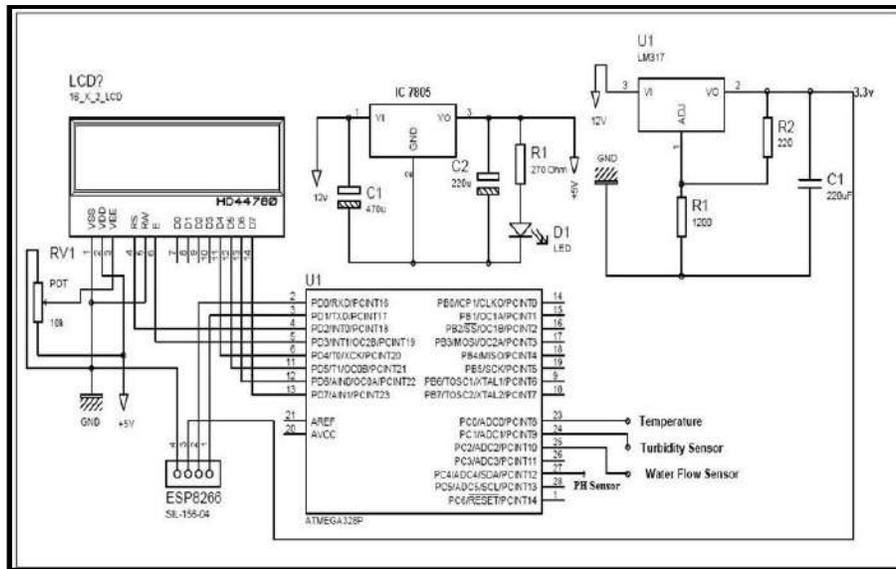


Fig.9: Overall schematic circuit

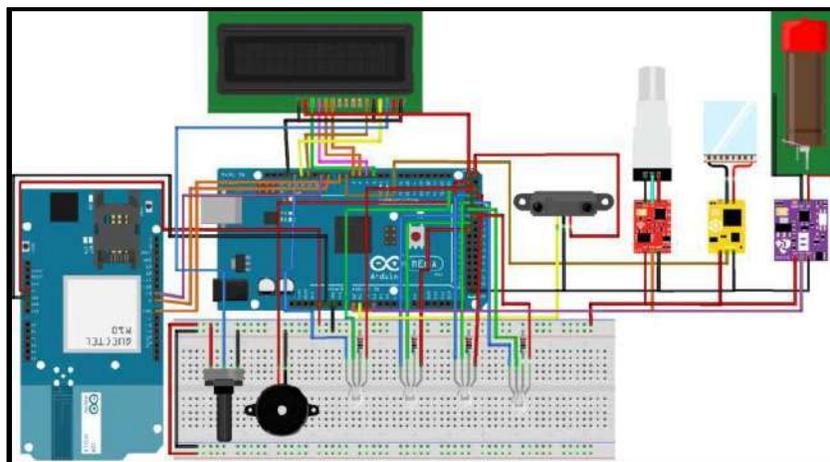


Fig.10: Overall hardware design

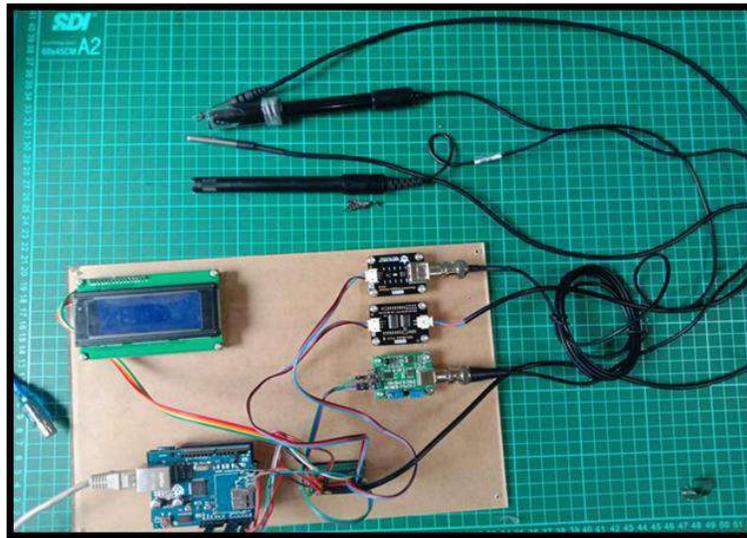


Fig.11: Overall hardware output

Software

The design of software in this automation system is made using the Arduino IDE (Integrated Development Environment) application. Arduino IDE is a very sophisticated software written using C. The Arduino IDE consists of:

- Program editor, a window that allows users to write and edit programs in the Processing language.
- Compiler, a module that converts program code (Processing language) into binary code. a microcontroller will not be able to understand Processing language. What can be understood by a microcontroller is binary code. That is why a compiler is needed in this case.
- Uploader, a module that loads binary code from a computer into memory on an Arduino board.

```
File Edit Sketch Tools Help
doly
#include <Wire.h>
#include <LiquidCrystal_I2C.h>
#include <Ethernet.h>
#include <SPI.h>
#include <OneWire.h>
#include <DallasTemperature.h>
#include <EEPROM.h>
#include "GravityTDS.h"

#define TdsSensorPin A1
GravityTDS gravityTds;

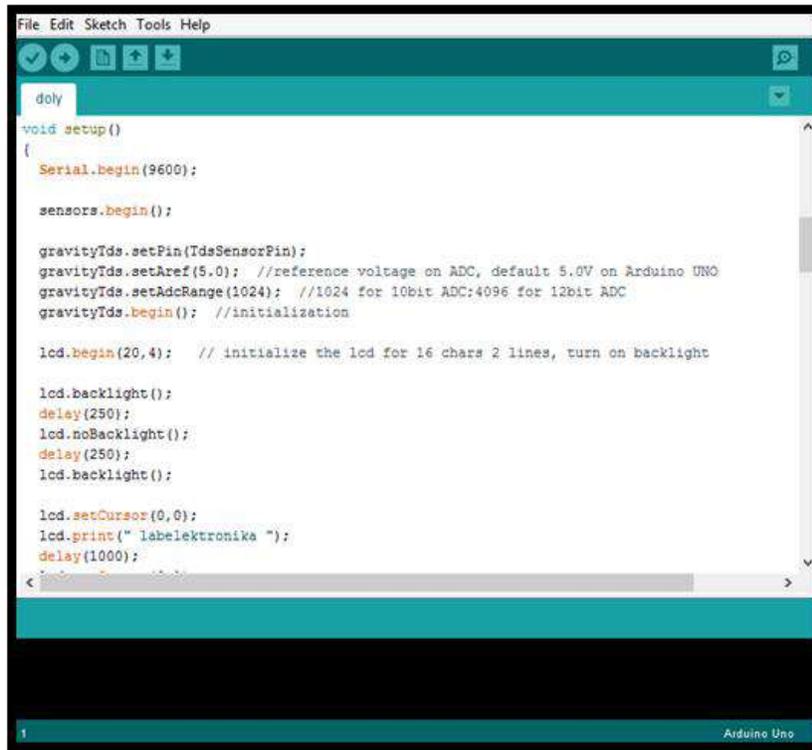
float temperature = 25,tdsValue = 0;

#define WEBSITE "www.lab-android.com"

LiquidCrystal_I2C lcd(0x27, 2, 1, 0, 4, 5, 6, 7, 3, POSITIVE); // Set the LCD I2C address
EthernetClient client;

byte server[] = {156, 67, 209, 210};
byte mac[] = { 0xDE, 0xAD, 0xBE, 0xEF, 0xFE, 0xED };
byte ip[] = {192, 168, 1, 10};
```

Fig.12: Sketch sensors enter data into a web page



```
File Edit Sketch Tools Help
doly
void setup()
{
  Serial.begin(9600);

  sensors.begin();

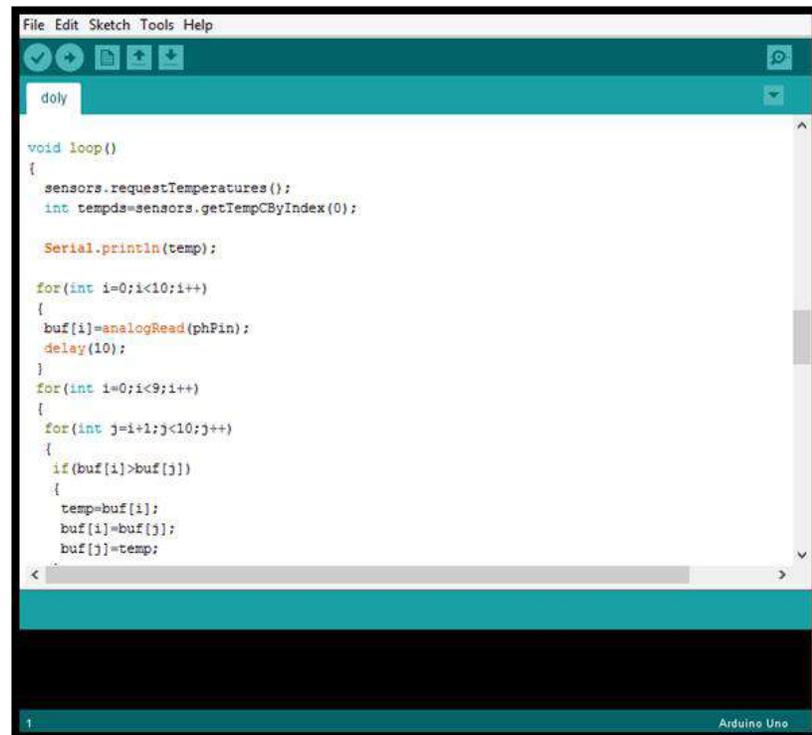
  gravityTds.setPin(TdsSensorPin);
  gravityTds.setAref(5.0); //reference voltage on ADC, default 5.0V on Arduino UNO
  gravityTds.setAdcRange(1024); //1024 for 10bit ADC;4096 for 12bit ADC
  gravityTds.begin(); //initialization

  lcd.begin(20,4); // initialize the lcd for 16 chars 2 lines, turn on backlight

  lcd.backlight();
  delay(250);
  lcd.noBacklight();
  delay(250);
  lcd.backlight();

  lcd.setCursor(0,0);
  lcd.print(" labelektronika ");
  delay(1000);
}
```

Fig.13: Sketch of data reading from the TDS Sensor



```
File Edit Sketch Tools Help
doly
void loop()
{
  sensors.requestTemperatures();
  int temps=sensors.getTempCByIndex(0);

  Serial.println(temps);

  for(int i=0;i<10;i++)
  {
    buf[i]=analogRead(phPin);
    delay(10);
  }
  for(int i=0;i<9;i++)
  {
    for(int j=i+1;j<10;j++)
    {
      if(buf[i]>buf[j])
      {
        temp=buf[i];
        buf[i]=buf[j];
        buf[j]=temp;
      }
    }
  }
}
```

Fig.14: Sketch of Temperature Sensor Readings

```

File Edit Sketch Tools Help
doly
...

lcd.print(pHValue);

lcd.setCursor(0,2);
lcd.print("Suhu =");
lcd.print(tempds);

lcd.print((char)223);
lcd.print("C");

lcd.setCursor(0,3);
lcd.print("TDS =");
lcd.print(tdsValue);

lcd.setCursor(11,3);
lcd.print("DO =8.5");

delay(1000);
lcd.clear();
}

```

Fig.15: Print data from the LCD to the website

Test and Verification (Testing and Verification)

After completing the Arduino IDE, you should check the error level generated in making the program. Usually we are told in the Arduino IDE at the bottom. Then the hardware is connected to the PC / laptop so that the data generated by the sensor can be read by the microcontroller. The data generated is displayed on the website using signals from TP-LINK routers. This stage the tools are made to work according to their functions and this research is documented in every process.

Webpage

Monitoring the quality of aquaculture fish ponds in this study is based on the website. Web is a display in a browser with a special domain address. The web can be built using PHP and HTML with a display using CSS language. The web is stored on one computer as a server. In addition to saving web programs, the server also stores a database to be accessed by the admin or client from the browser. The website was built using the notepad ++ program.

Domain name is the name that will send the message to the hosting server's IP address. So, when writing a domain name in the address bar, what is actually accessed is the IP server to be addressed to. To save costs and time, the authors use thephpmyadminweb page with localhost server that can be accessed for free and does not need to buy web hosting. In the web the Domain Basis data has been given, MySQL, status, data export and data import. This domain is used as a storage database that can be accessed by the web.

The function of the database is as a storage media that can be accessed by the web. The database was built using phpmyadmin which can be opened by accessing the page <http://lab-android.com/phpmyadmin> from the browser by first installing the XAMPP application (X, Apache, MySQL, PHP, Perl). This database is designed to store tables of water quality measurements (Time, Salinity, Temperature, Do and pH). Following are the views of webpage.

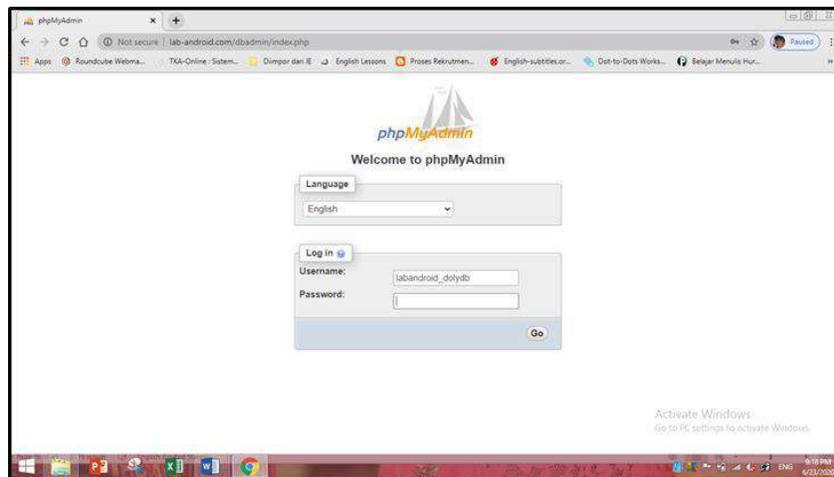


Fig.16: Login web page

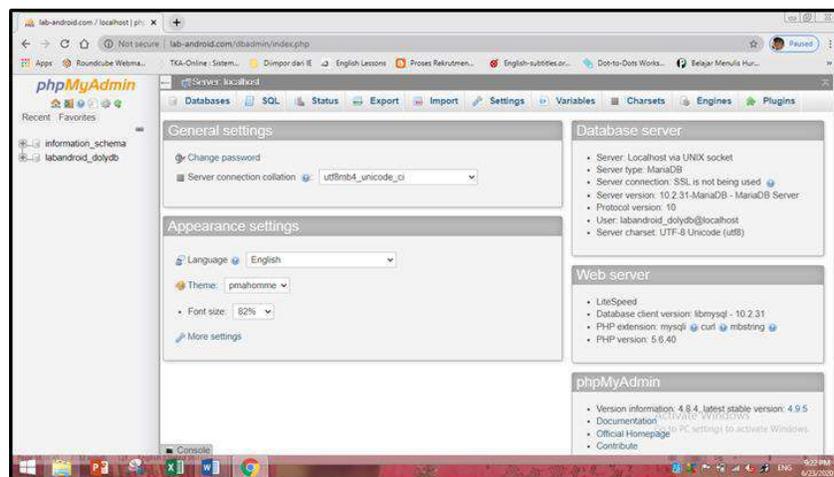


Fig.17: Screen after entering the web

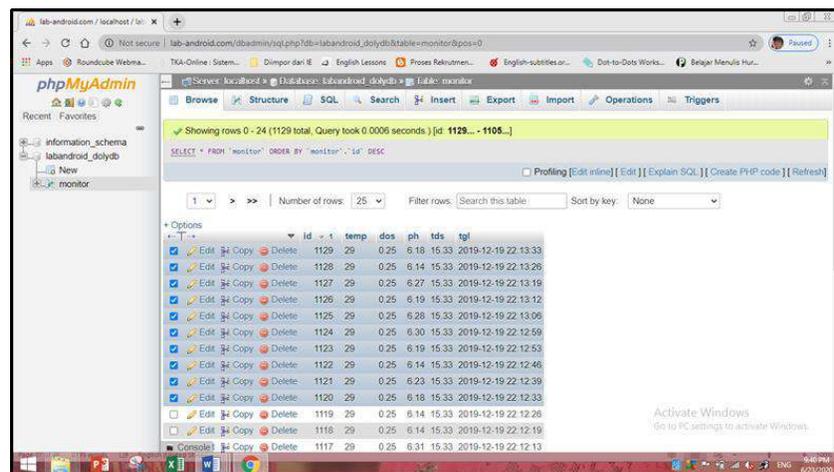


Fig.18: Pages of the test data

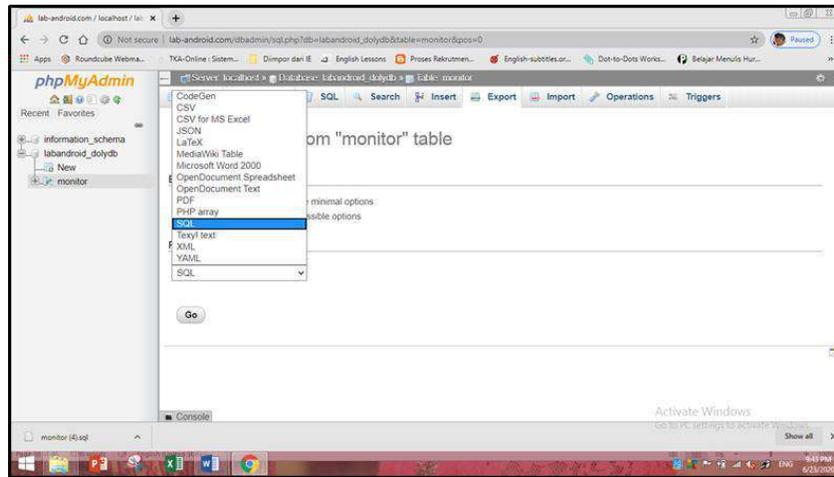


Fig.19: Data download with various applications

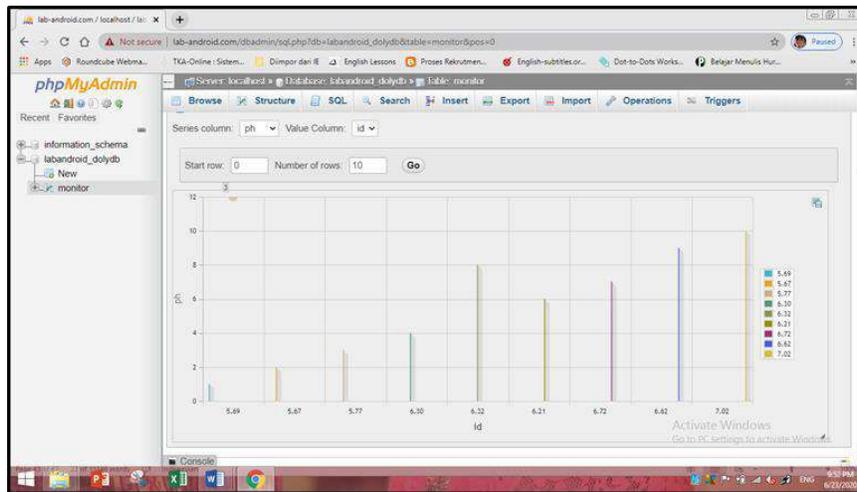


Fig.20: Display a block diagram for a pH sensor

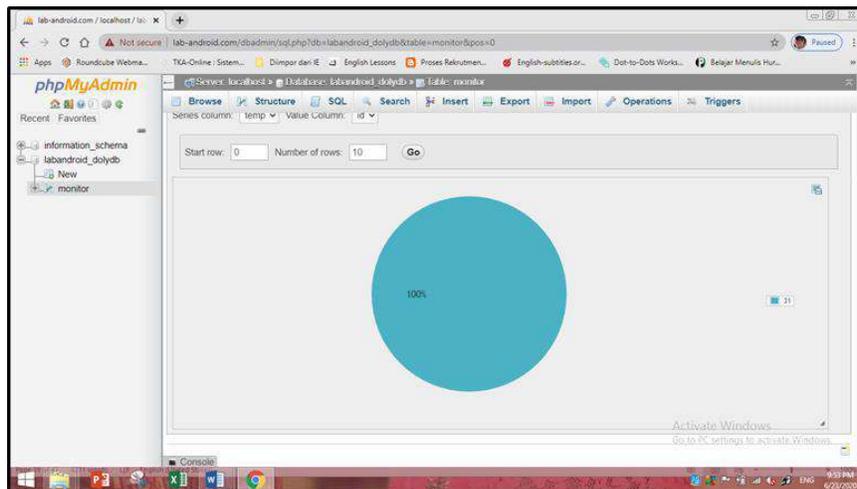


Fig.21: Pie diagram display for temperature

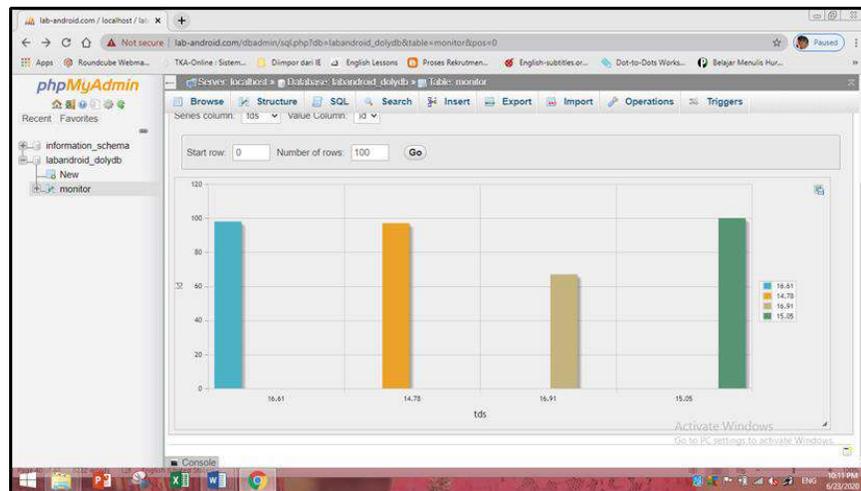


Fig.23: Display for TDS (Turbidity) sensor

Care (Maintenance)

After testing the tools and verification of the device should be carried out maintenance of hardware and software. Care is needed and there are still many bugs to be found. Every time it finds a bug the researcher has to fix it then do an update or update. Development is needed when there are changes from external and input data from fish farmers such as when there is a change in the operating system, or other devices.

V. CONCLUSION

After designing an online monitoring system for water quality based on the ATMega 328 microcontroller, it can be concluded that this tool works well and can be applied by fish farmers, especially in fishponds. In designing this tool used sensors that are connected (compatible) directly with the microcontroller ATMega 328. The sensor used to determine water quality uses DS18B20 temperature sensor, DHT11 sensors, Salinity sensors, pH sensors, and turbidity sensors which all use voltages below 5 V, so that it can be read by an ATMega 328 microcontroller. Hardware is connected to the website through a router. Data generated from these sensors are calibrated to their respective units and arranged so that they appear clearly on the website that has been created. This data can be viewed on the *lab-android.com/dbadmin* website. On the website we can see the data that can be arranged so that it displays graphic designs that make it easier to control.

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Agricultural and Agribusiness Policy: Reflections and Challenges for the development of the State of Goiás

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Abstract— *The growing grain market emerges the need for actions that stimulate rural economic development, from state support, through the Agricultural and Livestock Plan, from financing to commercialization of production. As the agricultural sector develops, the Agricultural Policy proves important in the provision of rural credit and insurance, and special sectoral promotion programs. The present work had as objective to demonstrate the importance of the Agricultural Policy for agribusiness, its reflexes and challenges, before the representativeness of this sector for the municipality of Rio Verde / GO, the State of Goiás and the country. The aim was to evaluate the instruments capable of promoting the agricultural / rural development offered by the State, and its function in relation to the system of storage, commercialization and distribution of production. The work was based on the inductive method, and quantitative and qualitative bibliographical research was carried out on materials published in official agencies of the agricultural sector, with the collection of indexes and accurate data. A study was carried out on grain marketing in Rio Verde / GO, the role of tradings, multinationals and cooperatives, and the grain storage system. Finally, discussions were held on the outflow of production, currently one of the major problems facing agribusiness. It has been seen that credit and tax incentives contribute significantly to the development of agricultural activity and the Agricultural Policy is responsible for implementing guidelines that assist the farmer in all stages of production.*

Keywords— *Agribusiness. Marketplace. Commercialization. Storage. Production Flow.*

I. INTRODUCTION

The Agricultural Policy is more evident from the implementation of instruments and/or guidelines that are intended to qualify the farmer/man of the field, as a labor holder, who deserves measures from the State that ensure the ownership of his land, guaranteeing him full employment and stimulating agricultural activities in the face of the country's industrialization process.

Agricultural policy instruments are used to formulate and implement policies aimed at the agricultural sector, promote investments, create incentives and/or

disstimulus for agricultural activities and should signal the path of expansion of the sector. The changes in the parameters of these instruments are published annually by MAPA, through the Agricultural and Livestock Plan (PAP) and Resolutions issued by the National Monetary Council. (FAESP, 2015)

In a more comprehensive interpretation of Federal Law No. 8,171/91, we perceive the importance of State support for agricultural development, especially when there is concomitant action with the rural producer, through extension practices, capable of guiding him on the correct

modes of production, storage, among others. Thus, Article 45 of that law provides that the Government should support and encourage rural producers to organize themselves in their different forms of associations, cooperatives, unions and condominiums.

The social duty to produce is linked to the constitutional principle of the social function of property, which ensures that all property must fulfill its social function, through rational and adequate use, with the proper use of natural resources and preservation of the environment, respecting labor laws and through exploitation that favors the well-being of owners and workers, under penalty of expropriation, as provided by Articles 184 and 186 of THE CF/88.

A bibliographic research was carried out for theoretical formulations, using articles, books, doctrines, legislation and other research works, and materials made available by entities and agencies in the sector. The research used the inductive, quantitative and qualitative method, through comparisons at the national level, with the collection of indexes and precise data, showing the dynamics of these numbers with the present day, interpreting these phenomena and attributing meanings to them.

II. METHODOLOGY APPLIED

The research embodies the great growth of agribusiness and its perspectives, generating the need to bring to society discussions about agribusiness, especially agricultural policy, showing its economic and social contribution to the municipality of Rio Verde and the Brazilian scenario, highlighting the reflexes and challenges for the development of the State of Goiás. We sought to evaluate the instruments capable of fostering the agricultural/rural development offered by the State, and its function in relation to the system of storage, commercialization and flow of production.

The southwest of the State of Goiás is considered by scholars of the sector as the center of Brazilian agribusiness. The instruments made available by the Agricultural Policy are of fundamental importance for the development of the region as well as the country. Thus, the answer was asked: What is the importance and social economic contribution of agribusiness to the state of Goiás and the municipality of Rio Verde/GO? Although grain storage is a price strategy, why does Brazil not have enough warehouses to stock production and farmers have a low rate of private warehouses? In view of record harvests, what is the most advantageous form of disposal for the

rural producer? How does agricultural policy work to improve transport conditions?

In short, agricultural policy uses the following instruments: rural credit, agricultural zoning, rural insurance, marketing and special sectoral promotion programmes. The latest measures are set out in the Agricultural and Livestock Plan 2018/2019.

2.1 GRAIN MARKET AND ITS EFFECTS ON AGRIBUSINESS DEVELOPMENT

Agribusiness not only transformed the socio-environmental relations of the municipality but also resulted in an increase in the number of inhabitants, the growth of the urban network, real estate speculation, the implementation of new industrial units, with the consequent increase in the number of job offers, among others, considering that the creation of EMBRAPA in 1972 was implemented through programs and investment projects in the productive area (XAVIER, 2013).

The main spring of this process is industrialization and, above all, grain production, especially soybean, corn and sorghum. In this promising agribusiness scenario, Goiás is the fourth largest grain producer at the national level, with an average production of 22.815 million tons, representing 9.5% of national production (SEGPLAN, 2018).

Productivity will continue to be the main factor driving the growth of Brazilian grain production in the coming years. Production is expected to increase mainly in soybean crop, concomitantly with the expansion of area in hectares. Research on genetic improvement has been carried out with a focus on increased productivity, through resistance to pests and diseases, and cultivars that are more stable and better adapted to different regions and cultivation conditions, with the consequent decrease in losses.

Despite the current economic, moral and political crisis, agribusiness stands out by breaking records in exports, according to mapa data. In February/2017, soybean exports increased 96.3% compared to February/2016, reaching US\$ 1.4 billion. In April/2017, soybeans led exports of Brazilian agribusiness, accounting for 52.2% of all sales of agricultural products, up 12.6% compared to April 2016, with US\$ 4.55 billion.

According to the Ministry of Industry, Foreign Trade and Services, in February 2018, Brazil exported 1.35 million tons of soybean meal, equivalent to 90.5% more than the one shipped in the same period last year. The country is expected to ship 16.20 million tons of soybean

meal produced in 2018, resulting in an increase of 13.3% more than the 14.30 million tons exported in 2017.

Brazil is expected to assume the position of the largest soybean producer in the 2018/2019 crop, the U.S. Department of Agriculture (Usda) estimated. According to the U.S. agency, the country is expected to produce 117 million tons of soybeans, slightly above the 116.5 million Americans. Brazil is already the world's largest exporter of soybeans and in the 2018/19 crop China is expected to import 103 million tons of soybeans, while the country will export 72 million tons. (FOLHA DE S. PAULO, 2018)

The International Grain Council (IGC) raised its world estimate for grain production in 2018/2019 (February/2019) to 2.12 billion tons, compared to a forecast of 2.08 billion tons in its previous projection (January/2019). In relation to the national grain production, it is estimated that it should reach 234.1 million tons, according to a survey conducted by CONAB. (MAP, 2019)

At an event held in Rio Verde/GO recently, Banco do Brasil (BB), together with the then President of the Republic, Michel Temer, the Minister of Agriculture, Livestock and Supply, Blairo Maggi and other political authorities, announced the launch of R\$ 12.5 billion for the hiring of anticipated costs, destined to the acquisition of inputs and agricultural services for the 2018/2019 harvest. (FAEG, 2018)

The anticipated costing allows rural producers differentiated conditions of negotiation with suppliers of inputs (seeds, herbicides, insecticides). The operations are intended to finance soybean, corn, rice, cotton and coffee crops, with interest rates of 7.5% to 8.5% per year, for a period of up to 14 months. The amount available is 16% higher than that applied last year and signals Banco do Brasil's investment in the agricultural sector and in the good prospects for the 2018/19 harvest.

With great influence and prominence in agribusiness, are multinationals. Multinationals are economic organizations based on the great mechanization of production, the development of better storage techniques and the creation of faster means of transport. They play an important role in the transfer of technology, scientific policy and cultural influence.

Agribusiness, concomitantly with economic development, is also important in the social sphere, in the generation of employment and income, a fact that raises the Municipal Human Development Index (MHDI), including, with emphasis on some cities in the region. There are a significant number of jobs generated, directly and indirectly, either in the field or in the large industries/companies that settled in Rio Verde after the

advent of agribusiness, totaling about 18.05 million people in the first quarter of 2017. (FAEG, 2017).

The CPR, created by Law No. 8,929/94, is a credit security that provides for the early sale of production with the future delivery of products, in this case, soybeans, where the producer receives resources for the cost of the crop. The producer issues the title to market its grains that have not yet been produced and receives the amount negotiated in advance, for the financing of the harvest.

2.2 THE GRAIN STORAGE SYSTEM

The storage system is one of the members of the Agricultural and Livestock Policy, established by the Ministry of Agriculture, Livestock and Supply (MAPA), where its main purpose is to ensure the flow of continuous supply, providing greater price and market stability.

The storage of agricultural products, especially in the case of soybeans, which has a large export volume, is a strategy that aims to meet the demands of the market, whether national or international, in the off-season, besides providing the producer with a higher price. Consequently, during the off-season, the costs related to road freight are much more favorable than in the harvest period. And not to mention that in the period of the harvest the price of the grain suffers reduction.

Among the advantages of storage, is that if the grains are stored correctly, these last for years with a minimum rate of deterioration, where, higher the humidity, the greater the risk of deterioration. The storage operations aim to achieve quality standards such as high specific weight, low moisture content, low degradation of nutritive components, low percentage of damaged grains, low sensitivity to breakage, high viability of seeds and absence of pests, insects, fungi or bacteria. (VENTURA; SILVA, 2015)

According to IBGE, the useful capacity available in Brazil for storage, registered in the second half of 2015, was 166.1 million tons, 3.3% higher than in the previous semester, a total of 7,918 active establishments.

Due to the good production performance achieved in recent years, storage capacity is lower than demand. In order to avoid storage problems after harvest, and also aiming at profit, producers are investing in their own warehouses, in their properties. Thus, farmers can market their production at the time that suits them best, according to the *commodity* market.

The risk of loss of grain quality is lower, and represents a cost unless the producer will have to disburse. This trend has gained prominence by banks, which in turn finance the construction of these warehouses, with incentives such as lower interest rates. Since the 2013/2014 harvest, MAPA has

provided R\$ 12 billion to subsidize investments in warehouses. (MAP, 2017)

One of the factors associated with the low number of warehouses in rural properties is the cost of assembling and maintaining a warehouse. Despite the credit incentives of the Federal Government, the producer bears a high cost for the construction of the warehouse, which sometimes inhibits the farmer from such investment, which has long-term return.

At the time of delivery of the grains are issued two credit securities related to storage, the Certificate of Agricultural Deposit (CDA) and Agricultural Warrant (WA). The CDA is a title that represents a promise of delivery of an agricultural product deposited in a General Warehouse. WA, on the other hand, is a title conferring the right of attachment to that product deposited in the warehouse. (AGRO SECURITY, 2015)

The CDA and WA are issued simultaneously by the storer, at the request of the depositor (farmer) of the goods that have opted for the issue of these securities instead of issuing the deposit receipt, but may circulate separately by nominative endorsement.

2.3 PRODUCTION FLOW: ONE OF THE MAJOR PROBLEMS OF AGRIBUSINESS

Dependence on highways and lack of investment in railways and waterways result in higher costs for the farmer. When it comes to logistics and transport and storage infrastructure, we see one of the major problems faced by those who produce when it comes to draining the harvest, which raise production costs and prevent Brazilian agribusiness from being even more competitive.

A study conducted by the National Association of Cargo Transport Users (Anut) showed that the precariousness of transportation causes the producer to have a disadvantage of US\$ 74 per tonne, compared to the North American and Argentine competitors, in relation to freight to the port and port expenses. In Argentina road transport is favored by distance, and in the United States long distances are overdue with the use of railways and waterways. (ESTADÃO, 2011)

Despite the resurfacing and duplication of highway works in several municipalities in the Midwest region, truck displacement over long distances is expensive and inefficient, for example to the ports of Paranaguá and Santos. That is, the improvement of roads alone does not guarantee efficiency gain in the transport of grains. (ESTADÃO, 2011)

Rail transport is an important route of flow, as it allows the movement of large volumes over long distances at a lower cost. Predicting that the volume of cargo will

triple by 2023, DNIT prepared the National Transport Logistics Plan, with the aim of redistributing demand, resulting in a program of 11,800 kilometers of railways.

Among the main and most efficient railroads in the country, we mention the Central Atlantic Railway (FCA), which is 7,080 km long, in view of being the axis of connection between the Northeast, Southeast and Midwest regions of Brazil. The state of Goiás has 685 km of the FCA that serves the southeast of the state and the Federal District. This railway integrates large ports such as Vitória/ES, Santos/SP, Angra dos Reis/RJ, Salvador/BA and Porto Seco de Anápolis/GO. (IMB, 2018)

Another very important railway is north-south, between Anápolis/GO and Açailândia/MA, which is ready for operation and will integrate into the stretch of the Carajás Railway that leads to the port of Itaqui in Maranhão. In Goiás, the railroad has 991 km of tracks, which will cross the north, central and southwestern regions of the state. The expectation is that this railroad will change the economic profile of Brazil, allowing to reach the ports of the north of the country, consolidating the municipality of Anápolis as a logistical reference in the central region of Brazil. (IMB, 2018)

Similarly to what happens with railways, waterway transport is also indicated for the transport of bulky loads over long distances, since it consumes less fuel, as a set of barges consumes less than half of the fuel required by a railway train. This would imply a reduction in the freight price, and consequently in the increase in the producer's net revenue.

The main Brazilian waterways are: the Araguaia-Tocantins waterway, which during the floods the navigable stretch reaches 3,000 km; the San Francisco waterway, which connects the midwest and the northeast being fully navigable at 1,371 km; the Tietê-Paraná waterway, allowing the transport of grains and other goods from Mato Grosso do Sul, Paraná and São Paulo, with 1,250 km navigable; and the Taguari-Guaíba waterway: considered the main waterway in transported loads. (BRAZIL SCHOOL, 2018)

In contrast to the scenario of precariousness in the flow of grain production, it is perceived how important is the Brazilian agribusiness, with special emphasis on the State of Goiás, which has its economy based on agribusiness. Data presented by the Mauro Borges Institute of Statistics and Socioeconomic Studies of the Department of Management and Planning (IMB/Segplan), in line with IBGE, in 2015, the municipalities of the interior of Goiás accounted for 73.1% of the STATE's GDP.

Among the 10 largest Brazilian municipalities in rioverde agriculture is in 3rd place and Jataí in 8th position. The municipality of Rio Verde is the largest grain producer in the state and also the largest tax collector on agricultural products and a diffuser of new technologies.

Thus, the following question is: How to drain the production of the municipality of Rio Verde/GO? Unfortunately farmers have to use the highways as the main means of transport. In Goiás there are two ports for the flow of production: the Port of São Simão and the Dry Port of Anápolis (Interior Customs Station).

III. RESULTS AND DISCUSSIONS

The Agricultural Policy is treated by Law No. 8,171/91, demonstrates the instrument capable of allowing the planning and implementation of agricultural policy, with the effective participation of the production sector, involving workers and rural producers, as well as the marketing, storage and transport sectors, as established in Article 187, caput, of the Federal Constitution of Brazil of 1988.

Rural credit is provided for in Law No. 8,171/91 as the main source of financing for rural activity. According to Article 48, "rural credit shall be provided by all financial agents without discrimination between them, through compulsory application, free own resources, appropriations of official credit operations, funds and any other resources". Therefore, rural credit can also be understood by the parallel between the social obligation to produce, assigned to the rural producer, and the subjective right to grant credit to the same producer.

MAPA announced through pap 2018/2019 the amount of R\$ 194.37 billion to finance and support the commercialization of Brazilian agricultural production. Of this total, R\$ 151.1 billion is allocated to the costing credit and R\$ 40 billion to investments. In the same way, R\$ 2.6 billion are being allocated to support the commercialization and R\$ 600 million for rural insurance subsidies.

Furthermore, the latter PAP increased to R\$ 2 million the income limit for the framing of rural producers in the National Program for Support to the Medium Rural Producer (PRONAMP) and revoked the condition that required to be at least 80% of the income for the framework of agricultural activities. (MAP, 2018)

In a survey released by Embrapa Soja, in the 2017/18 harvest, global soybean production was 336.699 million tons, of which 116.996 million tons were produced by

Brazil, in a planted area of 35.100 million hectares. On a global scale, Brazil ranks second in soybean production and exportation. (EMBRAPA SOJA, 2018).

The State of Goiás has the largest storage capacity in the Midwest region, both in relation to warehouses belonging to the public sector as well as those belonging to the private sector and cooperatives. According to the Faculdade Sumaré Logistics Group, in Brazil, the capacity corresponds to 80% of the harvest, while in the United States, it is 120%, that is, it can control the supply in the market by stocking the grains.

Unfortunately, there are few railways in operation, which face infrastructure problems, such as passing through cities, diversions, level crossings, etc., as a result of poor project development. There is no doubt that several of these government actions serve the particular interests of the administrators.

And yet, there is a great administrative difficulty in building new railroads, because in addition to the cost being high for public coffers, we have tenders and precarious contracts, not counting the environmental licenses that take years, expropriations that have seen lawsuits, among others.

Despite the large hydrographic basins existing in Brazil, more than 4,000 km of navigable coasts and thousands of kilometers of rivers, waterways are little used. Some parts of the Amazon and Paraguay basins, for example, require repairs for use. Another factor contributing to the low use of waterways is the costs charged per tonne on boarding and disembarking, which increases the value of transport by five times in relation to developed countries. (BRAZIL SCHOOL, 2018)

There are several criticisms of national ports, we cite, to exemplifying titles, the lack of yards for trucks, traffic jams, restrictions for the navigation of ships due to the low depth, bureaucracy, difficulty of access to the terminals, being responsible for the delay of delivery and thus the increase in the cost of the product, among others.

Nowadays agriculture has stood out for being one of the biggest generators of employment, which in a way worries about structural issues, the greater the production, the greater the difficulty in the flow of production. However, agribusiness stands out for its significant increase in the country's economy, according to the graph below we can note the importance within the economy in relation to agribusiness.

Chart : Balance of the Brazilian Trade Balance (in US\$ billion) - 1989 to 2017.



GDP studies the growth of agrarian activities increased about 4.3%, this in the first quarter of 2017, which shows a great importance in economic issues in the State of Goiás. According to Seplan-GO data, agricultural production has grown by about 50% in the last five years.

The ten richest municipalities in the State of Goiás account for 58.80% of the GDP of Goiás, representing R\$ 102.170 billion. These municipalities are: Goiânia, Anápolis, Aparecida de Goiânia, Rio Verde, Catalão, Itumbiara, Jataí, Luziânia, São Simão and Senador Canedo. It is noted that the municipality of Rio Verde is in 4th place in the state *ranking*. (ON DUTY, 2017).

It was noticed the excellent collaboration of the municipality of Rio Verde GO and the State of Goiás for the growth of the country, a growth that occurred in view of the increase of technologies and fertile soils, amidst good climatic conditions. In contrast, there was a great growth of the State of Goiás after the advent of agribusiness, marking the beginning of the economic and social development of the State.

IV. FINAL CONSIDERATIONS

The development of this research allowed an analysis of agricultural policy and its relationship with agribusiness, which proved to be of fundamental importance nowadays, and the role of the State for agricultural development. Agribusiness has grown at an accelerated pace, with levels above the national average.

It was found that the municipality of Rio Verde, State of Goiás became an industrial pole, being currently the largest grain producer in the state and also the largest tax collector on agricultural products and a diffuser center of new technologies. Agribusiness, directly and indirectly,

is responsible for much of the generation of employment and income, generating high expectations of production growth for the coming years.

The storage of the grains allows the farmer to market them at a later harvest, where, in the off-season, he can obtain a higher price due to market requirements. However, the storage capacity in Brazil is lower than the demand, which caused rural producers to invest in their own warehouses, using incentives offered by the Government, such as lower interest rates for financing.

The slowness/precariousness in the transport of production results in higher costs for the producer, directly influencing his income and the price of *commodities*. Most often the quality of the grains is affected, culminating in extreme disadvantage for the producer, when compared to other competitors. Despite rail and waterway transport being more advantageous, they are little used, since they lack infrastructure and /or investment for their proper functioning.

It was demonstrated the representativeness of the grain market for the State of Goiás, from an analysis of the development of agricultural activity in the region, demonstrating the tradings, multinationals and cooperatives that settled here, responsible for much of the wealth circulation of this agro-industrial pole.

It is concluded that the main objective of agricultural policy is to create formulas and implement policies aimed at the agricultural sector, promoting investments, creating incentives and/or disstimulus for agricultural activities, and should signal the path of expansion of the sector, through the Agricultural and Livestock Plan and resolutions issued by the National Monetary Council of Brazil.

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The Contribution to human resources of Institutional Scientific Initiation Scholarship Program of the Museu Paraense Emílio Goeldi

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Abstract— *The Museu Paraense Emílio Goeldi (MPEG) is one of the oldest museums in Brazil that carries out basic research, and preserves important scientific collections in the areas of Biological and Human Sciences. The institution works in the formation of human resources, at the level of scientific initiation (SI) and graduate studies. In relation to the SI, there is the Institutional Program of Scientific Initiation Scholarships (PIBIC/MPEG/CNPq), which is an initiative from the National Council for Scientific and Technological Development (CNPq) and aims to train staff at the undergraduate level and introduce the student to scientific knowledge. This work aimed to carry out a retrospective research on the research and guidelines conducted in the PIBIC/MPEG/CNPq, published in the respective Abstracts published annually. The period 1997-2019 was evaluated and emphasis was given to works with themes on the Coastal Zone or the Amazonian Continental Area. The following were considered: area of knowledge of the research; sub-area of knowledge and specialty (according to the table of CNPq knowledge areas); sector of activity of the supervisor; year of activity; student, institution of graduation of the supervisor; course attended by the supervisor and; research in the continent or coastal areas. Dynamic tables and graphics were produced. The results showed that the PIBIC/MPEG/CNPq program covered 1154 undergraduate students in the areas of basic and applied sciences. A total of 1877 scientific initiation scholarships were made available, 930 and 947 with themes about the continent and the coastal region, respectively. Several of these students entered the graduate programs at their home institution, at MPEG or at programs in other states or regions of the country. The conclusion is that the PIBIC/MPEG/CNPq is an opportunity offered to young Amazonian people to start working on research, human resources training and scientific, regional and national development, thus strengthening research and, consequently, the development of Brazil.*

Keywords— *Amazon, Coast Zone, human resources, scholarship.*

I. INTRODUCTION

The Museu Paraense Emílio Goeldi (MPEG) was created 154 years ago (1866), as a Museum of Natural History, by initiative of researchers and politicians from Pará, with the purpose of exposing to society part of the natural and ethnographic riches from Amazon, without entering into the forest. In this sense, it served as support for important scientific expeditions of renowned national and foreign scientists such as Agassiz, Martius, Spix, Wallace, and others, who investigated the biodiversity and ethnicities of Amazon from the 19th century [18]. It is worth noting that the material collected in these expeditions was deposited by them in European Museums [15].

Since 1871, MPEG has been considered among the oldest Brazilian institutions of natural and ethnographic research, under the name of *Museu Etnográfico e de História Natural*, Ferreira Penna. In the meantime, scientists from the institution started to publish their scientific works in local, national, and international journals, leveraging the knowledge about the Amazonian nature (biological and socio-cultural). As a result of their research, they have begun to form Scientific Collections in the areas of Zoology, Botany, and Ethnography, which today are important National, Neotropical, and World references [6, 14,18].

The demands of the Amazon led the institution to act, actively, in the areas of Human Sciences (Archaeology,

Anthropology and Linguist), Natural Sciences (Botany, Ecology, Geosciences and Zoology), Technological Innovation and Education (Environmental and Scientific), and also in the dissemination of scientific knowledge (Social Communication and Scientific and Cultural Exhibitions). Today it is one of the oldest museums in Brazil that carries out basic research and preserves important scientific collections in the areas of Biological Sciences and Humanities, characterized as of greater importance of the taxonomic group, for the Neotropical Region.

From the 1960's on, the institution also started to act in the formation of young potential students, interested in science. For several years now, it has been developing staff training programs, from middle to postgraduate levels. These actions perfectly meet the institutional mission: "To conduct research, promote technological innovation, train human resources, conserve collections, generate and communicate knowledge in the areas of natural and human sciences related to Amazon".

One of the staff training programs, at the university undergraduate level developed at MPEG is the Institutional Program for Scientific Initiation Scholarships (PIBIC/MPEG) which is an initiative of National Council for Scientific and Technological Development (CNPq) that aims at "awakening scientific vocation and encouraging special talents among university undergraduate students, through participation in Research Projects, guided by a qualified researcher," in public and private institutions throughout the country. The seriousness with which it has been developed shows its importance and necessity for the formation of professionals in all areas of scientific and technological knowledge in the country [9,17]. The seven SI Fellowship programs from CNPq are important pillars of the Graduate Programs, strengthening research and, consequently, the development of Brazil [1,3,10,15,17].

PIBIC/MPEG/CNPq started in MPEG in 1993 and has been providing high quality training to young Amazonian students, incorporating them into Research and Extension Programs and Projects (Education, Communication and Technological Innovation) developed at the institution. It is worth mentioning that over a thousand professionals who today contribute to the development of the Brazilian Amazon have been trained through this program.

In this sense, this work aims to disseminate the contribution of MPEG in staff training through PIBIC/MPEG/CNPq during the last 23 years, comparing and emphasizing the Coastal Zone and the Amazonian Continental Area.

II. MATERIAL AND METHODS

Data were compiled and analyzed from all the guidelines conducted under the Institutional Scientific Initiation Program (PIBIC), supported by the National Council for Scientific and Technological Development (CNPq), published in the respective Abstracts for the period (1997-2019).

2.1 Reviewed Literature

The research was developed relating the items: area of knowledge of the research, sub-area of knowledge and specialty, according to the adapted table of knowledge areas of CNPq. The area of activity of the supervisor, year of activity, student, institution of the graduation course of the student, course attended by the student, research in the continent, research in large coastal areas, members of the Coastal Studies Program of MPEG (PEC/MPEG).

Several publications were also consulted involving the contribution and impact of the Institutional Scientific Initiation Scholarship Program (PIBIC/CNPq) on other Brazilian institutions and other aspects involving the training of staff for discussion. The oriented works involve research in all areas of knowledge developed at MPEG, involving ecosystem functions and services, and/or socioeconomic and cultural benefits that are being evaluated and compared with the production of the PEC/MPEG.

2.2 Selection Criteria

To evaluate the contribution of the Scientific Initiation Scholarship Program of the Convention between the Museu Paraense Emílio Goeldi and the National Council for Scientific and Technological Development (PIBIC/MPEG/CNPq), data published in the Abstract's Books from 1997 to 2019 involving the 1) Areas of activity of the mentors, 2) Areas, Subareas and Specialty of knowledge of the research developed by the students, 3) Location of the research, Continental or Coastal, 4) Whether the research was conducted by member or not of the PEC/MPEG, 5) Name, Institution and Academic Training Course of the student and 6) Year of activity of the student and the mentor in the PEC/MPEG.

2.3 Data Collection

We consider four major Areas of Knowledge, grouping several areas of CNPq into a single area: 1) Biological Sciences, Health and Forestry - CBSF (Biological Sciences, Health Sciences, Forestry Resources and Forest Engineering), 2) Earth Sciences and Engineering - CTE (Exact and Earth Sciences, Engineering), 3) Humanities, Applied Social Sciences, Linguistics, Arts and Letters - CHSALLA (Humanities, Applied Social Sciences, Linguistics, Letters and Arts) and

Multidisciplinary - MULTD (when the research involved the combination of more than two areas of Knowledge);

The 27 sub-areas grouped by Area of knowledge were: 1) CBSF (Botany, Applied Botany, Ecology, Mycology, Microbiology, Fishing Resources and Fishing Engineering, Zoology and Applied Zoology), 2) CTE (Computer Science, Information Science, Physics, Geosciences, Geophysics, Physical Geography and Meteorology), 3) CHSLLA (Administration, Anthropology, Archaeology, Architecture and Urbanism, Political Science, Law, Economics, Education, History, Linguistics, Theology) and MULTD (Multidisciplinary).

The 28 Specialties grouped by Area of knowledge were: 1) CBSF, 16 (Beekeeping, General Biology, Bioprospection, Biochemistry, Botany Economics, Behavior, Ecosystems Ecology, Landscape Ecology, Medical Entomology, Ethnobotany, Phytochemistry, Inland Water Fishing Resources, Algae Taxonomy, Cryptogamos Taxonomy, Phanerogamos Taxonomy, Taxonomy of Fungi, Taxonomy of Recent Groups), 2) CTE, 13 (Classical Areas of Phenomenology and its Applications, Climatology, Landscape Ecology, Physics, Geoecology, Geography, Geomorphology, Methodology and Techniques of Computing, Pedology, Remote Sensing, Information Systems, Information Technology), 3) CHSLLA, 20 (Specific Sectors Administration, Public Administration, Anthropology of Afro-Brazilian Populations, Rural Anthropology, Urban Anthropology, Historical Archaeology, Prehistoric Archaeology, Special Rights, Agricultural and Natural Resource Economies, Indigenous Ethnology, Modern and Contemporary History, Applied Linguistics, Historical Linguistics, Pedology, Public Policy, Architecture and Urbanism Project, Information Representation, Sociolinguistics and Dialectology, Pastoral Theology, Special Topics in Education) and MULTD (Innovation, Multidisciplinary).

2.4 Conceptual structure of the data

To adjust the contribution from MPEG to human resources training, at the graduate level, through PIBIC/MPEG/CNPq, a compilation spreadsheet was organized containing the following items: a) Program Name (PIBIC), b) Year the Orientation took place, c) Supervisor - ORI, c.1) Name of the Supervisor, d) Research Location Area (Continental - CONT or Coastal - COAST), c.2) Coordination or Sector of the Supervisor in MPEG (Botany - COBOT, Communication and Extension - COCEX Earth Science and Ecology - COCTE, Human Sciences - COCHS, Research and Postgraduate program - COPPG, Planning and Follow-up Coordination - COPAC Zoology-COZOO), c.3) Work of the Supervisor at PEC/MPEG, e) Student: e.1) Name, e.2)- Institution of

Origin, e.3) Course attended at graduation, e.4) Title of the research, f) Area of knowledge of research -AC, g) Subarea of research knowledge-SUBA, h) Specialty of research - ESP.

The four areas, 27 sub-areas and 49 specialties were grouped based on the standard CNPq Table adapted. In the area 1) Biological Sciences, Health and Forestry - it was grouped the Biological Sciences, Health and Forestry Resources -CBSF, 2) Earth Sciences and Engineering - it was grouped the Earth Sciences and Engineering - CTE, 3) Humanities, Applied Social Sciences, Linguistics, Letters and Arts - CHSALLA and Multidisciplinary - MULTD - when the research involves more than two of these major areas to better visualize the research.

2.5 Data Analysis

The data were compiled and analyzed in tables of the EXCEL Program version 10.0. Pivot tables and graphics were produced for all items in topic 2.4. The tables were grouped by year of activity, Coordination (Area of Action of the Supervisor), Name and Action or Not of the Supervisor in the PEC/MPEG, Name, Institution and Course of the Student, Area, subarea and specialty of knowledge and location (Continental or Coastal) of the research developed by the student to show the contribution of PIBIC/MPEG/CNPq in the scientific formation of undergraduate students in an institution in the Brazilian Amazon during 23 years of the existence of the Coastal Studies Program (PEC/MPEG).

It should be noted that information regarding the courses and year of activity of students in the period from 1997 to 2003 was not computed due to its non-existence in the source consulted. This fact justifies the difference in information for these items in relation to the number of scholarships used in these periods.

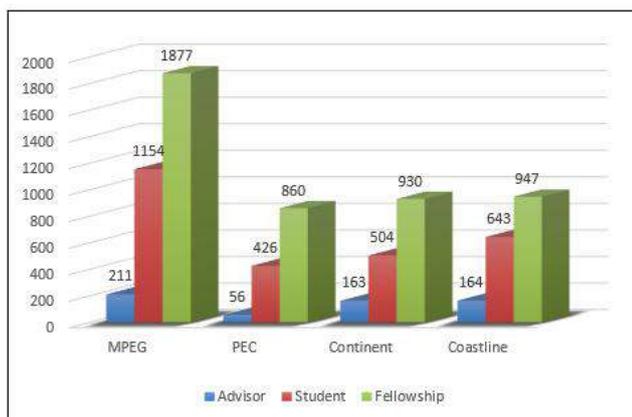
III. RESULTS AND DISCUSSION

The PIBIC/MPEG/CNPq Program covered 1154 undergraduate students, from 1997 to 2019, in the areas of basic and applied sciences developed in MPEG.

It is known that the ecosystems of the Brazilian Amazon coast have peculiar characteristics, resulting from their privileged geographical location, involving the Amazonas River delta and the interference of intertropical equatorial currents [11]. Its mangrove ecosystem, besides being the most preserved on the planet, is an important reservoir of biodiversity and conservation of continental areas [2,7,8,11].

Although the coastal and continental biomes have distinct characteristics, they have closely related structural functions, considering that nature is a continuous transformation of phenomena and processes that today are

quite altered due to the actions of humanity. Thus, researches involving structural knowledge, dynamics, and natural and artificial processes in the Amazonian transect-continent coast are of high importance for the conservation and maintenance of the planet. In this context, the PIBIC/MPEG/CNPq program has been contributing to the formation of young scientists since the 1990s' seeking to understand this complex system (Graphic 1).



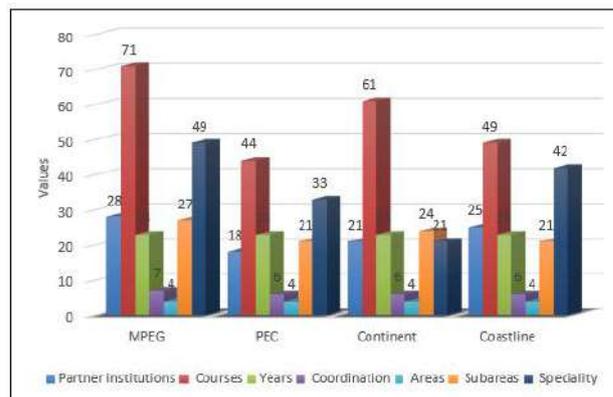
Subtitle: MPEG: Museu Paraense Emílio Goeldi
PEC: Coastline Studies Program

Graphic 1. Comparison between PEC and MPEG contributions at PIBIC/MPEG/CNPq Program, in Continental and Coastaline, from 1997 to 2019 period.

For 23 years (1997 to 2019), the MPEG/CNPq Institutional Scientific Initiation Scholarship Program contributed to the Scientific Initiation (IC) of 1154 potential young people in the Brazilian Eastern Amazon. These students came from 71 courses of 28 undergraduate programs in the State of Pará, Brazil. These students undertook 61 and 49 studies related to themes on the continent and coastal regions, respectively (Graphic 2). These data show the opportunities that MPEG has been offering to young Amazonian people to work in research, allowing them to enter and conclude graduate programs more quickly, to contribute to regional development. These results corroborate those of other authors for other institutions in other Brazilian regions [9,10,13,16,17].

Most of the students who choose the academic-scientific activities enter in the postgraduate programs existing in the institution of origin or in MPEG, others choose courses in programs allocated in other states or regions of the country, according to their particular interests. The performance of 211 researchers (supervisors) allocated in 7 Research Coordination, extension and technological innovation involving 49 specialties in 27 sub-areas of 4 areas of scientific knowledge shows the

amplitude of knowledge and experiences offered by the institution to potential Amazonian young. This training is substantial to broaden the vision and critical capacity of these young people by directing them to professional activities that they may exercise in the future [10,11]. The Coastal Studies Program (PEC/MPEG) which involves current and past activities, with 1/3 of the researchers from institution (supervisors) and contributed with 860 guidelines (Graphic 2).



Graphic 2. Comparison between PEC and MPEG contributions at PIBIC/MPEG/CNPq Program, in Continental and Coastline among partner institutions considering the coordination and chosen areas.

In this context, MPEG is a research, extension and technological innovation institution, contributing over 23 years with the formation of 1877 scholarships for scientific initiation, 930 of them on subjects related to the continent and 947 on the coastal region, in collaboration with the PIBIC and PIBITI/CNPq Programs. This activity allows young scientists to accelerate the period of entry and stay in graduate programs, thus making available, in a shorter time, Masters and Doctors to contribute to the development of the country, a fact also argued by other researchers, for other Brazilian regions [16,17,10].

3.1 Institutional Contribution by Sectors of Activities (Coordination) x Scientific Knowledge (Areas, Subareas, Specialities)

The Museu Paraense Emílio Goeldi (MPEG) is made up of seven Departments (former Departments) in which students have contact with supervisors in their respective sectors (Departments), either sent by educational institutions or on their own initiative, out of affinity with the area of knowledge, in order to develop supervised internships and after, they are guided to enroll in the annual calls for proposals of the PIBIC/PIBITI/MPEG/CNPq Programs, to apply for the scholarships. The students of IC (PIBIC/PIBITI) have the contact with research and science during the period of the current scholarship, are trained in

technical-scientific activities in the laboratory, in existing research projects supervised by their mentors. collections in MPEG and in field studies to develop their

Table 1. Human Resources Training through the PIBIC/MPEG/CNPq Program (1997-2019), by MPEG Coordination, in Continental and Coastal areas.

	COBOT		COCEX		COCHS		COCTE		COPAC		COPPG		COZOO		Total	
	CONT	COAST	CONT	COAST	CONT	COAST	CONT	COAST	CONT	COAST	CONT	COAST	CONT	COAST	CONT	COAST
Advisor	8	9	4	4	11	11	11	17	6	5	5	2	17	17	24	21
Student	172	202	8	17	115	85	151	141	11	16	5	2	191	189	661	646
Fellowship	230	286	10	25	204	131	206	218	10	8	9	14	5	2	920	947
Partner institutions	40	54	5	6	36	26	23	31	5	4	4	1	52	38	164	155
Course	13	15	4	4	19	17	13	25	8	6	0	0	9	9	38	42
Years	23	23	5	8	23	23	23	23	10	5	5	2	23	23	23	23
Coordination	18	17	6	9	21	18	32	218	10	9	4	1	22	15	61	49
Areas	4	4	2	1	4	4	4	4	4	4	1	2	1	1	4	1
Subareas	84	93	2	4	70	51	45	51	1	1	0	0	1	1	256	256
Specialization	9	13	4	6	9	8	16	14	8	7	2	1	13	15	21	25

Subtitle: COBOT: Botany Coordination; COCEX: Communication and Extension Coordination; COCTE: Earth Science and Ecology Coordination; COPAC: Planning and Follow-up Coordination; COPPG: Research and Postgraduate Program Coordination; COZOO: Zoology Coordination; CONT: Continental.

Since its creation, MPEG has prioritized the study of biodiversity, also contributing to the humanities (indigenous and cabloca), which justifies its greater action with the scientific initiation of potential young people, in Biological Sciences. Thus, the Coordination in Zoology (COZOO), which has the largest number of supervisors (61) and trained 327 students; the Coordination in Botany (COBOT), which worked with 64 supervisors training 326 students over a period of 23 years. On the other hand, the Coordination of Earth Sciences and Ecology (COCTE - Geosciences and Related), created in the 1990s to meet regional demands, had the work of 45 supervisors who trained 271 students. The Coordination of Human Sciences (COCHS) worked with 42 supervisors training 202 students. The Planning and Follow-up Coordination (COPAC), which is also a technology transfer and innovation area with 10 years of activity, involved 5 supervisors who trained 25 students. It is worth mentioning that training on Technological Innovation is also developed at the COBOT, COCTE and COZOO Coordination Offices. The Popularization of Science developed mainly by the Coordination of Communication and Extension (COCEX) tied with 10 tutors and 25 students, is developed in all Coordination (Tables 1 and 2).

Thus, the data show that basic research remains the institutional pillar, although some sectors are developing research in innovation and technology transfer. Therefore, since its creation (1866), MPEG has sought to know and understand the standards, dynamics and processes of biodiversity and Amazonian ethnic groups. In view of that,

it preserves and maintains the testimonies of its research in Neotropical Zoological Scientific Collections (Mastozoology, Oritology, Invertebrates, Herpetology, and Ichthyology) and Botanicals considered important collections of Neotropical flora and fauna. In the Humanities area it has one of the most important ethnographic and archaeological collections of the Brazilian Amazon. These collections support the Research Projects of the students of IC and PG (postgraduate program) of the institution, as well as those of national and foreign interinstitutional exchanges. Students who use these collections are encouraged to develop research that shows the evolutionary processes, uses and customs of the objects of study in their respective areas of knowledge.

3.2 Contribution of the Coastal Studies Program (PEC/MPEG)

The Coastal Studies Program from MPEC (PEC/MPEG) is one of the structuring programs from the institution. It was created in 1997, at the initiative of researchers who worked and are active in the Amazonian Coastal Zone with the mission "To generate, integrate and communicate knowledge about natural systems and the socio-cultural diversity of the coastal and marine Amazon". The PEC/MPEG has been developing interdisciplinary projects in various parts of the Amazon coast (Pará and Amapá), seeking to integrate communities with the mutual exchange of knowledge and experience [5,12]. Human Resource Training, from high school to graduate school, involving scholarship students and/or volunteers has been a

constant concern of the members of PEC/MPEG, as can be seen in table 2.

Table 2. Human Resource Training through the PIBIC/MPEG/CNPq Program (1997-2019), by MPEG X PEC/MPEG Coordination (1997-2019).

	COBOT		COCEX		COCHS		COCTE		COPAC		COPPG		COZOO	
	NPEC	PEC	NPEC	PEC	NPEC	PEC	NPEC	PEC	NPEC	PEC	NPEC	PEC	NPEC	PEC
Advisor	9	8	5	2	11	12	17	14	7	0	6	2	9	5
Student	204	137	24	2	141	66	137	145	5	2	14	0	256	76
Fellowship	407	209	33	2	219	116	200	224	41	0	5	2	392	127
Partner institutions	64	54	8	2	20	8	34	17	6	1	6	0	54	10
Course	17	10	5	2	20	16	20	20	11	0	5	2	11	6
Years	23	21	9	2	23	22	23	23	4	2	5	2	23	23
Coordination	21	19	12	3	10	19	32	28	14	0	3	1	14	11
Areas	4	2	2	1	4	4	4	4	3	0	3	1	4	3
Subareas	9	8	5	2	11	12	17	14	7	0	6	2	9	5
Specialization	6	9	6	2	9	5	15	9	10	0	2	1	11	6

Subtitle: COBOT: Botany Coordination; COCEX: Communication and Extension Coordination; COCTE: Earth Science and Ecology Coordination; COPAC: Planning and Monitoring Coordination; COPPG: Research and Postgraduate Coordination; COZOO: Zoology Coordination; CONT: Continental; PEC: Works in Coastal Studies; NPEC: Works in other areas.

Among 1154 Scientific Initiation (IC) students, 424 were trained in the PIBIC/MPEG/CNPq program, coming from 28 institutions (44 courses), guided by one of the 56 members of the PEC/MPEG over 23 years (1997 to 2019). The contribution to IC training by the members of the PEC/MPEG in the Coordination is shown in table 2. This fact confirms the importance of MPEG as a research institution focused on Amazonian natural history (sociobiodiversity) in the formation of potential researchers.

3.3 Partnerships

Collaboration in research projects and programs in inter-institutional and intra-institutional partnerships is important to fill institutional gaps, broadening horizons and enabling more successful knowledge generation. In this sense, a series of projects considered "Âncora" as IBID - (Projeto Manguezais Paraense: Recursos naturais, usos sociais e indicadores para a sustentabilidade, MADAM, (Programa Manguezais da Amazônia), PIATAM MAR, RENAS (Projeto Recursos Naturais e Antropologia Social), besides others that involved and involve national and international cooperation were and are of utmost importance for the performance of the PEC/MPEG [5]. The partnerships are shown in Table 3.

Table 3. Partnerships established by the PIBIC/MPEG in the period (1997-2019).

SCALE	COLABORATOR				
	1-5	6-50	51-150	151-300	>300
Advisor	15	7	2	1	2
Student	17	7	3	1	1
Fellowship	15	6	2	0	0
Course	22	5	0	0	0
Years	20	8	0	0	0
Coordination	24	4	0	0	0
Area	28	0	0	0	0
Subarea	20	7	0	0	0
Specialty	18	10	0	0	0

The higher education institutions that are partners in the PIBIC/MPEG/CNPq program are located mainly in the metropolitan region of Belém-Pará and total 28. The partnerships with these institutions generated 1154 participating students (from 1997 to 2019), and in 17 of them 1 to 5 students were trained, and in only one of them there were more than 300 students (Table 3). This demonstrates the insertion of MPEG in higher education courses in the state of Para as a fundamental action to enable the exploitation of these potentials in the academy and other development sectors of the country. Similar facts for the Amazon and other Brazilian regions are shown by other authors [1,3, 7,10,11,16].

3.4 Origin and Student Profile

The PIBIC/MPEG/CNPq scholarship holders go through an institutional selection process, for which they must meet the requirements of the public notice, such as: have good academic performance, without disapproval, demonstrate interest in research, tooth others. They are

indicated by a researcher with scientific production who will be their respective mentors.

The selection occurs once a year and the scholarship are valid for 12 months. In exceptional cases, when there are withdrawals or conclusions of new scholarship course calls are made to fill vacancies. These scholars are valid for less than 12 months. At the end of the scholarship period, students will present the research conducted during the PTBIC/MPEG/CNPq Seminar held annually in the form of an oral communication or panel, depending on the scholarship period. On this occasion, the quality of the Program is evaluated through the results presented, in addition to the interest, performance, and capacity demonstrated by the scholarship recipients.

3.5 Impact of Training for the Amazon Region (Participation/continuity of the scholarship holder in the Program)

The training offered to the PIBIC/MPEG/CNPq program fellows has shown that the contact and stimulus to the fellow with scientific research leading him/her to the academic universe is important:

a) Expand the capacity for interaction between students and researchers at various levels.

b) Improve the capacity of deduction and reasoning.

c) Enable them to enter postgraduate programs.

It is observed that most of the students coming from these programs enter the master's courses of MPEG and other institutions and also conclude the Master's course within the period (two years) established by CAPES (Coordination of Higher Education Improvement). It is worth mentioning that the PIBIC Program has been showing similar impacts in institutions from north to south of the country, demonstrating its important role in the process of training new scientists in the country [1,3,10,11].

IV. CONCLUSION

PIBIC/CNPq Program since its creation in the 1950s has been an important pillar for the training of new scientists in the country, and the PIBIC/MPEG/CNPq data has substantially contributed to the training of new professionals in the eastern amazon region.

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The intention of organ donation among nursing academics: Influence of knowledge on decision

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Abstract— Objective: to investigate the knowledge, opinion, and intention of students from a private university in Belém do Pará, Brazil, about the donation of organs and tissues for transplantation. Method: Cross-sectional, population-based, descriptive study with a quantitative approach. Result: The sample consisted of 302 students, in which it was evidenced that the intention regarding the donation of organs and tissues for transplantation is positive, since 55.8% of the participants intend to donate some organ or tissue. However, it was found that some demographic, socioeconomic and cultural factors can influence this decision. With this study, it was possible to identify the level of knowledge and the intentions of the population about the donation of organs and tissues for transplantation, making it essential to raise awareness among the population through training and information campaigns. Conclusion: Although the majority of participants knew and supported the donation of organs and tissues, there is still a great lack of confidence in the health system, in the diagnosis of brain death and a strong presence of beliefs and myths, such as fear of having the body multiplied.

Keywords— Transplantation, Tissue and organ procurement, Knowledge e Education, Nursing, baccalaureate.

I. INTRODUCTION

Transplantation is a complex process, which begins with the identification and maintenance of possible donors in brain death, capable of donating the following organs and tissues: heart, lungs, liver, kidneys, pancreas, intestines, corneas, skin, bones, tendons, bone marrow and veins. Regarding the living donor, there are rules to be followed, such as: the donor must have a blood relationship of up to four degrees with the recipient, in addition to undergoing various pathological tests and tests of liver, kidney and lung function¹.

Currently, the supply of organs and tissues available for transplantation is insufficient to meet the global demand of patients who need this procedure². Despite government initiatives to educate the population about the importance of donation, prejudices, and fears about this process still persist³. Therefore, it is essential to understand the reasons that make donation unfeasible, since organ and tissue transplantation is considered an effective therapy for several chronic and disabling pathologies, as well as for the rehabilitation process and increased life expectancy⁴.

In addition, it is understood that the intention to donate organs after death goes through abrupt and unpredictable moments, since the feelings of loss are immeasurable within the family of the potential donor. Therefore, in the final phase of life, the intensive care team's mission is to approach bereaved family members, contextualizing and reporting the possibility of organ donation in a multidisciplinary and timely manner. However, this process represents a challenging practice that requires health professionals to feel compassion, empathy, and knowledge to meet the care needs of the bereaved family and the potential donor⁵.

Given this reality, and based on the relevance of the subject, this study aims to investigate the knowledge and intention of nursing students about organ and tissue donation for transplants.

II. METHOD

Descriptive, cross-sectional, population-based cohort study with a quantitative approach, conducted at a private university located in the metropolitan region of Belém,

state of Pará, Brazil, in April 2019. The sample consisted of all students enrolled in the 1st, 3rd, 5th, 7th, 8th, 9th and 10th semesters of the nursing course, totaling 1,230 students. A 5% margin was adopted as a sampling error, with a 95% confidence level, establishing as an initial sample 302 students who signed the Free and Informed Consent Term, with the appropriate guidelines and who composed the final version of this research.

A questionnaire composed of double fragmentation was used, divided into parts (A) and (B). Part (A) aimed to identify the sociodemographic profile of students, while part (B) aimed to relate specific questions about organ and tissue donation for transplantation, as factors that influence decision, intention to donate and death cerebral.

The data were stored in the Windows® Office Access 2018 software and the results were presented in tables. Statistical processing was performed using the Bioestat® 5.38 and Statistical Package for the Social Sciences® (SPSS) 22.0 software. In addition, to describe the sample profile of the 302 students, frequency tables of categorical variables were prepared with the values of absolute frequency (n), percentage (%) and descriptive statistics of continuous variables (age, sex, etc.) with minimum, average, maximum and standard deviation values.

When comparing categorical variables, chi-square adherence tests were used. The analysis of variance (ANOVA) and the "Student's T test" were applied to compare the performance in the knowledge test according to the semester. The level of significance adopted for the statistical tests was 5% ($p < 0.05$) for rejection of the null hypothesis.

This research was carried out based on the National Health Council (CNS), based on resolutions 466/2012 and 510/2016 of the National Council for Ethics and Research (CONEP). Thus, the research was authorized by the Ethics and Research Committee (CEP) of the Campinense Institute of Higher Education (ICES-UNAMA), under CAEE: 06943018.2.0000.5173, and with the ethics committee opinion number: 3,658,687.

III. RESULTS

The final sample consisted of 302 students, of whom, it was observed that the intention to donate organs and tissues represented a positive result, since 81.1% stated that they intend to donate some organ or tissue in their body. Among these students, 55.5% were between 17 and 26 years old, however, this age group was still predominant in 56.5% of the students who declared that

they did not intend to donate their organs. Therefore, there seems to be no statistically significant association ($p > 0.05$) between the intention to donate organs and tissues and the age group, as shown in Table 1.

As for questions about the authorization of organ donation from a deceased family member, who was classified as a potential donor and who had shown an interest in donating their organs in advance, it was found that 91.1% of respondents would authorize the donation of organs of that relative.

Furthermore, similar results were observed when the participants were asked about the authorization for donation of organs from a family member who received the diagnosis of brain death, in this case, 80.1% of the interviewees stated that they would authorize the donation, however, only 47, 4% of respondents stated that they would authorize the donation if the deceased relative had not discussed the matter. Therefore, these results demonstrate a trend, statistically, favorable to donation when this topic is discussed in the family environment ($p < 0.05$), as shown in Table 2.

Appropriately, when participants answer specific questions related to organ donation, these responses respond favorably to this process, since 81.1% of students intend to donate an organ in their body, 82.5% authorize the donation of their organs after death, 86.4% of the organs or parents in life, if they were not harmed. In addition, it is questioned that 64.9% of the interviewees informed a close relative about the intention of their organs or had already talked to a relative about this subject, 74.5% demonstrated satisfactory knowledge about brain death studies and 48% affirm that a person is diagnosed with brain death only when he or she experiences total brain failure.

In continuity, it was also observed that 48% of the interviewees understand that the lack of knowledge on the topic is the main reason that leads people not to donate their organs after death, 51.7% fully trust the criteria used for the diagnosis of brain death, 52.3% believe there are organ sales in Brazil, 74.5% report that the average waiting time in the transplant queue is more than 3 years and 55.3% believe that purchasing power does not influence the person who receives a transplant, as shown in table 3.

Table 1: Age group regarding the intention to donate organs and tissues after death. Belém / PA, 2019

Age range	Do you intend to donate any organ in your body?						Total	p- Value ⁽¹⁾
	Yes		No		Do not know			
	n	%	n	%	n	%	n	%
17-26	136	55,5	13	56,5	22	64,7	171	56,6
27-36	71	29,0	5	21,7	4	11,8	80	26,5
37-46	34	13,9	5	21,7	5	14,7	44	14,6
47-56	4	1,6	0	0,0	3	8,8	7	2,3
Total	245	81,1	23	7,6	34	11,3	302	100,0

Source: Research protocol (2019).

⁽¹⁾Pearson's Chi-square test (Wilks' G²) for association (p-value <0.05).

*Significant Values; NS - Non-Significant Values.

Table 2: Intention to donate organs and tissues to family members. Belém / PA, 2019.

Intention to donate organs and tissues to family members		n	%	p-Value ⁽¹⁾
1 – Imagine that one of your parents warned you about your desire to be an organ donor. The doctor warned that this relative died. Did you authorize this person's organ donation?	Yes	275	91,1	<0.0001*
	No	6	2	
	Do not know	21	7	
2 – Imagine that another close relative of yours warned about your desire to be an organ donor. The doctor warns that this patient has been diagnosed with brain death. Did you authorize this person's organ donation?	Yes	242	80,1	<0.0001*
	No	18	6	
	Do not know	42	13,9	
3 – Imagine that a close relative has not discussed organ donation with you. The doctor warned him that this relative was diagnosed with brain death. Did you authorize this person's organ donation?	Yes	143	47,4	<0.0001*
	No	71	23,5	
	Do not know	88	29,1	

Source: Research protocol (2019).

⁽¹⁾Pearson's Chi-square test (Wilks' G²) for association (p-value <0.05).

*Significant Values; NS - Non-Significant Values.

Table 3: Distribution of specific questions about organ and tissue donation for transplantation. Belém/PA, 2019.

Specific Questions on Organ and Tissue Donation for Transplantation		n	%	p-Value ⁽¹⁾
Do you intend to donate an organ in your body?	No	23	7,6	X ² = 293.655 / P = 0.001*
	Do not know	34	11,3	
	Yes	245	81,1	
Would you authorize the donation of your organs after your death?	No	19	6,3	X ² = 328.974 / P = 0.001*
	Do not know	34	11,3	
	Yes	249	82,5	
Would you donate organs to relatives or friends in life if you were not going to harm him?	No	21	7	X ² = 383.053 / P = 0.001*
	Do not know	20	6,6	
	Yes	261	86,4	

Specific Questions on Organ and Tissue Donation for Transplantation		n	%	p-Value ⁽¹⁾
Have you alerted a close relative of your intention?	No	106	35,1	$X^2 = 26.821 /$ $P = 0.001^*$
	Yes	196	64,9	
Which relative did you talk to about this subject?	Son or Daughter	7	2,3	$X^2 = 131.81 /$ $P = 0.001^*$
	Brother or Sister	25	8,3	
	Mom	45	14,9	
	Dad	29	9,6	
In your opinion, what are the reasons that can lead people to not donate their organs after death?	Several close relatives	104	34,4	$X^2 = 235.351 /$ $P = 0.001^*$
	Not applicable	106	35,1	
	Ignorance of the theme	145	48,0	
	Selfishness	21	7,0	
Is brain death the legal definition of death, that is, is it the complete and irreversible halt of all brain functions?	Fear of not being dead	51	16,9	$X^2 = 234.523 /$ $P = 0.001^*$
	Do not believe in the health system	26	8,6%	
	Does not want to have his body mutilated	103	34,1	
	Religion	90	29,8	
When a person is brain dead, they are:	Others	11	3,6	$X^2 = 106.715 /$ $P = 0.001^*$
	False	24	7,9	
	Do not know	53	17,5	
	Truth	225	74,5	
Do you trust the diagnosis of brain death?	Dead	84	27,8	$X^2 = 130.358 /$ $P = 0.001^*$
	Do not know	44	14,6	
	Partially live	29	9,6	
	Only with the dead brain	145	48,0	
Are there organ sales in Brazil?	Partially Trust	89	29,5	$X^2 = 236.43 /$ $P = 0.001^*$
	I fully trust	156	51,7	
	I do not trust	57	18,9	
The average waiting time in the transplant queue is:	No	8	2,6	$X^2 = 90.603 /$ $P = 0.001^*$
	Do not know	136	45	
	Yes	158	52,3	
Who is most likely to receive a transplant?	More than 1 year	56	18,5	$X^2 = 236.43 /$ $P = 0.001^*$
	Over 3 years	225	74,5	
	Less than 1 year	21	7	
Who is most likely to receive a transplant?	Poor	32	10,6	$X^2 = 90.603 /$ $P = 0.001^*$
	Rich	103	34,1	
	Purchasing power doesn't matter	167	55,3	

Source: Research protocol (2019).

⁽¹⁾Pearson's Chi-square test (Wilks' G²) for association (p-value <0.05).

*Significant Values; NS - Non-Significant Values.

IV. DISCUSSION

This study presents positive responses regarding the opinion and intention of nursing students to donate organs and tissues for transplantation. Other studies have observed similar results, since in the study by Cardoso¹⁰, 81.6% of the interviewees reported having the intention to be an organ donor, while in the study by Costa et al.⁹ these results were even greater, as 85.2% of nursing students stated that they wish to donate their organs after death.

However, it was found that some demographic, socioeconomic and cultural factors may influence the decision of individuals to donate their organs and tissues or their families after death, such as ignorance of the topic, fear of having their bodies mutilated and for religious reasons.

It was found that, in a supposed diagnosis of brain death or death of a family member of the interviewed academics, the authorization for organ donation is correlated with a previous conversation on the topic, since the rates of academics who would authorize organ donation of a deceased relative, without previous conversation on the subject, is significantly ($p < 0.05$) inferior (47.4%) when compared to the questions that informed the realization of a conversation on the subject (91.1% and 80, 1%), therefore, the lack of communication from family members about the desire to donate their organs can reduce donation rates in the family environment.

In this research, it was also observed that academics belonging to the age group between 17 and 26 years old had the highest levels of intention to donate organs. Likewise, a study with a comparative analysis of the opinion and knowledge of the students of the last year of high school on transplantation and donation of organs and tissues, in a private school and a public school in Brazil, found that, of the 108 students interviewed who were in the 16 to 22 age group, 54% of students in private schools and 53% of students in public schools expressed the desire to donate their organs and tissues after death⁷.

Casarin⁸, showed in his study, carried out with 10 family members who authorized the donation of organs and tissues, that, despite the suffering of the death of a loved one, they did this act to save lives and help, in the broadest sense of the word and 80% of the interviewees who authorized the donation were over 30 years old, different from what was found in our survey, in which young people have more intention to donate.

The sample of academics surveyed shows positive attitudes towards organ donation and transplantation, because, in relation to levels of knowledge, we can say that

the population is informed about the topic, however, there are still gaps in the knowledge of these academics who must be resolved.

It was found that of the 128 (47%) interviewed, most understand that the lack of knowledge about the brain death criteria can negatively interfere in the decision to donate, since 195 (71.9%) academics demonstrated to know the criteria and, therefore, have the intention to donate, but the intention to donate is also high, even among the 45 (16.4%) who are unaware of the brain death criteria. In addition, the lack of confidence in the health system did not correlate with the non-intention to donate organs, as only 19 (6.9%) academics demonstrated that they did not trust the health system, however, it was found that the majority maintained the intention to donate your organs.

In this sense, according to Pacheco et al³, although donors and / or family members are aware of the desire of their loved ones to make the donation, they are still not informed about the appropriate means to fulfill this desire. In continuity, Costa et al⁹ showed in their research with 203 nursing students, from two public universities in the São Francisco Valley, that 48.8% of the interviewees classified their knowledge on the subject as regular, but 74.4% agreed with the concept of brain death and 79.3% know the proper criteria to become a donor.

The presence of myths and fears (mutilated body, organ trafficking, etc.) proved to be one of the barriers to donation in 93 (34.1%) of the students. In relation to this issue, Maynard et al¹⁰ affirm that the death of a loved one is almost always a traumatic and delicate moment for the family, when feelings such as pain, fear, despair, anger, and anguish mix. Almost instantly when a person is diagnosed with brain death, the family must be interviewed to know their decision regarding the donation of organs from the deceased relative, due to the rapid deterioration of the organs after death, which can make transplantation unfeasible.

Thus, it is essential to raise awareness among the population through training and information campaigns, as the existence of myths and beliefs on this topic demonstrates the need to inform and demystify, leading to a conscious and informed decision¹¹.

V. CONCLUSION

The results demonstrate that most participants heard about organ donation and had a positive attitude towards donation. In addition, most participants were aware of the importance of donating. It is also worth mentioning that,

although most participants are aware of and intend to support organ donation, there is still mistrust in the processes carried out by the Health System, in addition to the lack of confidence in the diagnosis of brain death and in the presence of beliefs such as fear of have your body mutilated.

The knowledge and positive intention to donate organs and tissues of nursing students revealed in this study will be used as basic data to provide education on the subject, including content on organ transplantation in the regular nursing curriculum in the future, contributing to the expansion of donation.

This study had the following limitation: the involvement of nursing students based on only one institution of higher education, which makes it difficult to generalize the results. Therefore, it is recommended to carry out similar research in other institutions, both in the national scenario and in international educational institutions.

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Accumulative Stability Increment of Multi-Storied Building Rested Over Soft, Medium and Hard Soil: A Review

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Abstract— To ensure that the building is with stand against all the load are acting on the building such as self weight of the structure, live loads & lateral loads such earthquake and wind forces. The first steps element of construction is foundations which are resting on the soil bed below it. The soil having different properties and phases in it. As per Indian earthquake codal provision the soil may be Soft, Medium and Hard Soil and also classified based on the zone wise. So it important to analysis structure the four different soil types phase because the topography and strata of soil surface are differ as per the different site conditions. This paper is based on the study of different research paper of different researchers which are used different soil types. On the bases of hard, medium and soft soil different researchers used in various building construction so that it get re action against the lateral loads. Based on the study it concluded that the maximum researcher is worked on the medium soil taken as a reference. The maximum amounts of research are earthquake basis in it and few are also wind parameter basis. Under building design somehow focused on the grade of concrete. The stability is more in hard soil and moderate in medium soil and the foundation adoptability is more required in soft soil.

Keywords— Lateral load, Multistoried building, Soil types, Shear wall, Stability increment.

I. INTRODUCTION

Buildings are subject to different types of lateral loads such as earthquake & wind loads. The behavior is varying with type of soil. The type consist as dense soil, medium & soft soil. The affection of different soil type when seismic waves as they pass through the soil layer. When a structure is exposed to an earthquake, it impact with the foundation & soil mass. Thus changes the movement of the earth. This shows that the type of soil, & also based on type of structure, affects the movement of the entire system of ground structures. Because seismic waves are transmitted from the ground, they consist of changes in the properties of the soil and work in different ways according to the corresponding properties of the soil.

Vibrations that disturb the earth's surface caused by waves generated in the earth are called earthquakes. It is said that earthquakes do not kill human life, but structures that are not built taking into account the forces of an earthquake. Currently, earthquake-resistant structures in India attach great importance to human security. India is a subcontinent with more than 60% of the area in an earthquake prone area. Most buildings built in India are

designed with permanent, semi-permanent moving loads in mind. But an earthquake is a random burden that leads to deaths, but it also violates the social conditions of India. The degree to which the structural response alters the characteristics of seismic movements observed at the foundation level depends on the relative mass and stiffness properties of the soil and structure. Thus, the physical property of the foundation environment is an important factor in the earthquake response of the structures it supports. The future demand of each city will ultimately contribute to attracting population and living demand. This requirement leads to the development of a multi-story building. To resist lateral forces and stay in place, tall structures need stability with or without any improvement in the same soil type and optimization of stability. The issue of high construction stability has now become a major issue as communities approach cities that provide them with amenities. Along with the stability issue, another thing is optimization that maintains the efficiency of the massive structure and its load on the soil that ultimately carries it. Concrete is mainly the indisputable and necessary material that is used in construction to develop infrastructure around the world.

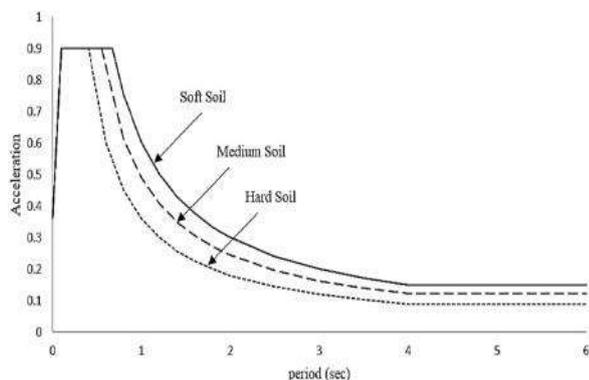


Fig. 1: Curve between Acceleration vs. Time period of hard, medium and soft soil.

The curve is basically shown the response of earthquake. The response is in terms of vibration analysis of the structure. The vibration phenomena are taken place with structural natural time period and acceleration generated on it. The three curves are drawn in it. Hard soil is below bottom curve shown that less time and acceleration are achieved through it. Similarly the soft soil curve having maximum value so that responses are more in acceleration and time period terms. Medium soil exhibit in between them. These type of condition are vary with the site area and locality of the soil type. Hence it is important to study about stability based on hard, medium and soft soil.

II. LITERATURE REVIEW

The following literature papers are studied for the study and knowledge of Stability analysis of multi-storey building. The main emphasis on the soil type. The review on the literature is as follows:

As seismic waves are transferred from the soil, they consist of altering the properties of the soil and function differently depending on the respective properties of the soil. In this study, different soil strata are taken and the base shear and lateral displacement are determined with variations in the floors such as G + 4, G + 5 and G + 6 and areas such as 3, 4 and 5. IS 1893: 2002 "Criteria for Design of Earthquake Resistant Structures" offers a response spectrum for different types of soil, such as hard, medium and soft. A building is modeled in SAP-2000 with different Winkler springs as its base corresponding to different soil properties This research has enormous benefits in the field of earthquake geotechnical engineering, (Ketan Bajaj, S.V. Jitesh, T Chavda et. al. (2013))

The article consists of assessing the state of the local influence of the site based on the structural interaction of

the soil with the dynamic behavior of the soil. At this middle moment, the resistance of the building frames is considered 3 models of 5, 10 and 15 storey buildings. Two types of soil were taken with shear wave velocities of less than 600 m / s, representing De and Ee soil classes according to classification AS1170.4-2007 (Earthquake in Australia) with bedrock depth of 30 m. The structural sections of the selected frames were designed in accordance with AS3600: 2009 (Australian Standard for Concrete Structures) after inelastic dynamic analysis from four different earthquakes. The above frames were then analyzed under three different boundary conditions: (i) a fixed baseline under the direct impact of earthquake records; (ii) a fixed base taking into account the influence of the local area, modifying only the earthquake record; and (iii) a flexible base (given the full interaction of the soil structure). The analysis results in terms of baseline shear and structural drift for the above boundary conditions are compared and discussed. It is concluded that the traditional inelastic design procedure, including only the local area effect, excluding SSI, cannot adequately guarantee structural safety for buildings with an average rise, withstanding resistance above 5 floors, resting on soft soil, (B. Fatahi, B. F. Harry & et, al. (2014))

The paper is based on the Conventional analyses of structures. The assumptions are taken as the base of structures to be fixed. However, the soil below foundation alters the earthquake loading and varies the lateral forces acting on structure. Therefore, it is unrealistic to analyze the structure by considering it to be fixed at base. Multistorey reinforced concrete framed buildings of different heights with and without shear wall supported on raft foundation incorporating the effect of soil flexibility are considered in present study to investigate the differences in spectral acceleration coefficient (S_g , base shear, and storey shear obtained following the seismic provisions of Indian standard code and European code. Study shows that the value of base shear obtained for symmetric plan building is lowest in buildings with shear wall at all the four corners, (Jayalekshmi B. R. and Chinmayi H. K (2014))

This design report includes seismic analysis and design of five R.C. floors. A building with an asymmetric plan in different soil conditions. The building is modeled as a three-dimensional spatial frame with six degrees of freedom at each node using the software SAP2000 v 14. Response spectra in accordance with IS 1893 (part 1): 2002 for stony or hard soils and soft soils. The dynamic response of the supported structure, in particular in soft soils, can vary significantly in amplitude and frequency from the reaction of an identical structure supported in very hard

soils or rocks. However, evidence of many examples of the failure of rigid structures based on flexible soils and intensive analytical studies conducted in recent years have made significant progress in the field of interaction between soil structure and analytical methods. This interaction phenomenon mainly depends on the mechanism of energy exchange between soil and structure. The effect of the interaction of soil and structure is given. Cause under buildings with high rigidity on free floors behaves differently. Baseline changes have significant differences: high values for support structures in loose soils and low values for hard soils. This is mainly due to the higher absorption capacity of soils compared to mountain materials, **(Ranu R. & A. B. Deshmukh (2015))**.

In this article, nonlinear studies of the history and response spectrum were carried out using Etabs-2015 software to study the effect of soil conditions under an isolated base. The effect of ground flexibility is examined in this study to examine differences in spectral acceleration, baseline shear, material displacement, object drift, and material shear, derived from the seismic provisions of the Indian Standard Code. Different soils are systematically compared and discussed for the earthquake resistance of multi-story buildings. A parametric analysis of buildings equipped with insulation devices is carried out to select the appropriate type of soil. Research shows that the base shear value increases with increasing soil flexibility and superstructure stiffness. It was also noted that spectral acceleration (SA) and spectral displacement (SD) are higher under soft soil conditions, which gives us evidence that the spectral response of the structure is related to the state of the soil. The document concluded that hard ground and medium ground are suitable for building basic insulation. In addition, analysis and design considerations for basic insulated and traditional designs are offered to enable the designer to better understand the preliminary design stage, **(Amer Hassan, Shilpa Pal (2017))**.

The seismic analysis of the building is main aim of this study. It is based on an inclined surface with inclined angles of 16, 20 and 24 degrees. The surface is influenced by interaction of the soil structure. Building fill effect included for analysis. Hard, medium and soft soils are used for the effect of the interaction of the soil structure. ETabs based analysis is carried out as per codal approach IS-1893: 2002 using linear mechanics. The response parameters such as baseline displacement, fundamental time period, line displacement and axial force are compared for buildings with fixed and flexible basements. It is observed that the effect of the interaction of the soil structure leads to an effective decrease in the base shift.

However, the main period of time, long-line displacement and axial force increase by influence of the interaction of the soil structure, **(Qudsia Bhavikatti, S. B. Cholekar (2017))**

In this Project, the state of human comfort in a high-rise building under wind excitation is estimated using the peak acceleration estimate using the Indian standard code IS 875 (part 3): 2015. Consider four different frame pipes of a high-rise circular structure having G + 20, G + 30, G + 40 and G + 50 with different conditions, that is, a normal plate, a secondary beam, a waffle plate and a ribbed plate are taken. A typical round floor with a diameter of 50 m and symmetrical in plan in both main directions. Then, using ETABS-2013 software, the maximum displacement is estimated by dynamic building wind analysis using the corrosion factor method. Using maximum bias, the Acceleration Peak will be calculated using IS-875 (Part 3); 2015 for various structural conditions of scaffold pipes and construction modes. The peak acceleration obtained in the analysis is compared with the reference data provided by Smith. S.B. and the Cull book and human comfort perceived level are calculated for the Indian tertiary level of the described location of India, from which the evaluation of the effective high-rise building under dynamic wind load is analyzed **(Arvind Vishwakarma & Savita Maru (2019))**.

In the current era or scenario, the G + 12 structure located in zone III is considered for analysis. The analysis is carried out for seismic zone III. The structural model is analyzed and compared with different porch locations for seismic zone III according to IS 1893-2016 for analyzing the response spectrum. Results are assessed for offset, line offset, baseline offset, etc. Results are obtained and presented as plots and tables for the seismic zone. A building with a porch exposed to seismic effects with seven different locations, based on the analysis results, was obtained for seven locations of a multi-storey building. The results show several results: maximum displacement at location 7, maximum basic shear at location 1, maximum axial force at location 6, maximum column shear force at location 1, maximum location 1 of the column bending moment, beam shear force **((Abrar Ahamad, Ankit Pal & et. al. (2020))**.

This article provides a short description of determining the best porch location with the help of Staad-pro. The analytic approach is used under it. The article aim is seismic wave's effect; Staad-pro approach is used under it. This article concludes that it is really important to use analytical methods before building multi-story buildings in seismic and non-seismic areas. After studying all the documents, we can easily understand the importance of

analytical methods. We can easily calculate the effect of seismic loading using programs such as Staad pro and E-tabs before the construction of multi-storey buildings. Calculation and modeling is the main purpose of the conclusion, (Abrar Ahamad, Ankit Pal & et. al. (2020)).

In this era of multi-story building design and architectural vision, a new idea is required. The diverse competitors surrounded by them made the construction with their own choice, as well as market demand and a multi-story structure, perform extremely important work in innovative and new fields. This should explain the complexity of the production of the region, along with the architectural and structural point of view. Composite and varied floor arrangements on similar substrates require reliability with a constructive approach. These types of structures are the Twin Tower structure used in this modern globe. In this study, outcome evaluation parameters such as floor displacement and drift are derived from the props of the multi-story structure of the twin tower located in Zone III earthquakes, earthquakes impact the structure under 5 different shapes, and studied with Staad pro assistant software design, (Mahendra Kumawat, Ankit Pal & et. al. (2020))

The structure is now ready with a lot of modern traditions such as tall construction, etc., and there the need is met with fresh modernization and latest thoughts. Many associated innovators have used them to build a structure with their own alternative as well as market demand. The parameter estimates for consequences such as floor displacement and drift are derived from the foundations of any multi-story structure located in an earthquake. Zone III, earthquake effects affect the building under 7 different best sized columns to reduce baseline displacement. For base shear reduction, use the best column size of columns with the same concrete class in a multistory building under seismic loading to study base shear reduction and verify with the E-Tabs design software alliance, (Aasif Khan, Ankit Pal(2020)).

The current work shows the literature survey of various researchers who have been contributing in this field. Conclusions with the outline of the proposed work are provided at the end of the work. It conclude the above literature review, it is found out that it is necessary to introduce stiffness increasing members in tall structures to increase the lateral load handling capacity. Various researches already done till now in terms of stability improvement. Since one side of the current theme is to increase overall stiffness to resist lateral load but the other side is; that it increases overall construction cost. To maintain these two things, wall belt supported system plays a major role. Hence wall belt supported system should be

implemented in tall structures. The upcoming proposed work shows various wall belt stability cases with different grades of concrete with different thickness. The optimum case of stability by comparing all the decided cases of different thickness will be implemented and shown in upcoming papers (D. K. Upadhyay & S. Jamle (2020)).

The shear wall belt system so introduced to make the tall structure stiff and the lateral movement of the same will reduced. To demonstrate this, total 10 tall structures are prepared and analyze it by applying the wall belt of different thickness of different grades. After deep comparative analysis, it has been found out that Building case B7 emerges as the best wall belt grade stability case. maximum displacement in X direction has a minimum value of 314.063 mm for Building case B7 and value of 166.992 mm obtained same in Building B7. The values are more in Building case B0 when shear belt is not used then it drastically decreases since stiffness is more when shear belt is used. Base shear values increases with increase in additional member in a structure. Building case B0 seems lesser value of base shear. Building case B4 and B7 seems lesser value of shear forces with a value of 3317.0919 KN. Maximum Axial Forces in Column for all Wall Belt Stability Cases seems lesser in Building case B7 with a minimum value of 4922.3212 KN. Shear forces in column increases with increase in additional member in a structure and behaves same as base shear parametric value (D. K. Upadhyay and S. Jamle (2020)).

The current work is going -to show the stability criteria of changing the grades of beams without altering the size at various floor levels. Total 6 cases of the current theme created and analyzed with the help of software approach after then result is compared. Result shows that the increase of stability has seen in Case BS3 and Bs4 and would be recommended whenever this type of stability activity performed, (Bhagwat Mahajan, Sagar Jamle(2020)).

As the current study carried out a comparative and understandable behavior of the multistoried building column component with regular and irregular grade of concrete. A software analytical approach is used for the analysis of total five similar building models with same and different grades. Different cases show its different behavior and define its own importance of grade change. At last conclusions have drawn for the efficient and final case that shows optimal location of grade change in concrete columns in a symmetric structure. Grade location case T shows least parametric values after comparison with other grade location cases, (Romesh Malviya Sagar Jamle (2020)).

The current work demonstrates the destructive effects of earthquake over a multistoried building. For this, Total 12 shear wall stability case residential apartment building models are prepared and are assumed to be located at seismic zone III with shear wall located at its core. These models have different shear wall thickness viz. 0.140m, 0.160m, 0.180m and 0.200m combined with M20, M30 and M35 grades of concrete. Observing all the parameters, for making the multistoried building more stable, it is necessary to increase the thickness of shear wall members with higher concrete grade (**Manoj Patidar, Sagar Jamle (2020)**)

The present study describes about group action of pile group, modeling of four piles were taken for study. In study, spacing between pile groups are taken as 2.5D and 3.5D (D-Diameter of pile).0.8 is the diameter of four pile group. Different pile arrangements are taken such as rectangular, square, staggered; diamond 1 and diamond 2. Analysis for different shapes of pile groups are done by RS method using software approach. bending moment ,Displacement, Shear force and three types of stresses are evaluated under the analysis of models, (**Mansi Jajoriya, Arvind Vishwakarma & et. al. (2020)**).

The paper is based on the study of pile group. The modeling is based on the of four piles groups is carried out taking space between them as 2.5 and 3D.The dia. of piles is 0.6 and the dia. of the group of eight piles is 0.4, the form chosen to organize the group of piles is Rect., Square, 2 types of Diamond and staggered pattern. The analysis of the different groups of shape piles will be carried out using the RS method based on STAAD Pro. Parameters such as displacement, SF and BM are taken into account for the pile group analysis. The paper concluded that other than regular grouping rectangle and diamond pattern is also play efficient role when square model is not to be preferred as per site conditions, (**Mansi Jajoriya, Arvind Vishwakarma & et, al. (2020)**).

The tall structures needs firm stable ground to achieve lateral stability with lesser ground area for living and commercial purposes. The stabilization of the structure has done when using the current guidelines of the Indian Standardization. The dual structural configurations are now the main criteria for current tall structures. Since the construction an industry expand day by day and follows the financial customs that operates cost effective structures, (**Mansi Jajoriya, Arvind Vishwakarma & et, al. (2020)**).

III. CONCLUSIONS

The following conclusions are made based on the above research papers.

1. The maximum researcher worked on medium type of soil. So that it of medium range adopted for the analysis.
2. Medium soil placed result are moderate under moderate magnitude, soft soil are results having more magnitude and lesser results are gets in hard soil structure.
3. The Model type is based on the moment resisting framed type mainly other than this hull core; shear wall & belt also used by some researchers. The result taken as building frame are displacement, bending & overturning moments, base shear for earthquake based so that rigidity of the structure.
4. The results are varying with change in the structural frame type.
5. Shear wall play an important role in the rigidity of the building.
6. Grade of concrete also play important role in the strengthen of the structure.
7. Static approach and linear dynamic approach is adopted.

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Strategies for Preventing Adverse Events in the Surgical Center

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Abstract— The study aims to identify the strategies used to prevent adverse events in surgical centers. The method used was a systematic literature review, based on the LILACS, MEDLINE, BDNF, Science Direct, PubMed/MEDLINE databases. The following descriptors were crossed: “Medical errors AND Surgical Centers”, “Patient Safety AND Surgical Centers”. 841 publications were found in the databases, of these, 709 were in MEDLINE, 56 in LILACS, 38 in BDNF, 11 in Science Direct and 27 in PubMed. Only 2 articles were included in the review, which included strategies such as: implementing an incident reporting system and a formal event analysis program, perioperative checklist, morbidity and mortality conferences, identification bracelets, training or systematic education in the introduction of new devices. To reduce adverse events, it is necessary to identify them, because the perception of failures in the different phases of care, allows the identification of recurrent errors and a critical assessment for decision making, which contributes to the prevention of subsequent errors and more effective interventions.

Keywords— Medical Errors, Patient Safety, Surgicenters, Accidente Prevention, Comprehensive Health Care.

I. INTRODUCTION

Due to numerous factors, the assistance provided to patients in health care establishments has the potential to cause incidents [1]. Among health incidents, the adverse event is characterized by, necessarily, bringing harm to the patient, resulting from the assistance and which is not related to the prognosis of the underlying disease [2].

A study in 26 countries showed that more than 130 million adverse events (AEs) happen annually in hospitals, leading to 2.5 million deaths a year due to unsafe health care [3,4]. In Brazil, the Surgical Center (SC) is

responsible for 4.11% (N = 3,095) of the total number of incidents recorded in the last Patient Safety and Quality in Health Services Bulletin [5]. The SC is a complex hospital unit, characterized by multiprofessional assistance, and which requires a safe and high quality procedure [6]. An average of 187 to 281 million surgical procedures are performed annually, worldwide. Data demonstrate that for 25 people, 1 will need to undergo this type of procedure, so it is essential that these procedures are done safely, minimizing errors and failures in the assistance process [7,8].

It is estimated that 50% of AEs, associated with surgical interventions, are due to preventable causes, such as, object retention in the patient after the procedure, incorrect limb amputation, emergency medication unavailability, incorrect surgical positioning, and site infections surgical, among others [9-11].

For the patient, these errors result in physical, psychological and financial damages, which are associated with prolonged hospital stay, hospital readmission, additional surgeries and reoperations, irreversible damage, and even death [9, 12].

In view of the magnitude of these problems, international strategies such as the World Alliance for Patient Safety, Global Challenges, the Surgical Safety Checklist (SSC), and national strategies such as the National Patient Safety Program (NPSP), the implantation of Safety System Nuclei (SSNs), and the Brazilian Network of Sentinel Hospitals, among other measures, were created with a focus on improving the quality of patient safety in order to reduce possible incidents and adverse events [8, 12-14].

The concern with the surveillance of the quality of services is relevant, as it strengthens the creation of effective strategies for risk management, and demonstrates the worldwide commitment of health organizations to the theme and the need for supervision and prevention of damage in health care. In addition, for patient safety to be effective, it is necessary to spread a safety culture that recognizes the importance of quality management of processes and technologies applied in services [2].

These strategies were created based on the understanding that there are flaws in the health care process, but reinforces the need for teamwork in order to be organized in the face of the adverse situation that has occurred, providing the elaboration of new plans, actions to minimize risks, the use of specific protocols that adapt to the reality of the hospital unit, and purposefully increase patient safety [2, 7]. Considering the above, it is essential that the surgical team - surgeons, anesthesiologists, nursing professionals - know and understand the attributions and competencies exercised by each of the members of the multidisciplinary team, as the surgical patient and the scenario of the surgical environment are characterized by vulnerability and the risks inherent to the surgical anesthetic procedure. Responsibility for care based on safe practices reinforces the nuances surrounding the stages of the perioperative period and the needs for assertive care and justifies the relevance of identifying strategies for preventing AEs in the operating room [9,15].

II. METHODS

This is an integrative literature review, carried out in November 2019 from the guiding question "What are the strategies used for the prevention of adverse events in surgical centers?", Formulated through the PICO - Patient, Intervention, Comparison strategy and "Outcomes" (outcome) [16].

The research was carried out in the databases LILACS (Latin American and Caribbean Literature in Health Sciences), MEDLINE (International Literature in Health Sciences), BDNF (Nursing Database) contained in the Virtual Health Library (VHL), Science Direct, PubMed (US National Library of Medicine National Institutes of Health)/MEDLINE. The search for descriptors in Portuguese for the research was carried out with the help of Health Sciences Descriptors (DeCS), and the search for English translations by Medical Subject Headings (MeSH).

The following strategy was used to cross the descriptors: "Medical Errors AND Surgical Centers", "Patient Safety AND Surgical Centers", "Medical Errors AND Surgical centers", "Patient Safety AND Surgical centers". For the selection of articles, the following inclusion criteria were applied: articles derived from original research, published in the last seven years (2013 to 2019), in English, Portuguese, Spanish and German, with full text available and free that answered the proposed objective. Duplicate publications were excluded from the search, which were considered those contained in more than one database and the same publication with different languages, in addition to review articles, chronicles, narratives, letters to the editor, dissertations and theses.

For data analysis, a spreadsheet was created with the aid of Microsoft® Office Excel software, cataloging articles by crossing descriptors, database, author, year, title and language. For the screening and selection of articles, the PRISMA method (Transparent Reporting of Systematic Reviews and Meta-Analyses) was used, this method is performed in four stages [17].

In the first stage "Identification", an initial analysis was carried out to screen for duplicate articles. Then, in the second stage "Selection", a second screening was made based on the titles and abstracts of all articles. After analyzing the abstracts, in the third stage "Eligibility", the sample was delineated from reading the text in full, excluding those that did not meet the inclusion criteria. In the fourth stage "Inclusion", a total of two articles, were selected, meeting the criteria established as described in Fig.1.

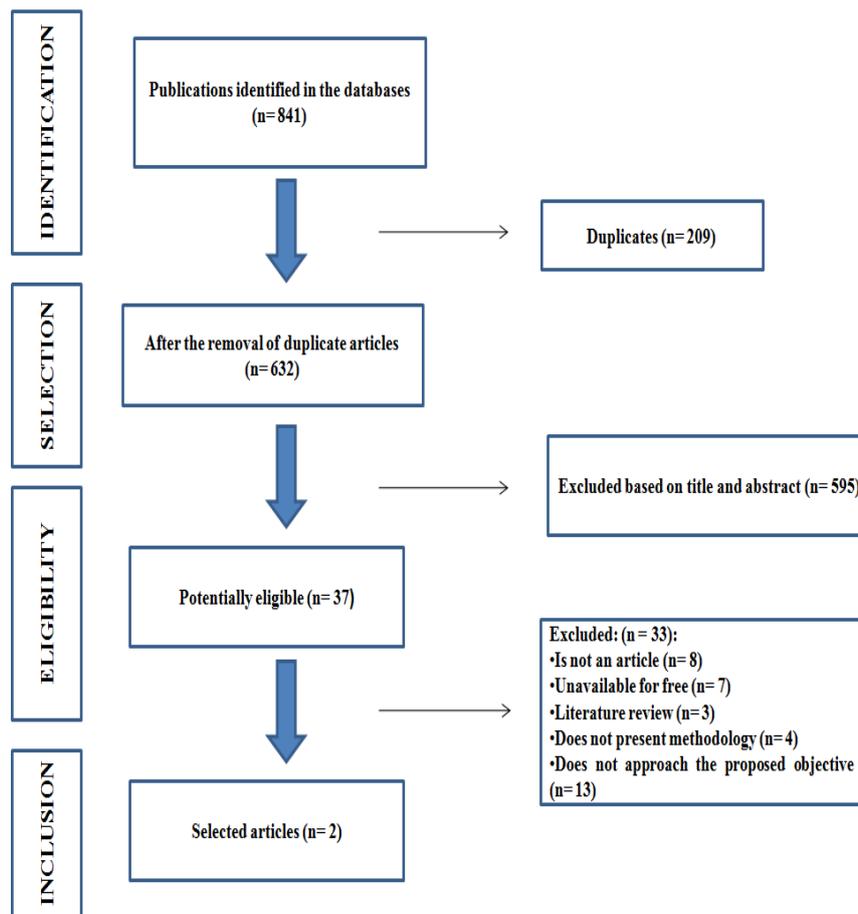


Fig. 1: Flowchart representing the stages of article selection. Recife, Pernambuco (PE), Brazil, 2020. Adapted by PRISMA [17].

Source: Created by the authors.

After the stage of inclusion of the articles, the level of evidence of the selected studies was defined and determined in accordance with the Agency for Healthcare Research and Quality, to assess the quality and strength of the recommendation contained in the articles. This system classifies the quality of the evidence found in V levels in an increasing way, thus, the higher the level, the greater the confidence in the results found [18].

In order to simplify the understanding of the publications selected in this systematic review, the data were organized into figures and tables, presented in a descriptive manner.

III. RESULTS

A total of 841 publications were found in the databases. For the crossing of descriptors: “Medical Errors AND Surgical Centers” 371 publications were identified, “Patient Safety AND Surgical Centers”, 443 publications

were identified, “Medical Errors AND Surgical centers”, five publications were identified, “Patient Safety AND Surgical centers”, 22 publications were found. Regarding the databases, 709 publications were found in MEDLINE, 56 in LILACS, 38 in BDNF, 11 in Science Direct and 27 in PubMed.

During the screening stages, 209 duplicate publications were excluded, leaving 632 publications. After reading the title and abstract, 593 publications were excluded, leaving 37 publications. Of these, eight publications did not fit as articles, seven articles were not available for free, and three articles were literature reviews. Thus, 19 were selected to read the full text in its entirety, of these, four articles did not have a clear methodology, 13 articles did not address the proposed objective. The final sample of this review consisted of two scientific articles, selected by the inclusion criteria previously established.

Both selected studies are international, published in the last five years. Table 1 lists data from articles such as: title,

author and year of publication, place of study, objective of the study, data collection instrument, level of evidence and methods.

Table.1: Data extracted from articles selected for systematic review. Recife, Pernambuco (PE), Brazil, 2020.

Title	Author/Year	Study location	Objective	Type of study	Level of evidence	Material and Methods
When a checklist is not enough: How to improve them and what else is needed	RAMAN et al. / 2016	Chicago	Understand why the time intervals and the verification lists are sometimes not efficient in the prevention of adverse surgical events and identify necessary additional measures to reduce these events.	Retrospective case review	V	From this analysis of incidents with the CAST (casual analysis based on systems theory) categorized recommendations were elaborated using the VA Action Hierarchy tool.
Implementation and evaluation of error prevention measures in surgical clinics: Results of a current online survey	ROTHMUND et al. / 2015	Germany	Evaluate the current status in the use and evaluation of measures to improve patient safety in surgical clinics	Survey type inquiry	V	Application of an online questionnaire with 52 standardized questions about specific measures and instruments for the prevention of surgical errors

Source: Created by the authors.

A total of 3,328 surgeons participated in the German study, who answered an online questionnaire on the current status of use and evaluation of measures for patient safety in surgical clinics [19].

Whereas, the study carried out in Chicago, was made from the analysis of 380 complex cardiac surgeries during 24 months, of which 30 adverse events were identified, and

sought to evaluate the reasons why the checklists are not effective in preventing events thus generating stronger, intermediate or weaker recommendations [20]. These results are shown in table 2.

Table. 2: Results found in the systematic review articles. Recife, Pernambuco (PE), Brazil, 2020.

Strategies for the prevention of adverse events

- Use of lists for perioperative verification;
- To adapt the verification lists to the necessities of the surgical team;
- To periodically review the protocols and work processes;
- To implement weekly meetings between the nursing team and the surgical team to facilitate multiprofessional communication;
- To standardize the names of the equipment to facilitate communication;
- To promote systematic training in the introduction of new devices;
- Padronizar os nomes dos equipamentos para facilitar a comunicação;
- Promover treinamento sistemático na introdução de novos dispositivos;
- To elaborate coherent and consistent reports to the incidents with medical devices;
- To implement international patient safety goals; use of identification bracelets; Preoperative laterality marking;
- To implement surgical management and planning tools and good practices in the surgical team;
- To implement an incident report system and a formal program for the analysis of adverse events;
- Outline the infection statistics of the surgical site;
- Outline the infection statistics of the surgical site;
- To stimulate safety culture as a priority of the health system, and co-responsibility of the multiprofessional team.

Source: Created by the authors.

IV. DISCUSSION

Since 2004, strategies have been created in an attempt to strengthen patient safety, through the implementation of safety lists, standardization of procedures and a growing concern with the safety culture of professionals. However, it is still seen, in analyzes [11,21], that specific problems persist, which highlights the importance of identifying the strategies that are being adopted for the prevention of adverse events in the surgical environment.

AEs in surgical procedures represent the majority of AEs occurring in the hospital environment [22,23]. As one of the useful tools for the prevention of AEs, the use of perioperative checklists is described [19,20]. The literature maintains that surgical checklists, especially the checklist recommended by the World Health Organization, increase the climate of safety [7,24].

However, some issues cannot be resolved just by using the surgical safety list. Limitations such as the lack of communication between members of the surgical team, absence of supplies, incomplete surgical team, with consequent delays in surgical planning, absence of implants and inadequate handling of equipment or instruments, can be minimized with institutional policies that encourage not only the use checklists but periodic updating and review of work protocols and processes, and assessment of professional skills and continuing education needs [20,25].

Preoperative laterality marking is one of the recommended actions in safe surgery and is based on the significant volume of surgeries in the wrong location [19]. Systematic review conducted in 2015 found 28 different rates of occurrence of surgeries performed in the wrong location, with an average estimate of 0.09 adverse events per 10,000 surgeries [25].

This type of event occurs due to gaps in the surgical assistance verification process, which includes prior verification of the surgical procedure, confirmation of the patient and the surgery site; and laterality marking [26].

To reduce the occurrence of these events, the use of the identification bracelet is also suggested as a preventive measure [19]. Data from a survey carried out based on the observation of 30 cardiac surgery procedures, showed that in 90% (n = 27) of the cases the identification was not done correctly, this being a conference indicator that prevents the procedure from being performed on the patient wrong [24].

Among the identified measures, the observance of national guidelines on the notification of AEs and the elaboration of coherent and consistent reports on incidents with medical devices, as well as the incentive to systematic training in the acquisition of new devices, as evidences highlight the frequency of AEs in the surgical environment, such as burns resulting from the improper use of

electrocautery and pressure injuries associated with surgical positioning [11,21].

The implementation of weekly meetings between the nursing team and the surgical team to facilitate multi-professional communication is a point discussed in the literature. It corroborates the management actions and mutual cooperation between the members of these teams, and attitudes of co-responsibility and decision-making for patient safety [20,21].

The improvement in communication also has a positive impact on the safety culture, since a survey of 148 health professionals in the surgical center showed that the safety dimensions are low in a hostile environment and unfavorable to communication [27].

The implementation of an incident reporting system and a formal AES analysis program are described as effective measures, as the analysis of the occurrence of these AEs allows the development of prevention strategies [19,20]. However, it is emphasized that these reports should not be implemented with the intention of generating punitive measures, but rather, promoting resolute actions or practical solutions [28,29].

The design of infection statistics [19], is a recommendation supported by the prerogative that surgical site infections represent the main infections related to health care. These statistics can provide information on essential prevention measures for reducing infection rates, such as care for hand hygiene, how to safely administer medicines, how to decontaminate care environments, how good processing practices of health products and the handling of devices in the patient [26].

Conferences on morbidity and mortality rates [19] they are important educational tools to understand the occurrence and aspects of adverse events and assist the team in the search to qualify health care and patient safety. A study that sought to characterize the number of initiatives resulting from these conferences or periodic meetings, monitored and analyzed 59 conferences and identified 282 initiatives or proposals resulting from these meetings, related to multi-professional teams, the creation or modification of checklists or checklists of security, protocols or institutional policies [30].

However, there is still a lack of evidence on the effectiveness of these conferences, in addition to some negative aspects such as their retrospective character, in the form of reports, where important information can be suppressed, and the random frequency of these meetings and the lack of standardization, makes that this measure is not as effective, if not carried out effectively [30,31].

In this context, nurses have an essential role in implementing a culture of safety in the surgical environment, as their leadership role encourages the team to develop safe attitudes that favor a safe environment, essential for the implementation of improvements [32].

V. CONCLUSION

To reduce the incidence of adverse events in the operating room, it is necessary to identify them, since the perception of failures in the different phases of care, allows the identification of recurrent errors and a critical assessment for decision making, which contributes to the prevention of subsequent errors and more effective interventions.

From this research, it was possible to identify few studies on the subject, although it is so relevant to patient safety. Studies on strategies for preventing adverse events in the surgical environment contribute to the body of knowledge for a public health problem and provide management and the surgical team with a scientific basis for implementing measures such as assertive communication, teamwork and evidence-based practices such as using the surgical safety checklist, demarcating laterality, among other measures.

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Development of Linear Water Wave Dispersion Equation using Critical wave Steepness Criteria

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Abstract— This study begins by examining the wavelength based on criteria of critical steepness, both in deep water and shallow water, and it is compared to the wave length of the linear water wave dispersion equation. It was found that the wave length of the linear water wave dispersion equation is too long. The wave length adjustment of the linear water wave dispersion equation can be done by multiplying the left part of the equation with a coefficient greater than one.

Furthermore, the analytic dispersion equation is formulated using weighted total acceleration, thus there is a coefficient on the left segment of the dispersion equation. The formulation is done by assuming the small amplitude wave so that the obtained dispersion equation is as same as the dispersion equation of the linear water wave theory, but using a wave length matching the criteria of critical wave steepness.

Based on critical wave steepness, it is found that the wave length of the linear wave theory is too long. To shorten it, it can be done by multiplying the left segment of the dispersion equation of the linear wave with a coefficient, where the coefficient can be obtained from critical wave steepness criteria and by analytical.

Keywords— Water Wave, Critical Wave Steepness, Linear Water Wave Theory.

I. INTRODUCTION

Wave steepness of water wave is the ratio between wave height H and wavelength L which is $\frac{H}{L}$. In the water wave, there is a value of the wave steepness in which when exceeded, the wave will break. The value of the wave steepness is called critical wave steepness. The first researcher proposing this critical wave steepness is Michell, J.H. (1893), while the most recent is Toffoli, A. et al (2010). The result of the research by Michell (1893) followed by other researchers formulating breaker index in the form of $\frac{H_b}{L_b}$, in which H_b is breaker height and L_b is breaker length, those researchers are Miche, R. (1944), Battjes, J.A. and Jansen, J.P.F.M, (1978) and Battjes, J.A. and Stive M.J.F. (1985). Actually, there are still many more, but in this study, it was selected they who did not using the bottom slope as their parameter, for practicality. The study was conducted at two water depth conditions, namely deep water and shallow water. At deep water, research was done by using the criteria of Toffoli, A. et al (2010) and using the Wiegel's equation, Wiegel, R.L. (1949, 1964), in which it is an equation stating the relation between the maximum wave height in the wave period. With the equation Wiegel, R.L. (1949-1964), the wave height in a wave period was calculated, then wavelength

for critical wave steepness was calculated using relation Toffoli, A., et al (2010). With this wave period, the wave length of the linear wave theory is also calculated. Further, the two wavelengths were compared. It was found that the wavelength of dispersion equation of the linear wave theory is too long. The wavelength of dispersion equation of the linear wave theory can be shortened or adjusted to the wavelength of the criteria of critical wave steepness by multiplying the left part of the dispersion equation by a coefficient greater than one.

In shallow water, the wavelength study was carried out using the Miche's equation, Miche, R. (1944), to calculate the breaker length. This calculation requires input of breaker height and breaker depth. The breaker height was calculated by using the equations from Komar, P.D. and Gaughan, M.K. (1972). Furthermore, with the input of breaker height, the breaker depth was calculated by the McCowan, J. (1894). Wave height of deep water was calculated using the Wiegel's equation, Wiegel, R.L. (1949, 1964), by setting a wave period. After obtaining breaker height and breaker depth, breaker length was calculated using the Miche's equation Miche, R. (1944). With the obtained breaker length, the breaker steepness was calculated, and the obtained breaker steepness is much smaller than the criteria Toffoli, A., Babanin, A., Onorato,

M., and Waseda T. (2010). This result showed that the breaker length of equation Miche, R. (1944) is too long. In order to obtain a wavelength matching the criteria of Toffoli et all, the right segment of equation Miche, R. (1944) was multiplied by a coefficient.

The wavelength at the breaker depth was also calculated using a linear wave dispersion equation, and the longest wavelength is obtained where the breaker wave steepness became too small. To get the results of wavelength matching the criteria of Toffoli, et all of shallow water, the left segment of the dispersion equation from the linear wave theory was multiplied by a coefficient, as was the case with deep water.

Furthermore, analytical linear wave dispersion equation is formulated in which there is a coefficient on the left segment of the equation. In the process of formulation, small amplitude and long wave assumptions were carried out as well as the formulation of linear wave dispersion equations Dean, R.G., Dalrymple, R.A. (1991). The dispersion equation is formulated using the Kinematic Free Surface Boundary Condition (KFSBC) and the Euler momentum equation, wherein the two equations were weighted total acceleration, Hutahaean , S. (2019).

In addition, the wavelength formulated based on the nonlinear wave conditions was reviewed. In the results of dispersion equation, there is a coefficient regulating the wavelength. With this dispersion equation, the shortest wave length was obtained.

II. STUDY ON DEEP WATER

In this section, a wavelength study will be conducted using criteria Toffoli, et all (2010) and with, equation Wiegel,R.L. (1949,1964).

2.1. Wave Length Estimation using criteria Toffoli et all (2010).

Criteria of Toffoli et all (2010) for critical wave steepness in deep water is,

$$\frac{H}{L} = 0.170 \dots\dots(1)$$

H wave height and L is wave length. Meanwhile, criteria from Michell, J.H. (1893), $\frac{H}{L} = 0.142$. With (1), the relation between wave length and wave height can be stated, which is,

$$L = \frac{H}{0.170} \dots\dots(2)$$

The wave height in (2) is obtained from equation Wiegel,R.L. (1949,1964), which is the relation between the maximum wave height in a wave period,

$$T = 15.6 \sqrt{\frac{H_{max}}{g}} \dots\dots(3)$$

This equation can be written into an equation for maximum wave height, i.e.

$$H_{max} = \frac{gT^2}{15.6^2} \dots\dots(4)$$

The dispersion equation of the linear wave theory, Dean (1991), is

$$\sigma^2 = gk \tanh kh \dots\dots(5)$$

σ is angular frequency $\sigma = \frac{2\pi}{T}$, T is wave period, g is gravitational acceleration k is wave number where $k = \frac{2\pi}{L}$, L is wavelength and h is water depth. In deep water where $\tanh kh = 1$, (5) becomes,

$$\sigma^2 = gk \dots\dots(6)$$

Table 1. Comparison of wave length from (2) and (6)

T (sec.)	H _{max} (m)	L(m)		$\frac{H_{max}}{L_{eq-6}}$
		Eq. (2)	Eq.(6)	
6	1,451	8,536	56,207	0,026
7	1,975	11,619	76,504	0,026
8	2,58	15,176	99,924	0,026
9	3,265	19,207	126,466	0,026
10	4,031	23,712	156,131	0,026
11	4,878	28,692	188,919	0,026
12	5,805	34,145	224,829	0,026

The calculations results of wavelength with (1) and (6), presented in Table 1. It showed that the wavelength of the linear wave theory (6) is much longer than the wavelength of the critical steepness wave (1). With the wavelength from (6), it was obtained wave steepness $\frac{H_{max}}{L} = 0.026$.

This value is much smaller than Michell,J.H (1893) where $\frac{H_{max}}{L} = 0.142$ and from (2) where $\frac{H_{max}}{L} = 0.170$. From this calculation result, it was obtained that the wavelength of dispersion equation of the linear wave theory is too long, where a very large wave height will be obtained if the wave height with (1) is calculated using the wavelength. To improve the wavelength of dispersion equation of the linear wave theory, the left segment of (5) is multiplied by a coefficient γ^2 ,

$$\gamma^2 \sigma^2 = gk \tanh kh \dots\dots(7)$$

Where on deep water,

$$\gamma^2 \sigma^2 = gk \dots\dots(8)$$

With $k = \frac{2\pi}{L}$ and with wavelength stated with (1), which is $L = \frac{H}{0.170}$, (8) can be written into equations for γ^2 , i.e.

$$\gamma^2 = \frac{0.170(2\pi g)}{\sigma^2 H} \dots\dots\dots(9)$$

$\sigma = \frac{2\pi}{T}$, where wave height H obtained from (4) with input of wave period T determined, it was obtained value $\gamma = 2.566$ for all wave period, as presented in Table 2.

Table 2. The value of wave length of deep water with $\gamma = 2.566$

T (sec.)	H _{max} (m)	L(m)		γ
		Eq. (2)	Eq.(8)	
6	1,451	8,536	8,536	2,566
7	1,975	11,619	11,619	2,566
8	2,58	15,176	15,176	2,566
9	3,265	19,207	19,207	2,566
10	4,031	23,712	23,712	2,566
11	4,878	28,692	28,692	2,566
12	5,805	34,145	34,145	2,566

III. STUDY ON SHALLOW WATER

In this section, a research on breaker steepness $\frac{H_b}{L_b}$ resulted by breaker index and compared to critical wave steepness (1) will be conducted. There are a number of breaker indexes in the form of $\frac{H_b}{L_b}$, where H_b is breaker height and L_b is breaker length. With input of breaker height H_b and breaker depth h_b , breaker length L_b can be calculated.

There are two form of equations of breaker index, which are using the bottom slope as a parameter and do not using the bottom slope. In this study, to make it easier, the breaker index that does not use the bottom slope as a parameter was used. The breaker index equations include,

1. Miche's Breaker Index

$$\frac{H_b}{L_b} = 0.142 \tanh\left(\frac{2\pi h_b}{L_b}\right) \dots\dots\dots(10)$$

2. Battjes dan Jansen's Breaker Index

$$\frac{H_b}{L_b} = 0.14 \tanh\left(\frac{0.8}{0.88} \frac{2\pi h_b}{L_b}\right) \dots\dots\dots(11)$$

3. Battjes dan Stive's Breaker Index

$$\frac{H_b}{L_b} = 0.14 \tanh\left(\left(0.5 + 0.4 \tanh\left(33 \frac{H_0}{L_0}\right)\right) \frac{2\pi h_b}{0.88 L_b}\right)$$

.....(12)

These three equations are seen as derivatives of the criteria of critical wave steepness of Michell's which is $\frac{H}{L} = 0.142$.

Of the three breaker index equations, (10) will be used. Calculation of breaker length L_b using (10) needed input of breaker height H_b and breaker depth h_b . Breaker height H_b was calculated using equation of breaker index from Komar and Gaughan (1972), which is

$$\frac{H_b}{H_0} = 0.56 \left(\frac{H_0}{L_0}\right)^{-1/5} \dots\dots\dots(13)$$

H_0 is deep water wave height obtained from (4), while L_0 is deep water wavelength calculated with (6). Breaker depth h_b was calculated using equation of breaker index from McCowan (1894), which is

$$\frac{H_b}{h_b} = 0.78 \dots\dots\dots(14)$$

Table 3. Breaker length L_b calculated with (10)

T (sec.)	H ₀ (m)	H _b (m)	h _b (m)	L _b (m)	$\frac{H_b}{L_b}$
6	1,451	1,689	2,165	20,409	0,083
7	1,975	2,298	2,947	27,779	0,083
8	2,58	3,002	3,849	36,282	0,083
9	3,265	3,799	4,871	45,92	0,083
10	4,031	4,691	6,013	56,691	0,083
11	4,878	5,676	7,276	68,596	0,083
12	5,805	6,754	8,659	81,635	0,083

In the Table 3. it is seen that obtained breaker steepness $\frac{H_b}{L_b} = 0.083$ that is smaller than 0.170. In an effort to achieve critical wave steepness values, (10) is developed by multiplying the right segment with a coefficient of 1.36267, so (10) becomes

$$\frac{H_b}{L_b} = (1.36267)(0.142) \tanh\left(\frac{2\pi h_b}{L_b}\right) \dots\dots\dots(15)$$

In Table 4., the calculation results are presented with (15), which is obtained breaker steepness $\frac{H_b}{L_b} = 0.170$ and breaker length L_b becomes much shorter, which is approximately half of the breaker length of (10).

Table 4. Breaker length L_b calculated with (15)

T (sec.)	H ₀ (m)	H _b (m)	h _b (m)	L _b (m)	H _b / L _b
6	1,451	1,689	2,165	9,933	0,17
7	1,975	2,298	2,947	13,52	0,17
8	2,58	3,002	3,849	17,658	0,17
9	3,265	3,799	4,871	22,349	0,17
10	4,031	4,691	6,013	27,591	0,17
11	4,878	5,676	7,276	33,385	0,17
12	5,805	6,754	8,659	39,731	0,17

The next study is an attempt to get value γ on (7) for shallow water. By using (13) and (14), it is obtained breaker height H_b and breaker depth h_b . With the breaker depth, breaker length with (7) is calculated by trial and error namely by changing the value γ , and it was obtained value $\frac{H_b}{L_b} = 0.17$ and obtained value $\gamma = 2.23$ with wavelength in Table 5.

Table 5. Breaker length L_b calculated with (7), $\gamma = 2.23$

T (sec.)	H ₀ (m)	H _b (m)	h _b (m)	L _b (m)	H _b / L _b
6	1,451	1,689	2,165	9,932	0,17
7	1,975	2,298	2,947	13,519	0,17
8	2,58	3,002	3,849	17,657	0,17
9	3,265	3,799	4,871	22,348	0,17
10	4,031	4,691	6,013	27,59	0,17
11	4,878	5,676	7,276	33,383	0,17
12	5,805	6,754	8,659	39,729	0,17

In the case of calculation of breaker length with (7), it was used $\gamma = 2.566$ as result of research on deep water, then it was obtained breaker steepness $\frac{H_b}{L_b} = 0.211$ (Table 6). The value of this critical breaker steepness can be hapened, considering the occurrence of wave energy compression that is the occurrence of shoaling and shortening of the wave length when the waves enter shallower waters.

Table 6. Breaker length L_b calculated with (7),

$\gamma = 2.566$

T (sec.)	H ₀ (m)	H _b (m)	h _b (m)	L _b (m)	H _b / L _b
6	1,451	1,689	2,165	7,988	0,211
7	1,975	2,298	2,947	10,873	0,211
8	2,58	3,002	3,849	14,201	0,211
9	3,265	3,799	4,871	17,973	0,211
10	4,031	4,691	6,013	22,189	0,211
11	4,878	5,676	7,276	26,849	0,211
12	5,805	6,754	8,659	31,952	0,211

From the results of research on deep water and shallow water, it is found that for the dispersion equation of the linear wave theory to produce a wavelength meeting the criteria of critical wave steepness, the left segment of the equation must be multiplied by a coefficient γ^2 as it is with (7). Research on deep water is obtained value $\gamma = 2.566$, while research on shallow water is obtained value $\gamma = 2.23$, both are on the critical wave steepness of 0.170.

IV. FORMULATION OF DISPERSION EQUATION ANALYTICALLY

In the following section, the dispersion equation will be formulated analytically where there are coefficients γ^2 on left segment of dispersion equation.

4.1. Characteristic Point

The velocity potential of the Laplace equation solution by the variable separation method consists of two components of the sinusoidal equation, which are component *cosinus* and component *sinus*, i.e.,

$$\Phi(x, z, t) = A \cos kx (C e^{kz} + D e^{-kz}) \sin \sigma t + B \sin kx (C e^{kz} + D e^{-kz}) \sin \sigma t \dots\dots\dots(16)$$

Hutahaean (2019) has shown that both velocity potential components have the same wave constant, thus it can be written as,

$$\Phi(x, z, t) = G \cos kx \cosh k(h + z) \sin \sigma t + G \sin kx \cosh k(h + z) \sin \sigma t \dots\dots\dots(17)$$

Function *cos kx* and *sin kx* has a intersection point where both functions have the same value, the point is called the characteristic point. By studying the value of the wave constant at the characteristic point, the constant value applies to all points on the entire wave curve. At the characteristic point of the velocity potential equation, it can be written as,

$$\Phi(x, z, t) = G \cos kx \cosh k(h + z) \sin \sigma t \dots (18)$$

Where in this equation, it is defined a new constant which is $G = 2G$. Constant G obtained at the characteristic point must be divided by $\sqrt{2}$ if it will be applied to the complete velocity potential equation (17). However, the important part in this case is that the wave constants G and k can be formulated on the conditions $\cos kx = \sin kx$.

4.2. Weighted Total Acceleration

Hutahaean (2019), formulated the weighted total acceleration equation using the Taylor series where KFSBC became,

$$\gamma \frac{\partial \eta}{\partial t} = w_\eta - u_\eta \frac{\partial \eta}{\partial x} \dots (19)$$

while the surface momentum equation becomes,

$$\gamma \frac{\partial u_\eta}{\partial t} + \frac{1}{2} \frac{\partial}{\partial x} (u_\eta^2 + v_z w_\eta^2) = -g \frac{\partial \eta}{\partial x} \dots (20)$$

Where $\gamma = 3$ and $\gamma_z = 1.63$ is a coefficient, $\eta = \eta(x, t)$ is water surface elevation equation, u_η is particle velocity on the surface water in the horizontal direction- x , w_η is particle velocity on the surface water in the vertical direction- z .

4.3. Water Surface Equation, $\eta(x, t)$

The water surface equation will be formulated using linearized KFSBC as it is done in the formulation of the dispersion equation of the linear wave theory, which is by assuming the small amplitude wave and long wave, the second term on the right segment (19) will be very small compared to other terms, so it can be ignored, thus (20) becomes,

$$\gamma \frac{\partial \eta}{\partial t} = w_\eta$$

By using potential velocity of Eq. (18), where $w = -\frac{\partial \Phi}{\partial z}$

$$w_\eta = -Gk \cos kx \sinh k(h + \eta) \sin \sigma t$$

By working on the assumption of small amplitude wave

$$\text{where } (h + \eta) = h \left(1 + \frac{\eta}{h}\right) \approx h.$$

$$\gamma \frac{\partial \eta}{\partial t} = -Gk \cos kx \sinh kh \sin \sigma t$$

Integration to time t , obtained water level equation .

$$\eta(x, t) = \frac{Gk}{\gamma \sigma} \sinh kh \cos kx \cos \sigma t \dots (19)$$

4.4. Formulation of Linear Dispersion Equations

By working the assumption of small amplitude and long wave, the second term of the left segment of the momentum equation can be considered as a very small number, then the (20) becomes

$$\gamma \frac{\partial u_\eta}{\partial t} = -g \frac{\partial \eta}{\partial x} \dots (20)$$

From velocity potential equation of (18), particle velocity in the horizontal direction- x is,

$$u_\eta = -\frac{\partial \Phi}{\partial x} = Gk \sin kx \cosh k(h + \eta) \sin \sigma t$$

By working on the assumption of small amplitude dan long wave,

$$u_\eta = Gk \sin kx \cosh kh \sin \sigma t$$

$$\frac{\partial u_\eta}{\partial t} = Gk \sigma \sin kx \cosh kh \cos \sigma t \dots (21)$$

From (19),

$$\frac{\partial \eta}{\partial x} = -\frac{Gk}{\gamma \sigma} k \sinh kh \sin kx \cos \sigma t \dots (22)$$

Substitution (21) and (22) to (20)

$$\gamma Gk \sigma \sin kx \cosh kh \cos \sigma t = g \frac{Gk}{\gamma \sigma} k \sinh kh \sin kx \cos \sigma t$$

For $\sin kx \cos \sigma t$ was not zero, these elements will eliminate each other between the left and the right segment of the equation,

$$\gamma^2 \sigma^2 = gk \tanh kh \dots (23)$$

This equation is the dispersion equation of the linear water wave which is the same as (7) where there is a coefficient γ^2 on the left segment of the equation. Therefore, it can be shown analytically that there is a linear wave dispersion equation where there is a coefficient in the left segment γ^2 . Analytically (using the Taylor series), were obtained $\gamma = 3$. However, if the $\gamma = 3$ is used, a complete momentum equation should be used, Hutahaean (2019).

As an illustration of the wave length produced by (7) or (23), is as shown in Table 7, where a wave period of 8 sec is used.

Table 7. Wave length on several value γ , wave period $T = 8$ sec.

h (m)	L_{linear} (m)	L_γ (m)		
		$\gamma = 2.23$	$\gamma = 2.57$	$\gamma = 3.0$
15	81,79	20,09	15,176	11,103
14	79,982	20,087	15,176	11,103
13	78,008	20,082	15,175	11,103
12	75,85	20,072	15,174	11,103
11	73,489	20,053	15,173	11,103
10	70,898	20,018	15,168	11,102
9	68,049	19,955	15,159	11,102
8	64,903	19,842	15,136	11,1

7	61,409	19,643	15,087	11,095
6	57,501	19,301	14,979	11,078
5	53,082	18,736	14,753	11,028
4	48,006	17,831	14,299	10,885
3	42,031	16,419	13,443	10,505
2	34,691	14,227	11,9	9,595
1	24,794	10,648	9,088	7,561

In the Table 7., L_{linear} is wavelength with dispersion equations of the linear wave theory or $\gamma = 1$, while L_γ is the wavelength calculated by values $\gamma = 2.23, \gamma = 2.566$ and $\gamma = 3.0$. What needs attention is that there is a huge difference between L_{linear} and L_γ , in which it confirms that further research is needed on the wavelength of the water waves.

4.5. Nonlinear Dispersion Equations in Deep Water

In the case of non-linear assumptions, namely the assumption of small amplitude and long wave, the nonlinear term equation in the momentum equation of (20) is also done. The formulation is not written here because the limited space, where the formulation can be seen in Hutahaean (2019). The nonlinear dispersion equation in deep water is,

$$\gamma^2 \sigma^2 \left(1 - \frac{kA}{2}\right) + \frac{\gamma^2 \sigma^2}{4} (1 - \gamma_z) kA = gk \left(1 - \frac{kA}{2}\right)^2$$

.....(24)

where A is wave amplitude, $\gamma = 3.0$ while $\gamma_z = 1.63$. Actually γ_z is function of γ , Hutahaean (2019), where for $\gamma = 3$ then $\gamma_z = 1.63$ will be obtained.

Comparison between the wave length of (8) and the wave length of Eq. (24), where in (8) used the value $\gamma = 2.566$ while in (24) used the value $\gamma = 3.0$ with $\gamma_z = 1.63$ is as follows,

Table 8. Comparison between wave length (8) and wave length (24)

T (sec.)	H (m)	L_{eq-8} (m)	L_{eq-24} (m)	$\frac{H}{L_{eq-24}}$
6	1,451	8,536	5,933	0,245
7	1,975	11,619	8,076	0,245
8	2,58	15,176	10,548	0,245
9	3,265	19,207	13,349	0,245
10	4,031	23,712	16,481	0,245

11	4,878	28,692	19,942	0,245
12	5,805	34,145	23,732	0,245

In Table 8, it can be seen that the wave length of (8) with $\gamma = 2.566$ is longer than wave length (24) with $\gamma = 3.0$ and $\gamma_z = 1.64$, where $\frac{H}{L_{eq-24}} = 0.245$ while $\frac{H}{L_{eq-8}} = 0.17$ which is the criteria of the critical steepness wave (1). The values $\gamma = 3.0$ and $\gamma_z = 1.63$ is entirely an analytic result, while the value $\gamma = 2.566$ is derived from the criteria (2) which is the experimental result. Based on this condition, another opinion needs to be reviewed, namely the criteria of critical waves from Michell, J.H (1894), $\frac{H}{L} = 0.142$, which will produce value $\gamma = 2.345$. Comparison with Michell's criteria, presented in Table (9).

Table 9. Comparison of the wave length of different criteria.

T (sec.)	H (m)	L_{eq-8} (m)		
		$\gamma = 2.345$	$\gamma = 2.566$	L_{eq-24} (m)
6	1,451	10,22	8,536	5,933
7	1,975	13,91	11,619	8,076
8	2,58	18,168	15,176	10,548
9	3,265	22,994	19,207	13,349
10	4,031	28,388	23,712	16,481
11	4,878	34,349	28,692	19,942
12	5,805	40,878	34,145	23,732

From the wave length comparison in Table 9, it is actually still quite difficult or further study is needed to determine the value γ in (8). From the results of the comparison, γ a moderate value can be determined, that is, the value used $\gamma = 2.566$. However, the results of studies using the Toffoli's criteria on shallow water, produce a value $\gamma = 2.23$ which is quite close to 2,345 which is value γ from Miche;'s criteria. Thus, as a temporary conclusion is that it is better to use the value $\gamma = 2.345$ in (8) both in deep water and shallow water so that the analysis of water waves is not done in critical wave conditions.

V. CONCLUSIONS

In this study, it was found that the wave length of dispersion equation of the linear wave theory is too long to reach the criteria of critical wave steepness. The wave length of dispersion equation of the linear water wave can be shortened by multiplying the left segment of the

equation by a coefficient. Therefore, the first conclusion is that the dispersion equation of the linear water wave theory can be corrected by multiplying the left segment of the equation by a coefficient.

Coefficient values can be obtained from the criterion equation of critical steepness wave from both in deep water and shallow water. The coefficient value obtained by the results of the study on deep water is different from that on shallow water. It is also different from the results of analytical research, but it can still be estimated the best value among the coefficients obtained with the consideration that the analysis of water waves is not carried out in critical wave conditions. However, further research is needed to obtain a better single coefficient.

Wavelength and wave number are important parameters in modeling the dynamics of water waves. With a better wave number, the water wave model will produce a phenomenon that is closer to the natural water wave phenomenon.

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InterLib: Collaborative Tool for Translators and Interpreters

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Abstract— *The spread of information and communication technology (ICT) has revolutionized the way we share information. Collaborative tools have a great importance for teaching-learning activities, so as to assist in the dissemination of knowledge. In the area of education, the Brazilian Sign-Language translator or just Libras translator and interpreter is the main agent enabling the communication between teachers and Deaf students. This specialist needs to overcome different challenges, such as proficiency in the languages they translate, interpretation techniques, history and deaf culture. They also must lead with to specific contents taught to the Deaf student during different disciplines. This paper presents the development of a collaborative tool called InterLib, which has as main objective the qualification of these professionals toward these specific contents through the socialization and dissemination of knowledge. Thus, in regards of the lack of specific technologies for this purpose, a mobile application was developed aiming at facilitating the interactivity and collaboration of the Libras interpreters.*

Keywords— *Collaborative tools. Libras translator and interpreter. Mobile application. Socialization of knowledge.*

I. INTRODUCTION

Communication is the way to transfer knowledge and interact into the society and this can be done by speaking, writing or else through signed language. Communicating is also sharing [1].

In this way, where there is language, there is also communication, since it is linked to dialogue. Knowledge is disseminated by languages enabling human expression of thoughts and feelings [2].

Furthermore, the socialization of information is the relationship between the sum of several activities that grants participants (Transmitters-Receiver or Producer-Users) equal conditions for the production, treatment and dissemination of knowledge [3].

However, if a large part of the population easily feels apart from the society that surrounds each one, some peoples, because of cognitive or physical barriers, face many difficulties in communicating. It is the case of Deaf peoples suffering for the lack peoples dominating the sign language and able to maintain a full dialogue with them.

In Brazil, through the promulgation of Law nº 10.436 / 2002 [4] Libras, as a form of communication and expression that has a linguistic system of visual and motor nature, has officially been recognized as the support for transmission of ideas and facts coming from communities of Deaf people.

Libras, also legally recognized as a means of communication and expression within the Brazilian educational system, must be included as a discipline in special education courses, speech therapy and Universities. This sign language allows better interaction with the Deaf, and at school, between teachers and students, or between them and their colleagues. [5].

Gonçalves et al. [6] points out an extremely important fact that is the attention given by Deaf students during a class to translators and interpreters, because they are the final transmitter of what is being taught. However, these professionals are graduated in Letters/Libras, without having necessarily a deep knowledge and great technical vocabulary in a taught technical area such as engineering, psychology or laws, for instance. It considerably complicates the knowledge transmission [7].

Furthermore, another important issue is the scarcity of specific signs making sometimes the Libras' Translator or Interpreter unable to assist the Deaf in the teaching-learning process of specialized disciplines. When no existing specific sign exists to represent a term or concept, they need to use the technique called "Typing", which is the spelling of a word using the digital or manual sign language alphabet. Thus, this difficulty makes the information transmission slow and difficult for Deaf students in the educational context.

However, according to Melo and Da Silva [8], accessibility in communication can be optimized with the use of Digital Technologies (DT). Schimiguel et al. [9] exposed that it is possible to create content covering different languages and media, transforming them into Assistive Technologies (AT).

AT have gain notoriety during the last years. They are defined by as a set of resources and services designed to

improve the skills of people with special needs, providing better independence and social integration [10].

A common type of DT that has great acceptance according to this theme is the Collaborative Digital Systems (SDC). This kind of technology provides a way to people that have a common goal to interact between them in order to optimize their tasks. In the vision of Gerosa et al. [11], creative knowledge is better stimulated when the work is performed in groups.

Thus, understanding the challenge for the Libras Translator and Interpreter to act efficiently in every areas of knowledge into the Brazilian Educational System, a strategy to assist this professional was suggested, based on the creation of collaborative software: InterLib. InterLib enables to feed and share a database with information, such as a sign video, a sign classification, and contextual and conceptual descriptions for the sign, for every technical discipline. These data come from the community of Deaf people or professionals from this area of activity so that, through collaboration, knowledge about the various types of signs can be shared and disseminated at a larger scale.

Therefore, this paper describes the creating process of a mobile application named InterLib, that in addition to the main objective explained above, aims to achieve some other important goals, referencing the public in which this software intended to reach as: Integration, usability, functionality, appearance, reliability, navigability, security, among others.

II. METHODOLOGY

The steps that were taken to build the tool proposed by this work are shown in Figure 1:

2.1 Literature review

A bibliographic review was carried out in order to map the theoretical basis of the themes involved, such as the importance of Libras translators and interpreters as vectors in the teaching-learning process; and collaborative tools providing interaction mechanisms that contribute to these activities.

A technique called Systematic Review (SR) was used in the literature review of this research. Thus, it was intended to conduct a comprehensive survey on the State of the Art related to the operation of the software that helps teamwork with teachers, translators, and sign-language interpreters. The SR is a research technique that is based on finding specific evidence in the scientific literature, for project feasibility study purposes. SR is defined by a search process and a protocol that originates the steps of planning, execution, and results of the summarization.

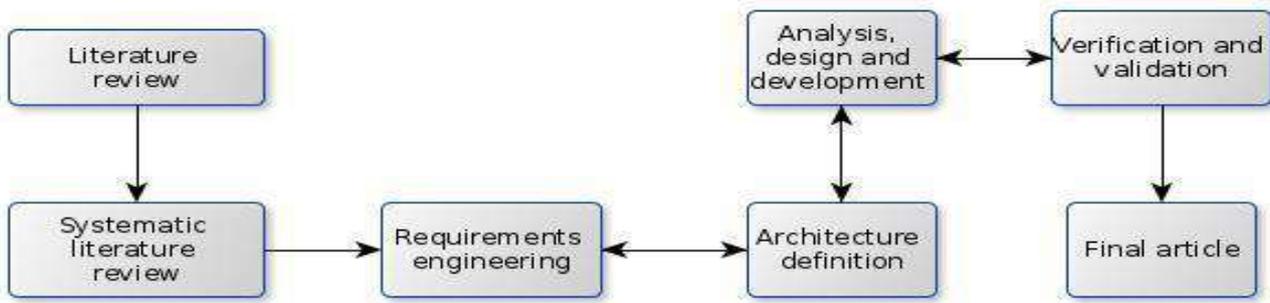


Fig. 1: Overview of activities developed in the methodology.

2.2 Requirements engineering

In this stage, it was sought to gather information about the existing systems related to this area of study to obtain the functional and non-functional requirements for building the tool, as well as from this information extract the user and system requirements. Information sources have included documentation, key, and potential stakeholders, as are some specifications that were used to build similar systems.

The techniques used in this point of work to obtains these specific data is described in the Table 1.

2.3 Architecture definition

From the collection of requirements mentioned in the previous step, researches were carried out in the literature in order to verify the appropriate architecture and the ideal structure of the components to compose the tool. Due to a wide variety of scenarios that can be presented, the scope of the main available architectures was analyzed.

Therefore, the choice by Model-View-Controller architecture was determined based on the resource, context, and platform restrictions in which InterLib intend to be inserted. In this sense, connectivity, processing power, security, development productivity, and usability were also evaluated.

2.4 Analysis and design of the tool

In this phase of the project, the prototyping technique and application development were implemented through an incremental cycle, as can be seen in Figure 2, with the delivery of intermediate functional versions.

The InterLib was analyzed and designed using the main UML (Unified Modeling Language) diagrams to better clarify the application's functionalities as well as update the documentation. The diagrams prioritized the interaction perspectives, internal, structural, and behavioral of the modeling as can be seen in Figures 3 and 4.

Table.1: The specific techniques used to collect requirements in the development of InterLib.

Techniques	Description of the use
<i>Point of View</i>	Brainstorming 13 was carried out with stakeholders to structure the requirements in order to obtain different perspectives on the tool.
<i>Scenarios</i>	Prototypes were built to simulate the suggested requirements in order to better prioritize them.
<i>Closed-Ended and Opened-Ended interviews</i>	Questionnaires with varied subjects were applied through a set of predefined questions, as well as unstructured questions, in order to obtain the main functionalities of the software.

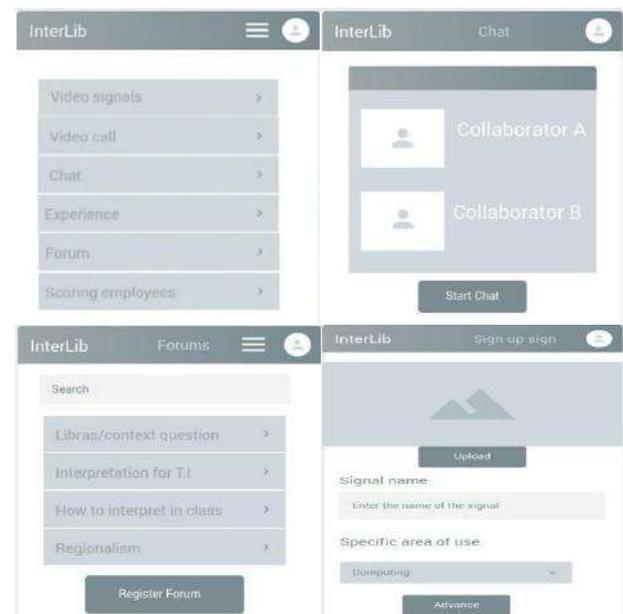


Fig. 2: Prototype – InterLib.

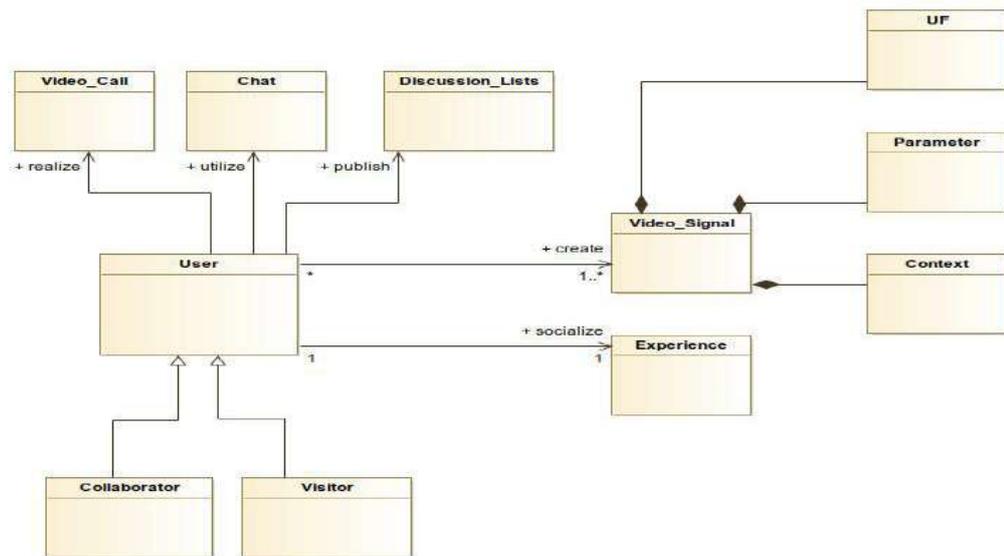


Fig. 3: Class Diagram - InterLib.

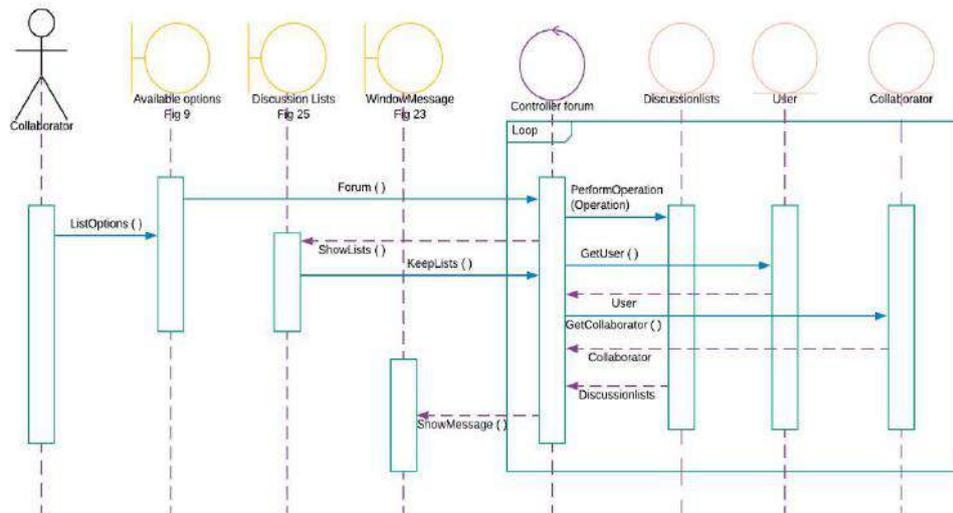


Fig. 4: Sequence Diagram - InterLib.

For every intermediate versions tests involving users were applied in order to find out if the implemented functions attended their purpose, and, in addition, to discover and correct possible functional errors before the system effective deployment. The following tests were performed: Interface, unit, components, user, system, performance and releases.

2.5 Verification and validation

At last, a final evaluation and validation processes were carried out to analyze whether the tool matches with the requirements and then offers the features expected by users.

To this purpose, user satisfaction questionnaires and acceptance tests were applied in order to compare the developed application in relation to its original requirements, in addition to the current needs of the user. Twelve experts received the app to test and give their qualitative opinions about the tool.

An evaluation form in which the user would answer the questions displayed in Table 2 collected the opinions about the application.

The specialists invited to evaluate the InterLib tool were teachers, professionals who have been working in the field of Pedagogy for more than 10 years and have extensive experience in the use of Sign Language in large Educational Institutions in Brazil, interpretation in seminars and

congresses or who are leaders of entities linked to the social inclusion of the Deaf, specifically in the state of Pará.

Table.2: Questions applied to the experts.

Number	Question
1	Does the tool serve satisfactorily for use by Libras translators and interpreters in order to improve their knowledge?
2	What are the weaknesses and strengths identified in the application?
3	What is the analysis regarding the usability of the application, that is, does it perform its tasks easily and quickly in the shortest possible time, without requiring a great knowledge of its use or long learning process?
4	What improvements and/or new features are suggested for the tool?

III. RESULTS AND DISCUSSION

The first final version of the application, with the main features outlined in the requirements gathering stage, was made available to the evaluators for a period of 30 days. Figure 5 shows the main screens of the InterLib App. Besides, tutorial videos were provided to ease the user's familiarization during their first contacts with the tool.

Considering the assessments from the experts, two of them emphasized the importance of this type of software and how it is improving the work of Libras translators and interpreters by helping to transmit information more accurately. They explained that this initiative is relevant both nationally and regionally.

Five evaluators classified InterLib as a new proposal for visualizing linguistic variations, cataloging usual and unusual signs, as well as a new and viable proposal for the creation of a video database of signals, divided by area of knowledge, and accompanied by its regionalization.

Meanwhile, another expert highlighted the project's originality and its importance for expanding knowledge in Libras. In addition, all the evaluators reported, as the application's main contribution, the initiative to promote interaction between Libras professionals and how it favors knowledge sharing.

IV. CONCLUSION

From the observation of the importance of an Interpreter or Libras Translator for Deaf students in a classroom, this

research aimed at building a collaborative tool focusing on qualifying Libras translators and interpreters through the socialization of knowledge, and in addition to ease interactivity and information sharing.

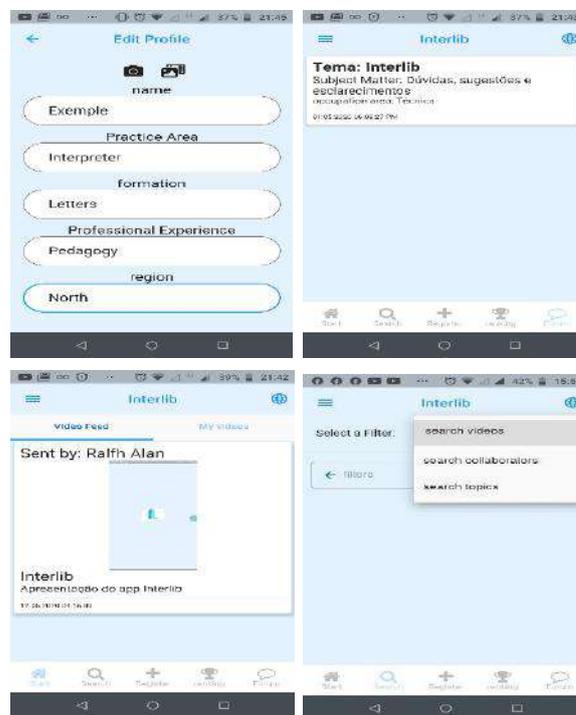


Fig. 5: Main Screens of InterLib.

Based on the possibilities offered by this new application, such as the publication of videos showing new signs and the exchange of information between professional interpreters of Libras with little knowledge and others with more experience in specific areas, there will be a condition of improvement in the performance of the translation and transmission of the information correctly and accurately.

As future works, the improvements suggested and validated by the specialists will be considered. Based one of those observations, there is the intention to develop one mechanism, similar to a ranking, trying to involve the active users, so that there is an improved performance in a great part of the platform's users.

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Formulation of a low fat fresh cream based on gums from *Beilschmiedia obscura* seeds

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Abstract— The purpose of this work is to improve the conditions for extracting and using gums from *Beilschmiedia obscura* (BO) seeds, with a view to formulating a light fat-reduced cream. To this end, the study of the effect of the extraction time on the extraction yield and on the expression of some functional properties of these gums has been carried out. The extraction time was varied from 15 to 120 minutes (min); the yield, the apparent water absorption capacity (AWAC), the solubility index (SI) and the emulsifying activity (EA) were measured. A centered composite plan has been developed to optimize the solubility of these hydrocolloids. Then, a substitution plan was implemented to lighten the fat-free creams. The proportions of 5%, 10%, 15%, 20%, 25%, 30% and 35% of substitutes have been formulated and the fat content, consistency and color of the mixtures have been determined. A sensory analysis was also done. From this work, it emerges that the extraction time has an influence on the properties of the gums studied. Indeed, the yield of *Beilschmiedia obscura* gums (BOGs) is optimum at 30 min of extraction. AWAC increases with extraction time while SI and EA are inversely proportional to extraction time. BOGs dissolve most between 70 and 80 ° C for speeds greater than or equal to 200 rpm and between 40 ° C and 80 ° C, for stirring speeds greater than 500 rpm. However, to avoid molecular damage to the water-soluble gums, it is preferable to dissolve them at 70 ° C and at 200 rpm. With regard to the formulation of fresh creams, the reduction made it possible to move from a fresh cream of 33.91% fat, to a cream of 20.1% of fat with BOGs, a reduction of 124.29 Kcal.

Keywords— *Beilschmiedia obscura*, Extraction, fat, gums, low-fat fresh cream , obesity and overweight.

I. INTRODUCTION

Obesity is a widespread disease that rages on all continents. It predisposes to chronic diseases like diabetes, cardiovascular diseases and cancer. Obesity is responsible for the deaths of 2.8 million people each year, or 6,850 deaths per day and the 5th leading cause of death worldwide [1]. In Africa, the number of overweight and obese children has increased by almost 50% since 2000. In Cameroon, 9.6% of the population over the age of 18 was overweight in 2014, or around 4,400 deaths [2]. This surge is justified by the change in eating habits and the sedentary lifestyle of the populations. To this end, the WHO

recommends the practice of sports exercises and the limitation of a high-calorie food consumption. Among the rich foods, there is milk.

In Cameroon, milk production is estimated at 172,000 tonnes [3], and results in the production of a wide range of dairy products made mostly from whole milk, the nutritional value of which is well established. Indeed, milk is a complete food, containing proteins (3.2%), carbohydrates (5%), minerals (0.9%) and lipids (3.6%) [4]. However, the consumption of whole milk given its high content of animal fat and saturated fatty acids, can lead to overweight leading to obesity and cardiovascular and

metabolic diseases [5] [6]. In order to avoid these health problems while benefiting from the advantages of milk and dairy products, the lipid load of milk is often reduced by the skimming process, this justifies the development of low-fat dairy products.

Furthermore, the cream eliminated during this process being rich in fat-soluble vitamins and essential fatty acids, must be valued for human consumption, hence the need to reduce only its energy value, while retaining its beneficial nutritional value. Indeed, the whole cream contains about 60% water, 2% protein, 3% lactose and between 30 and 40% fat [7]. The reduction in the latter consists of a reduction in fat between 12 and 29% [6]. However, this operation generally causes organoleptic defects on the finished product. To this end, the technology of low-fat dairy products generally uses food improvers (modified starches, water-soluble gums), to correct these defects. Anything that creates an extra cost for the low-fat industry. This situation is accentuated in Cameroon because, most of the food improvers are imported although the country abounds with significant potential. Indeed, the hydrocolloids were extracted from the seeds of *Beilschmiedia sp.*, a Cameroon forest plant, but not yet valued on an industrial scale [8]. In addition, with a view to promoting the use of Cameroonian potential in the manufacture of low-cost food improvers at the local level, the work of Edima [9] made it possible to develop methods for extracting *Beilschmiedia obscura's* gums (BOGs). However, the study of the effect of extraction time on the yield and properties of gums has not been carried out. As is the use of BOGs in a food matrix. In order to develop the Cameroonian potential, this study aims to improve the process of extracting BOGs for the manufacture of a low-fat fresh cream from fresh milk and BOGs.

II. MATERIALS AND METHODS

A. Materiel

The material used consists of *Beilschmiedia obscura* (BO) seeds and fresh milk.

The dry BO seeds were purchased in Meiganga, a town 160 km from Ngaoundéré (Adamaoua Region in Cameroon), during the month of March. Then, packed in polyethylene bags, and sent to the Physico-chemical laboratory of the National advanced School of Agro-Industrial Sciences of the University of Ngaoundéré. Once in the laboratory, the seeds are cleaned and washed with potable water, then dried for 48 hours at 40 ° C using a drier (P. Dominioni Lurate caccivio como, Italy). After drying, the seeds are ground using a grain mill (SAMAP).

Then, the powder obtained is sieved with a 400 µm sieve of Prufsieb brand mesh. The powder thus obtained is stored in airtight containers at room temperature.

Fresh milk was collected from the "Dalang" farm located 7 km from Bini Dang. After collection in previously washed and disinfected bottles, the milk is sent to the cheese workshop of the National advanced School of Agro-Industrial Sciences, in a cooler. Then, it was pasteurized at 80 ° C for 15 min; this using a hot plate (Heidolph, Germany). After cooling (room temperature), it is conditioned in a stainless steel pot and stored at 4 ° C in a refrigerator until it is used for the formulation of the light cream.

B. Study of the effect of the extraction time

The method used in this work is that of Edima [9]. 10 g of BO powder are mixed with 250 mL of distilled water. The solution is buffered to pH 7 with citric acid and Na₂CO₃, then brought to 68 ° C for extraction. The extraction is carried out at this temperature with stirring, varying the extraction time from 15 min to 2 hours (h) with a step of 15 min. Thereafter, the solution is centrifuged at 3600 rpm for 20 min. The gums contained in the supernatant are precipitated with ethanol for an alcohol / water ratio of 3: 1. Then, the whole is filtered and the wet gums dried at 38 ° C for 15 h. For each extraction time, the yield (Y), the apparent water absorption capacity (AWAC), the solubility index (SI), the emulsifying properties were evaluated.

B.1. Determination of extraction yield

The extraction yield is calculated from the following formula:

$$Y (\%) = M_2 \times 100 / M_1$$

With: M₁: the sample mass; M₂: the mass of gum; R: yield.

B.2. Apparent water absorption capacity

Apparent water absorption capacity (AWAC) is determined by the method of Philips [10]. 0.4 g of corn flour is mixed with 0.1 g of gum. This mixture of mass M₁= 0.5 g is associated with 10 ml of distilled water and the whole is subjected to stirring for 30 min using a stirrer (Heidoph, Germany) and centrifuged at 5600 rpm for 30 min (a Biofuge primoR Hereas centrifuge, Germany). The recovered M₂ pellet is weighed and the apparent water absorption capacity (AWAC) is calculated by the following formula:

$$AWAC \text{ (g of water / g of sample)} = [(M_2 - M_1) / M_1] \times 100$$

B.3. Solubility index

Solubility index (SI) determined according to the method of Anderson [11]. 0.1 g of gum is associated with 0.4 g of corn flour, the whole is mixed with 10 ml of distilled water and stirred using a brand magnetic stirrer (Heidolph, Germany) for 30min; then the mixture is centrifuged at 5600 rpm for 30 min (centrifuge Biofuge primoR Hereas, Germany). The M₂ pellet is collected, weighed, and brought to the oven at 105 ° C for 24 h. The weight of the dry pellet M₃ is determined and the following formula of the Solubility Index (SI) is applied:

$$SI \text{ (\%)} = \text{MSe} - [(M_3 - M_0) \times 100] / (M_2 - M_0)$$

With MSe: dry matter of the sample.

B.4. Determination of the emulsifying properties of gums

0.1 g of gum is dissolved in 5 ml of distilled water. The whole is mixed with 5ml of cotton seed oil (Azur, Cameroon), and stirred for 30 min using a magnetic stirrer (Heidolph, Germany).

The emulsifying activity (EA) is evaluated by the modified method of Muschiolok [12]. 10 ml of the emulsion solution are introduced into a graduated tube and left to stand for 30 min at room temperature. The height of the emulsified phase is measured and makes it possible to determine the emulsifying activity (EA) of the gums in%. The formula is as follows:

$$EA \text{ (\%)} = (H_e / H_w) \times 100$$

With, H_e: height of the emulsified layer; H_w: total height of the liquid in the tube.

C. Solubility optimization

C.1. Experimental design

A centered composite plan has been developed for this purpose. The factors considered being the temperature varying from 40 to 80 ° C and the stirring speed varying from 200 to 600 rpm. The experimental matrix used is represented by table I. For each test, the solubility index was evaluated as described above.

Table I. Experimental matrix for the optimization of solubility

N° Essays	Coded variables		Actual variables	
	X ₁ (temperature)	X ₂ (Speed)	X ₁ (temperature in °C)	X ₂ (Speed rpm)
1	-1	-1	40	200
2	+1	-1	80	200
3	-1	+1	40	600
4	+1	+1	80	600
5	0	0	60	400
6	0	0	60	400
7	0	0	60	400
8	-√2	0	32	400
9	√2	0	88	400
10	0	-√2	60	120
11	0	√2	60	700

C.1. Statistical analysis

Analysis of variance (ANOVA) was used to determine the influence of each factor as well as the degree of significance of each of these effects. The significance of each factor is determined by the Fisher test which is defined as the ratio of the mean square of the regression (CMR) to the experimental error (EE) (F = CMR / EE), representation of the meaning of each variable ordered on the model examined. The regression equation was also subjected to the Fisher test to determine the regression coefficient R². The calculations were made with STATISTICA 5.0 software. The confidence level considered is (1 - α) ≥ 0.9.

The validation of the model was made via the regression coefficient R² and the Absolute Average Deviation Analysis (AADA). The AADA must be substantially equal to 0 and less than 2 for the model to be validated. It is determined according to the following formula:

$$AADA = \frac{\sum_{i=1}^p \left(\frac{|Y_{i \text{exp}} - Y_{i \text{cal}}|}{Y_{i \text{exp}}} \right)}{p}$$

With, Y_{i exp} the experimental response and Y_{i cal} the response calculated from the model for an experiment i; p being the total number of experiments.

D. Development of a low fat fresh cream

D.1. Process for the production of low fat fresh cream

Fresh milk is filtered to remove impurities and then skimmed. The cream obtained is standardized via the introduction of the gum extract. The whole is homogenized and pasteurized at 80 ° C for 15 min, then cooled to 25 ° C. The lactic ferment is added and the whole is matured at 15 ° C for 15h, then conditioned.

D.2. Formulation of a light cream reduced in fat

A substitution plan has been implemented with the BOGs. The proportions of 0%, 5%, 10%, 15%, 20%, 25%, 30% and 35% of substitutes or BOGs were added to the cream. The different formulations are listed in Table II.

Table II. Different cream formulations produced

No. Essays	Cream proportions (%)	Proportions of substitutes (%)
1	100	0
2	95	5
3	90	10
4	85	15
5	80	20
6	75	25
7	70	30
8	65	35

D.3. Determination of the fat content of creams

The fat contents of the cream used and of the various formulations, were determined according to the method of Folch [13]. 100 ml of sample are added to a mixture of the extraction solvent Chloroform / methanol: 2/1, V / V, 200ml / 100ml. The whole is mixed using a mixer for 20 min. The homogenate must constitute a single phase. If this is not the case, add the mixture [CHCl₃ / CH₃OH 2: 1 (v / v)] in sufficient quantity to obtain a phase. The mixture is filtered under suction through a No. 3 sintered glass, in order to remove the denatured proteins. Then, 0.88% KCl (w / v) at a rate of 1/4 of the total volume of the supernatant is added and the mixture is homogenized. The whole is transferred to a separatory funnel. After separation of the two phases, the lower phase is recovered in a flask and the solvent is evaporated using a rotary evaporator at 50 ° C. The volume of lipids is measured, and the difference with the initial volume makes it possible to

calculate the lipid content of the different formulations. The results obtained were expressed as a percentage.

D.3. Determination of the penetration force

The penetration force is determined using a texturometer of the texture analyzer type (Brookfield, United States, 2011). The principle of measurement consists in applying a compressive force to a sample using a probe. As part of this work, a normal test using a rear extrusion probe was carried out. This analysis made it possible to compare the texture of light fresh creams formulated, with that of a light reference fresh cream with 14% fat (Bridelice brand, France). The penetration distance used was 6 mm, the mass of the probe 2 g and the descent speed 0.5 mm / s. The resistance of the sample is measured by a calibrated load cell expressed in grams. The values obtained in grams have been brought back to Newton by the following formula:

$$1g = 0.102N$$

D.4. Color determination

The effect of adding gums on the color of fresh creams was evaluated using a Lovibond RT 100 colorimeter. The L parameter (luminance) of each sample of cream is compared to the sample of fresh cream lightened to 14% fat (Bridélice, France).

D.5. Sensory analyzes

The sensory analysis was carried out by a hedonic test. The panel consisted of 10 people previously trained for 4 days in the tasting of thick fresh cream, using the reference sample. The descriptors considered during this analysis were texture, color, taste and odour. A general score was also assigned to each sample. During the sensory analysis, the different samples (20 g) of cream are presented in plastic bowls of white color, all identical, bearing codes with random 3-digit numbers. The samples were accompanied by bread and served in two sets. It was a question for the taster to assign a score ranging from 1 for the least appreciated sample, to 6 for the most appreciated sample. The evaluation of the general grades was done in the same logic. The results obtained were subjected to analysis of variance (ANOVA), to determine if there is a significant difference between the tasters and the treatments. Then, Duncan's multiple comparison test was done to determine which sample differed significantly from the other.

III. RESULTS AND DISCUSSION

A. BOGs performance

The results of the study of the effect of extraction time

on the yield and some properties of BOGs are presented in the following figures.

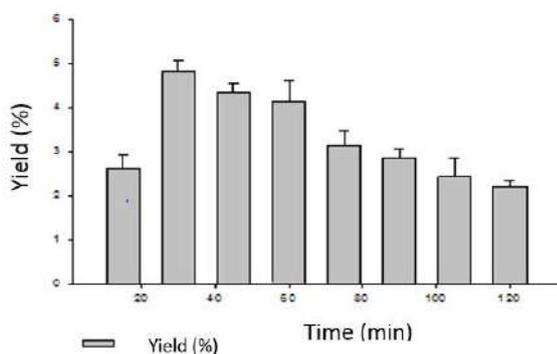


Fig. 1. BOGs extraction yield as a function of time

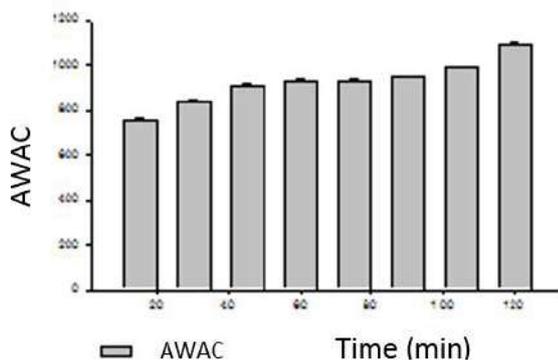


Fig. 2. AWAC of BOGs as a function of time

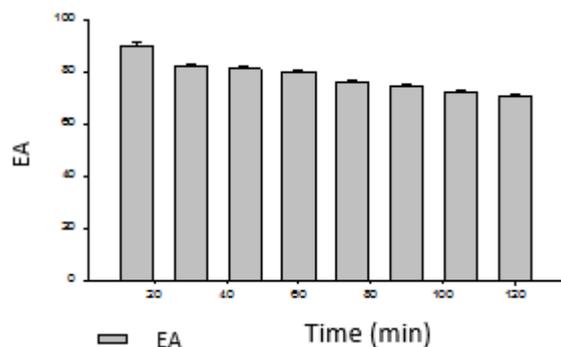


Fig. 3. EA of BOGs as a function of time

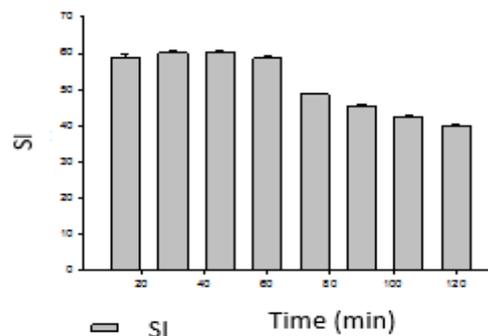


Fig. 4. BOGs IS as a function of time

From the results above it appears that, the yields obtained during this work increase with the extraction time in the interval 15-30 min, and beyond this interval, decrease with the extraction time. These results are different from the results of Panyoo [14] on *Grewia mollis* gums, in which the extraction time has no effect on the extraction yield. This can be justified by the difference between the samples (rigid shrub bark). However, these results are close to those of Wu [15] on sterculia seeds and those of Singthong [16] on Yanang leaves, which confirms that, the extraction time influences the yield of the gums. However, in these works the optimum yields are reached after 30 min. This can be justified by the difference in the extraction conditions and the raw material. The decrease in yield beyond 30 min may be due to the fact that over time, the gums extracted tend to bind to other macromolecules, for example the proteins present in the medium; this would decrease their ability to precipitate in the presence of ethanol during purification. The highest yield is 4.81%. This value is lower than that found by Ndjouenkeu [8]; This can be justified for various reasons. In particular, the difference of the samples used. Indeed, the studies of Ndjouenkeu [8] have focused on the seeds of *Beilschmiedia sp* while this work has focused on the seeds of *Beilschmiedia obscura*. In addition, in this work, the purification was done with ethanol while in the work of Ndjouenkeu [8], it was carried out by dialysis, with papain and TCA. The methods for determining extraction yields are also different. Ndjouenkeu [8] compared the percentage of gums to the total percentage of polysaccharides. While in this work, the percentage of gum is determined by making a ratio between the mass of the raw material and the mass of dry gum obtained.

The highest AWAC is 1100.01 g of water / g of gum and is obtained after 2 hours of extraction. It is higher than that found by Ndjouenkeu [8] which is 1053.6 g of water / g of gum. This difference may be due to the diversity of the raw materials used. In addition, in its work, AWAC was

measured using raw material powders, which is not the case in our context. AWAC increases with extraction time; This can be justified by the formation of intermolecular interactions between the gum molecules, forming aggregates which can trap the water molecules.

The highest EA is 90.01% and corresponds to a duration of 15 min of extraction. This value is higher than that of Ndjouenkeu [8] which is 60%. These results show that, the EA decreases very little with the extraction time. This phenomenon is justified by the formation of aggregates with the consequence, the reduction of the dispersion of gums in the environment [17]. This directly impacts the emulsifying activity so expression is conditioned by the dispersion of the gums in the solution. Indeed, [18] have shown that the emulsifying properties of locust bean gums are due to their ability to form films of liquids around the droplets. Knowing that, BOGs can be assimilated to hydrophilic chain arabinose and galactose polymers [8], the decrease in EA is therefore strongly linked to the formation of aggregates over time of extraction.

The results of the solubility index show that the solubility of BOGs varies little with the extraction time. The EA increase between 15 and 45 min. Beyond this range, it decreases. This decrease in solubility can be explained by the formation of aggregates over the extraction time. Dakia [17] state that the solubility of galactomannans is limited by the formation of aggregates. Furthermore, it should be noted that, the highest value of solubility is 60.01 %, which proves that these gums have difficulty in dissolving. This may be due to the extraction conditions. Indeed, the work of Richardson [19] demonstrate that, the solubility of galactomannans is a function of their origins, extraction and measurement methods. The hydrocolloids studied in this work have interesting properties whose expression is reduced by limited solubility.

B. Optimization results of BOGs solubility

The results of this analysis are collated in Table III.

Table II. Presentation of the BOGs SI results

No. Essays	Temperature (°C)	Speed (rpm)	IS obtained (%)
1	40	200	51,01
2	80	200	70,00
3	40	600	75,82
4	80	600	83,64

5	60	400	67,30
6	60	400	67,80
7	60	400	66,90
8	32	400	50,50
9	88	400	81,95
10	60	120	48,10
11	60	700	85,45

From the above table, it follows that, the highest SI of 85.45% is obtained at 60 ° C and at 700 rpm. While the lowest SI of 48.1% corresponds to 60 ° C and 120 rpm.

B.1. Model equation

The equation mathematically describing the BOGs SI is as follows

$$Y = 67.33 + 17.82 X_1 + 22.81X_2 + 0.70 X_1 X_1 - 5.58 X_1 X_2 + 1.25 X_2 X_2$$

With, Y = IS; X₁ = temperature; X₂ = stirring speed

From this equation it appears that, only the interaction temperature - agitation speed has a negative effect on the SI. Among all these factors and interactions, the speed of agitation is that which has the most effect on the SI because its coefficient is the highest (22.81); it is followed by the temperature factor which has a coefficient of 17.82. Then comes the temperature-speed interaction with a coefficient of -5.58. The quadratic interactions speed - speed and temperature - temperature come in last positions with respectively 1.25 and 0.70.

B.2. Model validation

The SI model was validated by the analysis of the R² and the AADA. The values obtained are presented in Table IV.

Table III. Probability table for the effects of BOGs SI

Validation element	Abbreviation	Value obtained	Standard value
Correlation coefficient	R ²	93,04 %	100%
Absolute Average Deviation Analysis	AADA	- 0,003	0

The value of R² is fairly close to the standard value; the difference between the value found and the standard is due to the different handling errors. The calculated AADA is

very close to 0. Using these two tools, the model describing the BOGs SI is validated.

B.3. Determination of the significance of the factors

Table V. Probability table for the effects of BOGs SI

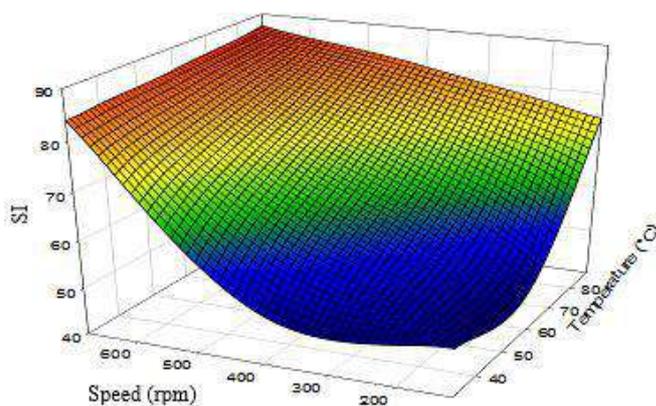
Source	Sum of squares	DDL	Quadratic mean	Report F	Probability
A:temperature	686,48	1	686,48	25,87	0,0038
B:vitesse	977,94	1	977,94	36,85	0,0018
AA	4,58	1	4,58	0,17	0,6948
AB	99,90	1	99,90	3,76	0,1101
BB	7,81	1	7,81	0,29	0,6107
Total error	132,70	5	26,54		
Total (corr.)	1906,75	10			

For a 95.0% confidence level, only the temperature and agitation speed factors have significant effects on the BOGs SI. In fact, their probabilities are respectively 0.0038 and 0.0018, all less than 0.05.

B.4. Response area

In order to better visualize the relationships between the different factors and the BOGs SI, response surfaces have been drawn; Figure 5 below shows this result.

From this figure it can be seen that, the BOGs SI increases with temperature and the speed of agitation. Optimal values are obtained between 70 ° C and 80°C at stirring speeds above 200 rpm, and between 40 ° and 80 ° C for speeds above 500 rpm. These results are close to those of Singthong [16] who showed that guar gums had a maximum solubility at 40 ° C and those of locust bean at 80 ° C. However, the high temperatures coupled with high agitation rates lead to destruction of the macromolecules. The work of Mao [20] reveals that, when the shear rates increase, the macromolecules of galactomannans quickly become entangled. This has the consequence of reducing the viscosity. To avoid this, it is preferable that the BOGs are solubilized at 70 ° C and at 200rpm.



SI of BOGs : ■ :40% ; ■ : 50% ; ■ : 60% ; ■ : 70% ; ■ : 80% ; ■ : 90%.

Fig. 4. Response surfaces of SI of BOGs

C. Results of the formulation of light creams with reduced fat content

C.1. Lipid content of the different formulations

The results of this manipulation are shown in Table VI. From this table it emerges that, the fresh cream obtained from the skimming of whole milk contains 33.91% fat. This value complies with the standard which recommends a minimum fat content of 30% [7]. Formulations made with BOGs reveal that only mixtures containing 10, 15, 20, 25 and 30% of BOGs extracts comply with the standard for light products, which means that the proportion of fat in a fresh cream is between 12 and 29 %. Adding 5% fat is not enough to have a light cream. While, the addition of 35 % gum extract is outside the regulation. To this end, the rest of the results will only concern formulations conforming to the standard.

TABLE VI. Lipid content of the different formulations

No. Essays	Proportions of fresh cream (%)	Proportions of substitutes (%)	MG content of creams BOGS (%)
1	100	0	33,91
2	95	5	30,15 (G ₁)
3	90	10	26,8 (G ₂)
4	85	15	23,45 (G ₃)
5	80	20	20,1 (G ₄)
6	75	25	16,75 (G ₅)

7	70	30	13,4 (G ₆)
8	65	35	10,05 (G ₇)

C.2. Determination of the consistency of the creams formulated

The results obtained are presented in Table VII. The data in this table reveal that, the highest consistency in BOGs is 8.26 N and corresponds to the formulation of 26.80% fat. The lowest consistency is 2.75 N and corresponds to the formulation of 13.40 % fat. That of the reference is 5.61 N with 14% fat. The value closest to the reference is 5.23 N obtained at G₄ (20.10%). This difference between the formulations and the reference may be due to the fact that, the reference has been reduced with a combination of modified starches and pectins, which have given more consistency to the cream, so that the relief has been greater. The addition of BOGs in fresh creams allows the absorption of excess water and balances the texture of the product. Note that, the reduction in consistency is proportional to the reduction in the fat content. This is explained by the fact that, the reduction in fat causes a reduction in the total solids of the product, thus generating a significant reduction in the firmness of the gel [21].

Table VII. Consistencies of the different formulations

No. Essays	Lipid proportions (%)	Consistency (N)
G ₂	26,80	8,26±0,65
G ₃	23,45	7,08±0,17
G ₄	20,11	5,23±0,23
G ₅	16,75	3,27±0,41
G ₆	13,41	2,75±0,15
R	14	5,61±0,34

C.3. Color determination

The results of this analysis are collated in Table VIII. The L parameter decreases with the addition of gums. This is in line with the work of Kumar [22] who demonstrated that, the addition of pectin and sodium alginate in a yogurt made from soy milk and mango reduced the L indices. It is the G₂ sample that comes closest to the reference.

Table VIII: Presentation of parameters L, a and b of the formulated creams

Sample s	L	a	B
G ₂	69,36	0,28	9,95
G ₃	68,96	0,96	10,61
G ₄	63,02	1,01	11,52
G ₅	55,21	1,39	11,57
G ₆	50,37	1,72	11,62

C.4. Sensory analysis

The data obtained from the analysis of BOGs creams are presented in the following figure. This figure reveals that, in general, the G₄ sample is the most appreciated; it is followed by G₃ and G₂. For the texture descriptor, the G₄ sample is the most popular followed by G₃ and G₂. The taste assessment shows that G₂ is the most liked followed by G₃ and G₄; but there is no significant difference between these samples. For the odour and color descriptors, G₂ is the most popular followed by G₃ and G₄.

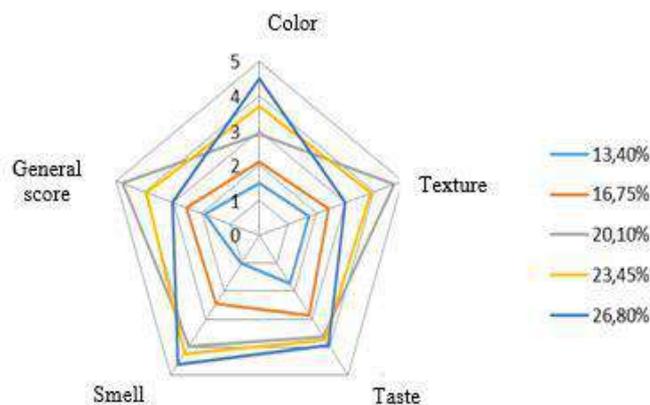


Fig. 4. Results of sensory analysis of fresh BOGs creams

IV. CONCLUSION

The extraction time has an influence on the gums studied. Indeed, the yield of BOGs is optimum at 30 min of extraction, the AWAC increases with the extraction time while the IS and the EA are inversely proportional to the extraction time. For this purpose, the BOGs must be extracted at 30 minutes to have a high yield combined with good functional properties. BOGs dissolve most between 70 and 80 ° C for speeds greater than or equal to 200 rpm and between 40 ° C and 80 ° C for stirring speeds greater than 500 rpm. However, to avoid molecular alterations, it is preferable to dissolve them at 70 ° C and at 200 rpm.

Regarding the formulation of light fat cream, the lightening of the creams made it possible to start from a cream with 33.91% fat to creams of 20.1% with BOGS. A reduction of 124.29 Kcal.

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Urban Housing in Nigeria for Sustainable Development: Challenges and Prospects

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Abstract— Urban Housing has been laden with host of problems, for which urbanization is seen as a major catalyst. The implication is manifested in high unemployment, over population with crowded housing, proliferation of slums, and squatter settlements, degradation of the environment, highly inadequate infrastructural and social amenities, increasing crimes and social vices and other social issues that could jeopardize development. The pervasiveness of urban housing constitutes serious challenges to city growth and sustainability in Nigeria. This study analyses housing problems using systematic review and observation methods of selected houses and the problems confronting them in Lagos and Ibadan, Southwest, Nigeria. It discusses the concept of sustainable development and through its findings, revealed the despicable living conditions of the urban residents and housing conditions in Lagos and Ibadan cities. The study therefore justifies the need for adequate housing, and provides a basis for official intervention in the urban housing delivery process towards achieving sustainable development in Nigeria.

Keywords— Adequate Housing; Urbanization; Sustainable development.

I. INTRODUCTION

The demand for housing increases in response to several factors, notably urbanization and population growth. According to Omiunu (2014), a high population growth will have significant effect on resource allocation such as housing and this could pose a big problem to the Nigeria housing and national development. Thus, urbanization and population growth if not adequately handled can put excessive strain on available housing which could negatively affect the attainment of sustainable development in Nigeria (Igwe, Okeke, Onwurah, Nwafor and Umeh, 2017). Nigeria's housing situation is gradually becoming critically bad and could make Nigeria fail in the sustainable development plans and goals. Hence, there is need to cushion housing challenges in Nigeria towards the attainment of sustainable development. The link of housing provision to sustainable development is hinged on its multidimensional impact on the promotion of quality of life, health, education, safety and security of individuals, households, communities (Ibem, and Aduwo, 2013).

Adapting Maslow's hierarchy of needs (1943), Jiboye (2011) and Emiedafe (2015) noted that adequate housing has always been one of man's basic needs; and a significant component for human survival which could serve as a useful barometer for gauging societal development. Hence, due to several other factors such as economic, political, industrialization, commercialization, and social mileages compared to the rural areas, there has been high rate of urbanization in Nigeria (Fitzgerald, 2017). According to Aliyu and Amadu (2017), urbanization implies a process whereby societies transform from a rural to urban way of life or redistribution of populations to urban settlements associated with development and civilization due to high rate of commercialisation, scientific development, political and cultural life. Coupled with the increase in the nation's population, a major problem of urbanization is housing challenge because people are attracted to cities and towns which lead to high population increase. With the increase in the number of people living in urban centers, there is continued scarcity of housing, which could be due to

insufficient expansion space for housing and public utilities, poverty, unemployment, and costly building materials which can only be afforded by few individuals (Conserve Energy Future, 2019).

Adapting the push and pull factor of migration by UNICEF (2001) and Stanojoska and Petrevski (2016), urban cities offer greater opportunities in terms of education, employments, research, and even the search for marriage partners in Nigeria. According to the United Nations-Habitat (2007), the majority of the world's people live in cities and slums- these are growing dramatically within the world's poorest cities, particularly, in Sub-Sahara Africa such as Nigeria. In 1996, the United Nations had put the global urban population growth at 60 million. Between 2001 and 2002, the world's urban population had increased by nearly one-half percent of the total population. This growth occurred largely in the East Asia and Pacific region. In Sub –Sahara Africa, which is largely rural – with only 32 percent of the population living in the urban areas, there is a very high urban growth rate of up to four percent (Ogunleye, 2005).

According to Enisan (2017), the rate of urbanization in Nigeria has been on the increase in the last two decades. Okupe (2002) noted that in the 1930s, only 7% of Nigerians lived in urban centers, and 10% in 1950s, but by 1970, 1980 and 1990, 20%, 27% and 35% lived in the cities respectively. However, in recent time, over 40% of Nigerians now live in urban centers of varying sizes and this has created severe housing problems, resulting in overcrowding in inadequate dwellings, and in a situation in which 60% of Nigerians are said to be “homeless” (Enisan, 2017). This has created a lot of social pressure on social services and infrastructure such as transportation, electricity, water supply, health services, housing, etc. In addition, Aliyu and Amadu (2017) noted that urbanization in Nigeria is mainly demographically driven providing no commensurate socioeconomic dividends and benefits to the urban population and areas. This has also led to urban health crises such as inadequate water safe supply, squalor and shanty settlements, lack of sanitation, lack of solid waste management, double burden of diseases and inefficiency, population congestion, and risky transport system.

The massive influx of migrants towards urban areas in Nigeria has resulted in the over-population of practically all cities. Like any other developing nations; Nigeria with a current population figure of over 140 million people, is experiencing rapid urbanization (Ajanlekoko, 2001; NPC, 2006). According to the United Nation (2007), Nigeria has

one of the highest urban growth rates in the world, with its cities ranking among the fastest growing in the world. Growing at the rate of about 5.5 percent annually from 1980 to 1993, and more recently, has increased to the rate of 5.8 percent which has resulted in a total urban population of 62.66 million people (or, 43 percent of the national population). By projection, this proportion is expected to increase to more than 60 percent by 2025 (UN, 2007). This rapid growth constitutes major problem to the urban residents whose quality of life and living conditions have deteriorated considerably (Ajala, 2005; Jiboye, 2009; Fitzgerald, 2017).

According to Abrams (1964); Jiboye (2011) and Amao (2012), the pace and scale of the growth in the urban areas have outstripped the capacity to maintain acceptable standards of public health, physical infrastructural development, environmental safety and healthy living environments, government's ability to provide services for sustainable, among others, therefore reducing the housing quality and quality of life in general in urban Nigeria. In the long run, this could hamper development and also the attainment of sustainable development in Nigeria making it to lag behind in global development.

In addition, housing stock in Nigerian cities are grossly inadequate and the increasing urban population has resulted in uncontrolled, overcrowded, and unplanned urban settlements culminating into settlements ill-suited for human habitation; especially in large cities like Lagos and Ibadan . Furthermore, in 2000, Nigeria needed 12 to 14 million housing units. It was also estimated that by 2020, the country will need 29 to 40 million housing units to solve the housing shortage in the country. In addition, Nigeria's poverty level rose from 46.3% in 1985 to 65.6% in 1996 and 70% till present with over half Nigeria's population living below the poverty level of US\$1.00 per day. With this gross poverty in Nigeria, affordable housing is both inaccessible and unavailable for the majority of the urban poor (Lagos State Report, 2004).

In the past, in recognition of the global housing need and the consequent homelessness pervading most communities, the United Nation Center for Human Settlement (Habitat) had inaugurated a world Habitat day in 1987 with the theme, Shelter for the Homeless. The aim of which was to explore ways of addressing the problem of global poverty and homelessness and to encourage various national governments to pay more attention to the shelter needs of their citizens (United Nations Centre for Human Settlement, 1993).

Furthermore, the Nigerian Government has through a myriad of administrations tried peripherally to address the issue of providing housing for the low income earners in the country. As part of its National Development plans, all citizens were to have access to a relatively decent and affordable housing. Along this direction, it introduced and established a National housing policy with the aim of providing an institutional framework for ensuring adequate housing both quantitatively and qualitatively (Adeshina and Idaeho, 2019). In spite of these efforts, little or no success has been made to meet the housing needs of the growing urban population in Nigeria (Jiboye, 2011; Emiedafe, 2015; Adeshina and Idaeho, 2019). While noting the fact that decent and habitable housing is a basic human need as postulated by Maslow (1943); Jiboye (2011); Emiedafe (2015) and Adeshina and Idaeho (2019), every individual has the right to this basic need and this is a significant component of the social dimension of sustainable development in Nigeria (National Affordable Housing Association, 2006). However, a large proportion of Nigerians still live in sub-standard, make-shift dwellings. The need to ensure decent and affordable shelter to the people, particularly the urban poor, is central to the improvement of their living standard towards attainment of sustainable development in Nigeria. Therefore, the aim of this study is to examine the urban housing scenario in Nigeria with a view to identifying the major challenges experienced by the urban population and identifying the likely prospects toward achieving sustainable urbanization in Nigeria.

II. REVIEW OF CHALLENGES OF URBAN HOUSING IN NIGERIA

Poor urban housing conditions constitute global challenge but this condition is worse in developing countries (United Nations, 2012) such as Nigeria. Aliyu and Amadu (2017) noted that urbanization is growing very rapidly in Asia and Africa and are projected as 56% and 64% urban respectively by 2050. Also, three countries which are Nigeria, India, and China are projected to account for 37% of the projected growth of the world global urban population between 2014 and 2050. The UN Habitat has stated that today, 600 million people lived in life-and health-threatening homes in Asia, Latin America and Africa (United Nations Human Settlements Programme (UN-HABITAT), 2006). From a global perspective, the problem of inadequate housing is a common challenge across the globe (Ezeigwe, 2015).

According to the UN Habitat (2010) cited by Igwe, Okeke, Onwurah, Nwafor and Umeh (2017); and Enoghase, Airahuobhor, Oladunjoye, Okwuoke, Orukpe, Ogunwusi and Bakare, 2015), 30 percent of the world's urban population lives in slums, deplorable conditions where people suffer from one or more of the following basic deficiencies in their housing: lack of access to improved water; lack of access to improved sewage facilities (not even an outhouse); living in overcrowded conditions; living in buildings that are structurally unsound; or living in a situation with no security of tenure (that is, without legal rights to be where they are, as renters or as owners); among others. In addition, more than two billion people are in desperate need of better housing (Enoghase et al., 2015; Ezeigwe, 2015). The Nigerian society is undergoing both demographic (people living longer) and epidemiological (change in population health due to changes in lifestyle) transitions due to urbanization and at a current growth rate of about 2.8%–3% a year, Nigeria's urban population will double in the next two decades (Aliyu and Amadu, 2017).

Nigeria has a population of over 140 million people (NPC, 2006), and the population is estimated at over 200 million in 2019 (World Population Prospects, 2019), and land coverage of an estimated 1million square meter. According to Omiunu (2014), the Nigeria population growth rate is 3.0% while Agbola and Agunbiade (2007) noted that the urbanization rate in Nigeria is 5.5%, a figure that is almost twice the population growth rate of the country. With the increase in number of people, there is also an increase in the demand of housing and services (Makinde, 2012).The rapid increase in urban population has resulted in very high cost of living brought about by great demands on inadequate urban housing and facilities. There is high cost of land, and housing, these are often in short supply and out of the economic reach of the most of the urban families. With the populated urban areas by a large number of people and with very low incomes, it becomes impossible for a large population of this people to be able to meet their housing demands. Hence, housing issues and challenge remains one of the most important challenges facing the country (Ezeigwe, 2015). According to Mabogunje (2004); Enoghase et al. (2015) and Ezeigwe (2015), in Nigeria, existing housing stock is 23 per 1000 inhabitant, and housing deficit of between 15 to 17 million while N12 trillion will be required to finance the deficit of the 15 million houses. The FHA (2007) noted that this is about four times the annual national budget of Nigeria.

Basorun and Fadairo (2012) categorized the challenges facing the Nigeria urban housing sector into: administrative, institutional and management challenge; financial and economic challenge; physical challenge; and local participatory challenge. In addition, house prices and rents have escalated very high above the general inflation problem in Nigeria (Nubi, 2008; Ezeigwe, 2015). Another important problem to housing in Nigeria is the high cost of land (Ezeigwe, 2015). According to Enoghase et al. (2015), in order to be able to meet up with the 15 to 17 million housing units needs as stated by Mabogunje (2004); Enoghase et al. (2015) and Ezeigwe (2015) would require about 17 million plots of land. This, when converted to the more common land unit of measurement (square kilometer) would yield an approximately 11,470 square kilometer- roughly the size of Rivers State, or approximately three times the size of Lagos State in Nigeria (Enoghase et al., 2015).

In Nigeria, there are three tiers of Government- Local, State and Federal but the impact of the Local and State governments are hardly felt in most Nigerian cities. Therefore, most community members usually come together to plan the way forward for their neighbourhoods. The limitation is usually the financing of major projects; and in very few areas where the Local and State governments are functional, opinions of the citizens hardly count. Whereas, the European Commission (2010) and Omiunu (2012) have stated that involving citizens in urban planning helps ensure sustainable economic development; and plays a vital role in providing well-planned cities. As citizens are deeply affected by urban planning, authorities need to ensure that they are involved and provided with a forum for expressing their opinions. Thus, the experiences from two major cities in Nigeria, comprising Lagos and Ibadan demonstrate the level of severity of the urban housing challenge in Nigeria.

III. REVIEW OF PROSPECTS OF URBAN HOUSING IN NIGERIA

According to Ibem and Aduwo (2013), housing provision could promote quality of life, health, education, safety and security among individuals, households and communities. Hence, Onibokun and Faniran (1995) noted that the urban housing sector plays significant roles as engines of national development. Therefore, for efficient urban housing in Nigeria, the following needs were suggested by Onibokun and Faniran (1995):

- i. There is need to educate the Nigerian government and its agencies in the conduct of value research on urban housing towards articulating the several problems militating the urban housing and providing recommendations and solution towards ameliorating these challenges in attaining sustainable development in Nigeria.
- ii. There is also the need for partnership orientation in the conduct of this research on the urban housing. This could be provided by local researchers from the various institutions and research institutes, the United Nations agencies and the bilateral and multilateral agencies who already know the value of research especially with regards to urban housing in developing countries such as Nigeria.
- iii. Also, donor agencies need to accord greater priority to the urban sector in Nigeria and promote partnership towards achieving sustainable urban housing development in Nigeria.
- iv. Donor agencies such as USAID, IDRC, the Ford Foundation, IFRA, the bilateral agencies, the UN system, the multilateral agencies, the World Bank, among others should provide support and promote urban research at a much higher level in Nigeria through capacity building of the NGOs and the institutions.

Also, Igwe et al. (2017) provides some solution for ameliorating urban housing in Nigeria towards sustainable development, and these include that:

- i. Governments at all levels of systems should provide low-cost houses so as to cater for the large number of low-income earners who are unable to afford a decent apartment and also to meet their housing needs.
- ii. Employers could also contribute to urban housing by providing housing or building loan to their staff with no interest to enable them build their own houses so as to cushion the housing challenges in Nigeria urban centres.
- iii. Government should develop economic, social and environmental policies that will facilitate urban housing that is both affordable towards ensuring urban housing sustainability in Nigeria.
- iv. Also, of importance is the renewal of urban sites and slums so as to change the poor environmental conditions that is known to be prevalent in major areas of the urban cities in Nigeria.

Of importance is that there should be the need for public-private partnership in the provision of urban housing towards sustainable development in Nigeria. According to Ilesanmi (2013):

- i. The private or public sector alone has not been able to serve their huge and growing housing needs in Nigeria. However, Basorun and Fadairo (2012) noted that the private sector has been far more efficient in the provision of societal goods and services such as housing than the government. Hence, it could be postulated that a joint partnership between the public and private housing sector could go a long way to ameliorating the urban housing challenge facing Nigeria.
- ii. Also, there should be the need for mixed public housing schemes directed towards the provision of enhanced institutional frameworks on innovative public-private partnerships and home-ownership schemes in Nigeria.

IV. METHODOLOGY

The study adopted the systematic review and also used the observation method. Relevant information was obtained from the field using the observation method through selected sampled houses in various environments of Ibadan and Lagos used in this study. These houses observed are a representation of what is obtainable in most urban houses occupied by the urban majority in Nigeria. Image photographs were taken and used for the study. Lagos and Ibadan cities are some of the most populated cities in Nigeria and even in Africa. There are six geopolitical zones in Nigeria which are: North Central; North East; North West; South East; South South; and South West. South West was purposively selected due to the fact that some of the largest cities such as Lagos and Ibadan cities are located in South West geopolitical zone.

Lagos, on the other hand is the most populous state in Nigeria and on the African continent. It has been known to be one of the fastest growing cities in the world (UN-HABITAT, 2006; Hartley, Potts, Flew, Cunningham, Keane and Banks, 2012; Anheier and Isar, 2012; Pinther, Förster and Hanussek, 2012; Cunningham, 2013; Benton-Short and Short, 2013), and one of the most populous urban areas. Lagos is a major financial centre in Africa; the megacity has the fourth-highest GDP in Africa and hosts one of the largest and busiest seaports on the continent.

Lagos covers an area of 3,577 square kilometre, representing 0.4 percent of Nigeria's geographic space. Total population is currently estimated at 16.86 million people. It is projected to reach 24.5 million by 2015, thereby making it the third-largest city on earth. Population density is high, averaging 4,713 people per square kilometre, but reaching 12,000 people per square kilometre in that part of the city referred to as the metropolitan area.

Ibadan is the capital and most populous city of Oyo State, Nigeria with a population of over 3 million (Population city, 2015). The exact population of Ibadan is not known because the National census of 1991 undoubtedly underestimated the number of inhabitants. The current estimate today varies from 2 to 5 million inhabitants (Ayeniyi, 1994; Olaniran, 1998). However, it is the third most populous city in Nigeria after Lagos and Kano, and the country's largest city with regards to geographical area. Ibadan is situated in the south-western Nigeria, and is a prominent transit point between the coastal region and the areas in the hinterland of the country. The principal inhabitants of Ibadan city are the Yorubas, as well as various communities and states from other parts of the country due to its central of attraction in Nigeria. By the year 2000, it was estimated that Ibadan covered 400 km² (Onibokun and Faniran, 1995). The growth of the built-up area during the second half of the 20th century (from 40 km² in the 1950s to 250 km² in the 1990s) shows clearly that there has been an underestimation of the total growth of the city.

These characteristics made it possible for Lagos and Ibadan to be purposively selected for this study. Also, information obtained from past literature were synthesized and used to provide answers to the research objectives of this study. In addition, the observation method was used to take pictures and images of several houses in the urban cities in Lagos and Ibadan, Nigeria, and these are used to provide evidences of the situations of urban housing in Nigeria.

V. RESULTS

The result is divided into two sections based on the selected locations used for this study: the first section provides the observation results for urban slums in Lagos while the other section provides the scenario of Ibadan, Oyo State, Nigeria.

5.1 A case study of Lagos state

Lagos epitomizes the phenomenal growth in urban population that is most typical of most African cities (Aluko, 2010). The pull into Lagos State has become increasingly

phenomenal that the State has become legendary for its congestion and urban housing problems. Lagos is an urban complex that embodies tremendous contrasts. As the former national capital and the major port of the largest country in Africa, it is a powerful magnet for migrants from all over Nigeria and neighbouring African countries. The rapid urban growth which Nigeria has experienced is well manifested in Lagos, the major parts of which are the product of modern economic, social and political forces in interaction with traditional culture which was the factor that distinguished life in the city from that in the countryside (Alagbe, 2006).

Ownership of a house is only a dream realized by only the upper 5 per cent of the income groups in Lagos (UNCHS, 1993). It is the desire of every family to have a place to call home, but the majority of the people living in Lagos can neither hardly rent quality housing nor own one. Notable amongst the areas in Lagos with very bad housing conditions are Ajegunle, Makoko, Agege, Bariga, Badia, Ilaje, Ijeshatedo/Itire, Iwaya, Amukoko, Iwaya, Makoko, Lagos

Island, Ikorodu, Mile 12, Market Area, Okobaba/Alli/Oromoko, Ijora/Oloye, Mushin, Idi-Araba, Agidingbi, Olaleye/Iponri, Oworonshoki, Ipodo/Ikeja, Marine Beach, Otto, Oshodi Market Area, Shogunle/Obalende, Sari Iganmu, Olusosun, Ogudu Village, Oregun, Orile, Agege, Aiyetoro Village, Somolu, Onigbongbo, Alausa Village, Ogba West, Iju, Ejigbo, Lawanson, Ikate, Abulejjesha, Ipaja, Egbe, Bolorunpelu, Maroko

A lot of Lagosians live in overcrowded houses, unsanitary and deplorable environments (see plates 1, 2). Families living in one bedroom apartment are very common. Also pertinent is the issue of overpopulation in many urban areas. According to Cities Alliance (2008), inadequate housing arises from the wide gap between demand and supply in Lagos state, resulting in denied access to housing and rapid growth of slums. Apart from slums and squatter settlements that are characterized by poor housing, poor environmental conditions, and overcrowding visible for all to see, inadequate housing is a phenomenon common in Lagos state.



Plates 1, 2: Deplorable living conditions (source-Jiboye, 2011).

Most areas lack good surface and waste water drains (see plates 3, 4). Sanitary facilities are absent in some houses and in houses where they are present, they are usually very unhygienic. The different types of sanitary facilities in use in most of these areas in Lagos include- Pit Latrine, pour flush toilet, and W.C attached to septic tank. Also, in many areas of these Lagos slums, many houses have no toilet.



Plate 3, 4: Unsanitary disposal of waste water

Air pollution in Lagos is also a major problem majorly due to the use of Generators for the supply of electricity (see plate 5), high number of vehicles on the roads, and concentration of industries in the state. Power generation and supply is very poor in Lagos state as well as other parts of the country, so people rely on the use of generating sets to do practically everything - from household use to commercial use. Also of

importance to housing problem is the high use of motorcycle riders which has been due to the overcrowding nature of the city, most of who feed from the riding business due to lack of employment due to high rate of competition due to high population of the state (see plate 6). All of these cause air pollution of the environment which could affect the health of the inhabitants.



Plate 5: Several generators used by single household.



Plate 6: Motor cycle riders in Lagos (google images)

In addition, most inhabitants Lagos lack access to water and have to walk quite some distance to get clean water, since they are not connected to pipe water network. Others pay exorbitant amount, almost 200 times more than the price of pipe water to water vendors to be able to get water for

domestic use (Fika, 2008). Some buy from houses with boreholes (see plate 7) while others get water from wells for daily use (see plate 8). Most people living in Lagos have to accumulate several containers for storage of water. (See plate 9).



Plate 7: Sale of water to the public



Plate 8: Well in the middle of dwelling (Jiboye, 2011)



Plate 9: Several containers for storing water

Waste collection and disposal in Lagos state is getting better because of the State government's efforts toward actualizing a clean environment in the state. But some areas still need proper waste disposal networks put in place. Open areas,

green spaces, quiet streets and recreational parks are important building blocks that compliment housing and for promoting quality of life in urban environments in Lagos. Green spaces and open areas are beginning to emerge in Lagos state. But open areas on individual plots of land which would ordinarily have served as setbacks are in most cases absent because most house frontages have been converted to shops for business purposes hence, leading to congestions and environmental problem which could lead to climatic problem (see plate 10).

According to Omiunu (2012), to achieve sustainable development, the needs of the present generation have to be met without compromising the ability of the future generations to meet their own needs. Majority of people cannot afford quality housing in Lagos. A high percentage of housing in Lagos is below quality level. A high percentage of the poor are homeless in Lagos and most of the people live in houses better attributable to slums.



Plate 10: Business activities in front of houses (source: Jiboye, 2011).

Hence, Lagos obviously is due for better planning in order to ensure sustainability of the environment and sustainable urban housing. A major challenge is the social and economic exclusions arising from not engaging a broad spectrum of the local people in the decision making process, as well as many people lacking access to finance (Cities Alliance, 2008). This has jeopardized the tendency to achieve sustainable urban housing in Lagos state, Nigeria, hence, there is need for attention to be directed to the cities by the governments and also by private housing sector.

5.2 A case study of Ibadan, Oyo state.

Notable amongst areas in Ibadan with poor housing conditions are Beere, Oje, Inalende, Mapo, Okepadi, Yemetu, Oniyanrin, Agbokojo, Akobo-Ojuirin, Bodija, and Ojoo. Housing condition in Ibadan is mostly deplorable. Coker (2007) concluded that nearly half (47.6%) of the houses surveyed in Ibadan are either sub-standard or unfit for human occupation. Nearly three out of every five houses (60.5%) has one defect or the other with respect to the neighbourhood environment. Houses located in the more recently developed areas of the city (low density zone) tend to fare better compared to those in the high and medium density zones from perspectives of both housing conditions and neighborhood environment. The inner core region, occupied by early settlers in the city, presents the worst scenario with respect to both quality of dwelling and neighbourhood environment. The quality of housing and neighbourhood environment reduces as the degree of density or level of crowdedness increases.

According to Fourchard (2003), the development of unplanned urbanization along the major roads of the city from the 1970s to the 1990s has finally given birth to notable slums in the north, the east and the south of the city. Also, 30 per cent of the derelict houses in Ibadan are found in the outskirts of the city at more than five km from the centre (Abumere, 1985). Most houses in Ibadan are very old, derelict and unsafe for habitation (see plates 11, 12) and sometimes, there are evidences of fallen building leading to the loss of lives and properties in Ibadan. According to Mabogunje (1968), half of the city constituted in the inner core area was occupied by "slum dwellings characterized by no identifiable sanitation facilities, housing in mud, physical deterioration and the highest population density area of the town". Despite the fact that these observations were made 46 years ago, they are still very much relevant as little or no differences exist between Ibadan of then and now.



Plate 11, 12: Unpleasant living environments in Ibadan (source: Makinde, 2012)

Sanitary facilities in most homes are very poor and unfit for human use hence, dangerous for the human health (see plate 13, 14). Also, most houses use external makeshift kitchens for cooking and keeping of kitchen wares (See plate 15).



Plates 13, 14: Typical toilets in Agbowo, Ibadan



Plate 15: External cooking area in Agbowo area of Ibadan

A major problem in the core area of Ibadan is the unavailability of water; lack of potable water is a common phenomenon in these areas. A resident's account of the situation suggests that even houses which have the facilities (pipes and taps) cannot get water more than once in a month. Waste disposal problems in Ibadan as in other cities are acute. Open areas, green spaces, quiet streets and recreational

parks are important building blocks that compliment housing and for promoting quality of life in urban environments. They are virtually absent in Ibadan.

People cannot afford quality housing in Ibadan (see plates 16, 17). Very high percentage of housing in Ibadan is below quality level. The poor are also homeless in Ibadan and most of the people live in derelict houses.



Plate 16, 17: Typical Houses in slum areas of Ibadan

Ibadan obviously is due for better planning in order to ensure sustainability of the environment towards achieving sustainable housing development in Ibadan city.

VI. PROSPECTS FOR SUSTAINABLE URBAN HOUSING DEVELOPMENT

The 1987 Brundtland Commission's Report, Our Common Future, defines sustainable development as "Development that meets the needs of the present without compromising the ability of future generations to meet their own needs." According to Elliot (2006), literally, sustainable development refers to maintaining development over time. The National

Affordable Housing Agency of Britain (2006) describes the concept as that which “ensures a better quality life for everyone, now and for generations to come”. In a broader form, it is the process of building our communities so that we can live comfortably without consuming all of our resources (Jiboye, 2011).

In recent times, the concept of sustainable development has been one of the most discussed and adopted global topical issues. The concept is a shift from a mere sustained growth of a society, to the level where such growth does not jeopardize the need of the future generation. Sustainable development is premised on the articulation and incorporation of environmental and human needs in the pursuit of economic growth and development objectives. However, it has human, socio-economic, and physical development dimensions (Oduwaye, 2009; Jiboye, 2011).

Sustainable development espouses the intrinsic link between socio-economic, cultural and environmental development as well as the right of the individual to improved living condition in any given society or nation. Thus, a socially, economically or an environmentally sustainable system should achieve distributional equity, provision of adequate social services including health, education, housing as well as functional and livable environment among many others (Lawanson; 2005; Jiboye, 2009).

In addition major challenge to sustainable urban housing provision in Nigeria as identified by Iwuagwu and Iwuagwu, (2015) and Olutoge and Obakin (2017) is the high costs of imported building materials. However, Olutoge and Obakin (2017) opined that alternative low-cost materials for sustainable urban housing and sustainable materials should be developed for adequate and sustainable housing provision in Nigeria. The prospect of a sustainable urban environment in Nigeria is a very exciting one because according to Jiboye (2011), high quality and well-managed housing is a cornerstone of sustainable communities. The quality and condition of housing has a major impact on health and well-being.

Therefore, a sustainable urban housing environment is where slums are completely non-existent and existing derelict housing in slums are brought to decent standards; and where homelessness are tackled by regenerating deprived areas, and making up new communities is prioritized. It is also an environment where adequate and affordable housing thrives thereby protecting inhabitants from extreme weather

conditions and where citizens have sufficient living conditions with no more than three people sharing the same room; an increase in housing supply where provision of affordable homes is key, and the provision of infrastructure and social amenities support for people who wish to own their homes on empty properties are made available; the identification and development of new growth areas by the Government and private participators; protection and management of existing green areas, improvements to local parks and public spaces and creation of green areas in areas where they are non-existent; an environment with the presence of secure tenure that prevents unlawful evictions; an environment with full access to an improved drinking water source and where access to improved sanitation facilities is priority.

In addition, sustainable urban housing could also be achieved by understanding the housing needs of the population through research and providing of a critical analysis of the housing needs from a cross or various socio-economic groups in Nigeria. This would go a long way in helping to overcome the challenges of urban housing towards achieving sustainable urban housing in Nigeria.

VII. CONCLUSION

The study has examined the challenges and prospects of urban housing in Nigeria. The study revealed the deplorable and pathetic situations of the urban housing conditions of majority of people in Lagos and Ibadan cities in Nigeria. The study justifies the need for urgent attention from government and other stakeholders which could lead to a joint partnership between the governments and private sectors towards addressing the problems of providing adequate urban housing and infrastructure for the urban poor. Unlike in developed countries where concerted efforts are being made to better the living conditions of citizens, the situation in Nigeria and other developing countries appears to be deteriorating. The need for the provision of adequate housing with all basic infrastructure put in place should be top priority in the national development programs. There is a need for all the stakeholders in the housing industry to recognize the fact that necessary infrastructure should be put in place in proposed residential sites even before the commencement of construction of housing projects by individuals. The Government owes its citizens a duty to put in place infrastructural facilities like potable water, waste water drainages and sewerage treatment plants, electricity,

solid waste management facilities. This would ensure the existence of sustainable urban environments where people are healthy and have no fear of a collapsed future for generations yet unborn.

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Turbining the Leopold Matrix

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Abstract— *The conservation of natural resources is a fundamental issue, in addition to being, in many cases, regulated by laws and decrees. In Brazil, resolutions require a rigorous environmental impact assessment to be carried out and the EIA (Environmental Impact Study) and RIMA (Environmental Impact Report) to be generated in any projects with activities that potentially cause degradation to the environment. A widespread way of assessing environmental impacts is the interaction matrix known as the Leopold Matrix. Many scientific articles use the original or modified Leopold matrix to perform the assessment of environmental impacts, although they commonly point out disadvantages or limitations in the use of the matrix. The purpose of this article is to propose a new matrix, named “Leopold Turbined Matrix”, with the elimination of the identified disadvantages, in addition to enhancing the advantages, without visually loading the matrix, in addition to including new elements, which enhance its ability to evaluate and predict environmental impacts. For this, an in-depth study was carried out on the applications of the matrix based on national and international scientific and technological. The developed “Leopold Turbine Matrix” solve identified disadvantages or limitations, in addition to including new criteria, so that it constitutes a new powerful, efficient and comprehensive tool regarding the assessment of environmental impacts.*

Keywords— *Leopold Matrix, Environmental Impact Assessment, Decision making.*

I. INTRODUCTION

The first discussions with the participation of representatives from different countries take place in June 1972, during the First World Environment Conference in Stockholm, Sweden. At this conference, an instrument of great importance for the preservation of the environment was created, the Environmental Impact Assessment – EIA [1].

An environmental impact can be defined as:

“[...]any change in the physical, chemical and biological properties of the environment, caused by any form of matter or energy resulting from human activities that, directly or indirectly, affect: I - the health, safety and well-being of the population; II - social and economic activities; III - the biota; IV - the aesthetic and sanitary conditions of the environment; V - the quality of environmental resources”. [2]

According to Batista et al [3], EIA is an aid tool in decision making, which aims to evoke all environmental factors, so that decisions take these factors into account when designing projects. The authors also emphasize that it is fundamental for the development of the conscious use of the scarce resources of the planet earth and can be conceptualized as the “[...] qualitative and quantitative interpretation of the changes, of ecological, social, cultural or aesthetic order in the environment” [3].

The EIA includes procedures to identify and classify potential impacts that an action may cause to the environment, predicting the dimension and losses of these impacting activities [4]. According to Sanguineto [5], it must be carried out by specialist technicians, helping organizations to execute projects with less damage to the environment. Consultation and popular participation are integral parts of this assessment, making EIA a participatory tool for environmental management [6].

The Brazilian law No. 6,938, of August 31, 1981, states that the assessment of environmental impacts is one of the instruments of the National Environment

Policy. This law establishes that, in an environmental impacts assessment, in addition to other elements, the Environmental Impact Report (RIMA) needs to be generated, which provides all considerations about the possible environmental impacts of a project and the Environmental Impact Study (EIA) that details all the technical analysis made by those responsible who must approve or not the project.

On the other hand, the Federal Constitution of 1988 also addresses the issue, in its chapter 4, article 225, § 1, item IV, with the requirement of the prior study of environmental impact for any installation of work or activity potentially causing significant degradation of the environment.

More recently, Law No. 12.305, of August 2, 2010, instituted the National Solid Waste Policy (PNRS), which regulates the guidelines for solid waste management with the objective, among others, of minimizing environmental impacts arising from the manufacture of goods or any impacting activity that generates waste that will need to be disposed of.

In this context, the aforementioned legislative documents are milestones that reveal the importance given by the federal government to the need for environmental impact assessment for the quality of life of future generations, although there is still evidence of accidents occurring [7] that could be avoided through inspection and monitoring, still incipient, from the government [8].

According to Pimentel et al [9], for the EIA to reach its objectives, its studies must follow some steps. These steps must be carried out cyclically, with feedback being made during the process. Are they:

- Identification. It constitutes a detailed analysis of the project so that it can identify all the impacting activities, their relations with each other and the consequences of each of these activities through the measurement of indicators.
- Prediction. Formed by a detailed analysis of the impacts, identified in the previous step, to determine the nature of the impacting activities, their magnitude, their extent and their effects.
- Evaluation. It is time to interpret, analyze and evaluate the data obtained in the previous steps, its importance and the need for its elimination, or at least, its mitigation.

One of the activities inherent to the analysis of environmental impacts, which makes up the EIA, is the Environmental Diagnosis, detailed below.

1.1. Environmental Diagnosis

The environmental diagnosis allows a broad view of the project to be studied and must be constituted by the enumeration and integral analysis of the resources of the environment to be affected by the impacting activities, including their interactions. The basic construction of an environmental diagnosis, takes into account three overlapping environments, the physical environment, the biological environment and the anthropic environment [10].

- Physical Environment: The physical environment is the entire structure that allows the development of life. The elements of this medium to be analyzed vary according to the type and size of the project, taking into account the local characteristics. Are considered factors physical, mainly: soil, climate and meteorological conditions, air quality, noise levels, geological and geomorphological formations, in addition to water resources, water quality and management[11].
- Biological Environment: The biological environment is formed by the local flora and fauna, including their interdependencies that involve the exchange of matter and energy. They must also be considered according to the type and size of the project. Are considered biological factors, mainly: terrestrial and aquatic ecosystems, in addition to those of transition[11].
- Anthropic Environment: Also known as socio-economic environment, the anthropic environment deals with the human being, his needs, capacities and relationships with others and with the environment around him. Like the others, they must be considered according to the type and size of the project. In this environment, the impacts on the communities directly or indirectly affected by the project, which are the communities residing in the project's impact area or those that, in a certain way, maintain some relationship with that place or with the people who live there. They are anthropic factors, basically: population dynamics, that is, their day-to-day activities, land use and occupation, living standards, social organization and productive and service arrangements, which can be affected by the project and its impacting activities [11].

Through the environmental diagnosis it is possible to identify the sensitive areas of the environment

in relation to the project. With the diagnosis made, it is necessary to assess the environmental impacts. There are several methods capable of assisting the professional in this task.

1.2. Environmental Impacts Assessment Methods

The methods of assessing environmental impacts have been created and evolved by several researchers over the years and aim to clarify the importance of environmental change in a simple and standardized way [12].

According to STAMM [10], people involved in the environmental impact assessment process need to know all the assessment methods, so that they can choose the most appropriate method for each specific project.

Among the main methods of assessing environmental impacts then the ad-hoc method, check lists, interaction networks [13], system diagrams, overlaying charts and matrices [14], with various applications published in the literature (articles with applications).

1.3. Leopold Matrix

Leopold's matrix was created by geologist Luna Bergere Leopold and his colleagues in 1971, in response to the 1969 United States Environmental Policy Act, which did not provide clear instructions on how to generate an environmental impact analysis report for one project [15].

The Leopold matrix presents a general and complete overview of the project's actions, the impacting activities resulting from it and the environmental conditions affected, allowing to verify which actions are most impacting and which environmental conditions are most affected [16].

Based on the study by Leopold [17], in general, the matrix does not exceed one hundred impactful activities and eighty-eight environmental conditions, totaling 8.800 interactions, and in most projects, these interactions are limited to between 25 and 50. The Leopold matrix can be presented in its reduced format and in its expanded format.

In their reduced format, the table lines indicate the environmental conditions that can be affected and the columns indicate the existing impacting activities that affect them. Each cell in the table shows exactly two pieces of information: the intensity of the impact and its degree of importance [18]. These two pieces of information are the criteria for analyzing each impact. A model of the reduced matrix is presented in Fig.1.

		Impactful activities of project				
		Activity 01	Activity 02	Activity 03	Activity 04	Activity 05
Environmental conditions	CA 01	2 / 1	2 / 3	1 / 1		
	CA 02			1 / 4	10 / 5	3 / 4
	CA 03	1 / 2		2 / 3	1 / 4	3 / 3
	CA 04	2 / 2				1 / 1

Fig.1: Leopold matrix reduced

Source: Adapted from Leopold et al [17].

The model presented in Fig.1 contains five impacting activities and four environmental conditions. Some of the intersections are blank, representing that the impacting activity does not affect that environmental condition. In the others, it is possible to observe two values. The top number represents the intensity (magnitude) of the impact, in relation to the environmental condition of the interaction. The higher the intensity, the more affected the indicated environmental condition will be. The bottom number represents the importance that the impact has on nature. There is no standard to measure importance, however, the greater the value, the greater the perception and sensitivity of the impact in relation to the physical, biotic and anthropic means. The numerical values presented in the matrix can vary, generally, from 1 to 10 or from 1 to 100 [17].

The values of the reduced matrix can be positive or negative, indicating whether the impact is beneficial, in the case of positive or harmful values, in the case and negative values [15].

In its expanded format, the table has a subdivision for each impacting activity. Thus, an impacting activity can generate one or more environmental impacts for a given environmental condition. Each environmental impact has its intensity and importance analysis registered in the matrix [17]. A model of the expanded matrix is shown in Fig.2.

Despite having been made with a specific purpose, the Leopold Matrix assumes a very general character and can be used to evaluate most projects that can cause environmental impacts [15].

		Impacting activities																	
		Ativ. 01			Ativ. 02				Ativ. 03				Ativ. 04				Ativ. 05		
		Imp. Ambiental 01	Imp. Ambiental 02	Imp. Ambiental 03	Imp. Ambiental 01	Imp. Ambiental 02	Imp. Ambiental 03	Imp. Ambiental 04	Imp. Ambiental 01	Imp. Ambiental 02	Imp. Ambiental 03	Imp. Ambiental 01	Imp. Ambiental 02	Imp. Ambiental 03	Imp. Ambiental 04	Imp. Ambiental 01	Imp. Ambiental 02	Imp. Ambiental 03	Imp. Ambiental 04
CA01		2	1	3	1	1	2	1	1	3	1								
CA02		2	1	3	1	2	4	1	2	3	1	2	1	2	1	2	1	2	3
CA03		1	2	1				1	3	2	2	4	2	2	1	2	1	3	4
CA04		1	2	4				2	5	3	4	6	1	3	2	1	3	2	3
		6	4	5															1

Fig.2: Leopold Matrix Expanded

Source: Adapted from Leopold et al.[17]

Over time, it was realized that, in many cases, two criteria were insufficient to carry out an efficient environmental impacts assessment. Based on the literature review, it is clear that each author decides to create his own matrix, without any standardization, resulting in the lack of analysis of some criteria and relevant information, difficulty in making and other disadvantages that will be analyzed on a case-by-case basis.

The objective of this article is to create a framework for creating a new, more complete Leopold-derived matrix, named “Leopold Turbinated Matrix”, with the compilation of all the criteria necessary for a rigorous evaluation, adding to each criterion a collection of information, which will leverage environmental impacts assessment work, providing the user with a simplified and consistent set of information for decision making.

II. MATERIAL AND METHODS

The research carried out in this article has a quantitative approach of an applied nature, as it generates knowledge for short-term use and is classified as qualitative-exploratory. In order to achieve this, documentary and bibliographic research was carried out in order to update, standardize and give greater completeness to the Leopold Matrix regarding the assessment of environmental impacts.

The methodological procedure was divided into 3 stages, described below.

1 - Conducting a literature review in order to deepen the concepts that involve the Leopold matrix. The original article of its creator and introductory studies related to the matrix were sought;

2 - Conducting a systematic review, in order to verify how the authors are using the Leopold matrix to assess environmental impacts, which elements are being used in the matrix and what are the disadvantages pointed out by these authors. This step was performed with searches in CAPES journals [19] for access CAFE, Scielo[20] and Scopus [21];

3 - Compilation of the identified advantages and disadvantages. From the obtained data, a proposal was made for a Leopold Turbinated Matrix that would enhance the advantages and mitigate or eliminate the disadvantages in the application of the original Leopold matrix.

III. RESULTS AND DISCUSSION

For a better understanding of the results, it is necessary to describe the applications already published for impact assessment using the Leopold matrix. Gebler et al. [22], for example, used this matrix to assess the impacts on strawberry production. The authors compared the method with another matrix used up to that moment, with gains for the Leopold matrix, with an extended Leopold matrix proposed, containing 17 environmental conditions, 9 of which are associated with the physical environment, 2 with the biotic environment and 6 with the anthropic environment. The matrix's standard criteria being maintained, and in its description, the impacting activities are not explicit, but directly, the forecast of the consequences of the environmental impacts that the activities may cause. The difference is in the addition of a column on the far right, indicating the total sum of the values presented in the matrix. The study points as a disadvantage in the use of the matrix, the impossibility of identifying indirect impacts and the fact of not considering spatial characteristics.

Cavalcante et al. [23] used the Leopold matrix, based on the analyzed perceptions, to quantify the environmental impacts in a cylinder factory with a total of 1.296 interactions. The analysis of this matrix generated several graphs that show important indexes of the identified impacts. This article describes the extended matrix with 16 environmental conditions of the physical environment, 4 of the biotic environment and 7 of the anthropic environment. It presents the impacting activity, an environmental aspect associated with the activity and the impacts that this activity can generate, totaling 43 environmental impacts in 10 impacting activities. The numerical values are placed according to the standard matrix and are considered 3 analysis criteria: Severity, Frequency and Classification. The difference is three

columns placed at the end of the matrix, one with the total sum of each line, another with the sum of the potentially impacting activities and the third with the degree of importance of the impact, obtained from a survey conducted with local residents. It also includes two columns in the middle of the matrix, indicating an impact situation and the final destination. The article does not point out any disadvantages in using the Leopold matrix.

Martins [24] used the Leopold matrix to assess the environmental impacts of the rural remnants located in the hydrographic basin of the Córrego Grotão, Ceilândia (DF). This work uses an extended Leopold matrix, with 8 environmental conditions of the physical environment, 5 of the biotic environment and 9 of the anthropic environment. It presents 4 impacting activities with 16 environmental impacts generated. The values are placed according to the standard matrix and are considered 5 analysis criteria: character, importance, coverage, duration and reversibility. The difference is the inclusion of columns related to ecological relationships of impacts and the values placed in colored cells and with positive and negative signs. Both the signs and the colors indicate whether the impact is beneficial or harmful. As a disadvantage, the work points out the fact that the matrix does not allow evaluating the frequency of interactions or making projections over time, in addition to presenting great subjectivity, without identifying indirect or second order impacts.

Kielinga et al. [25] used the Leopold matrix to assess the environmental impacts on organic food production. The article presents the Leopold matrix extended with 14 environmental conditions, without differentiating the physical, biotic and anthropic means and 16 environmental impacts, without presenting the impacting activities. The values and criteria used are the same as in the standard matrix. The differential of the work is the use of colors to differentiate between positive and negative impacts. The article quote no disadvantages over the matrix.

Souza et al. [26] used the Leopold matrix to assess the environmental impacts of the APP Rancho Tutty Falcão Gurupi (TO). The article presents the reduced Leopold matrix with 5 environmental conditions, 2 from the biotic environment, 2 from the physical environment and 1 from the anthropic environment, being analyzed in 5 environmental impacts. The values and criteria used are the same as in the standard matrix. The differential of the work is the inclusion of a line in the table with the averages of the values presented per column, of the interactions performed. The article quote no disadvantages over the matrix.

Oliveira et al. [27] used Leopold's matrix to carry out an environmental diagnosis of the impacts that occurred at the source of the Córrego Mutuca, in Tocantins. The authors opted for the use of the reduced Leopold matrix, with only 3 environmental conditions, two from the physical environment and 1 from the biotic environment, with 7 environmental impacts being analyzed, not to mention the impacting activities. The values and criteria used are the same as in the standard matrix. The differential of the work is the inclusion of a final line of the matrix, to calculate the average of the values of each column. The article does not point out disadvantages about the matrix.

Sajjadi et al. [28] used the Leopold matrix to analyze the environmental impacts of the landfill in the municipality of Gonabad and other waste management options that could be implemented. Adjustments and modifications were made to the Leopold matrix to better analyze the problem, showing the flexibility that the matrix has to adapt to the most varied types of projects. The results showed that the landfill was the worst among the options available for the locality, presenting the main problems of this option. The article presents the reduced Leopold matrix, with 22 environmental conditions, however, it does not divide them between physical, biotic and anthropic medium. It presents 18 impactful activities. The values and criteria are placed according to the standard matrix. There are no differentials at work. The article states that all means of assessing environmental impacts have disadvantages, but does not directly point out the disadvantages of the Leopold matrix.

Josimovic et al. [15] used the Leopold matrix to analyze the environmental impacts in the construction of wind farms in Serbia, presenting the local population the environmental impacts in a simple and precise way. The article presents four reduced Leopold matrices, one matrix for each of the analyzed criteria. They are: magnitude, significance, probability and duration of the impact. The study contains an analysis of 16 environmental conditions, 6 of which are physical, 5 are biotic and 5 are anthropic. It presents 9 impactful activities, with each matrix addressing only one result, numerical or literal, regarding the analyzed criterion. The difference in the work is the use of letters to indicate the influence of the impact, besides including, in the matrix that uses numbers (magnitude), two columns, one with the sum of the values and the other with the average of values for each environmental condition. It also includes, in this numerical matrix, two lines, one with the sum and one with the average, for each impacting activity. The

work does not point out the disadvantages of the Leopold matrix.

Falk et al. [29] used the Leopold Matrix to assess the environmental impacts of a tobacco production, with the identification of 61 interactions. This analysis made it possible to recognize the existence of negative impacts that could be mitigated and to observe scenarios where specialists could suggest changes to the project. They concluded that the matrix is an adequate tool for identifying the main environmental impacts, with flexibility and efficiency. With the matrix data, Falk et al. [29] also built graphics that helped to visualize environmental impacts. The authors used the reduced Leopold matrix, with 8 environmental conditions, 4 of which were physical and 4 anthropic. It presents 19 impactful activities, distributed among 8 stages of the process. It analyzes 5 criteria: value (positive or negative), order (direct or indirect), space (local, regional or strategic), time (short, medium or long) and dynamics (temporary, cyclical or permanent). The matrix has no numeric values. The differential at work is exactly the way the values appear in the matrix. Instead of putting numerical information, they put 5 letters indicating the classification of each of the criteria, allowing to differentiate positive from negative impacts, for example. The interaction matrix with letters instead of numbers is called by the authors "Leopold modified matrix". Another differential is to place in the matrix, the steps of the process that generate the impacting activities. The article does not point out the disadvantages of the Leopold matrix.

Rodrigues [30] used the Leopold matrix to assess the environmental impacts of the generation of solid waste on the UniFOATangerinal campus. The article presents the extended Leopold matrix, with 5 environmental conditions of the physical environment, 2 of the biotic environment and 4 of the anthropic environment. 11 impacting activities and their respective impacts are described. It analyzes 4 criteria: value (positive or negative), importance (small, medium or large), magnitude (scale of 1 to 3) and duration (short, medium, long). The matrix does not have numerical values, using ranges of values placed in the columns, with the addition of an X in the column corresponding to the interaction of the impacting activity. The differential of the work is the inclusion of a column indicating an impacting activity, whose benefit of the increase was not evaluated by the research. They also added a column describing the impact generated and a line, indicating the total markings for a given column. At the end of the process, another matrix is generated from the quantitative

of markings. The article does not point out any disadvantages in Leopold's matrix.

Guimarães et al. [31] used the Leopold matrix to evaluate the environmental impacts of the processes used in the daily life of a printing industry. In this case, an extended Leopold matrix was elaborated, containing 28 impacting activities and their respective impacts, without separating the analysis by environmental condition affected by the activities, nor is it about the means physical, biotic and anthropic means, analyzing only the impact on the environment as one all. It establishes three criteria: Magnitude (small, medium or large), importance (not significant, moderate or significant) and duration (short, medium or long), with numerical values associated with each of the parameters of the criteria. The work differential is the columns included in the matrix: An indication of the stage to which each impacting activity belongs; another containing the total sum of the values associated with each environmental impact, another containing the total sum of the values associated with each stage of the process and a last column containing the percentage that each stage contributes to the sum of the total values of the entire matrix. The article does not point out any disadvantages in Leopold's matrix.

Landim et al. [32] used the Leopold matrix to evaluate the environmental impacts on the production of bricks from a pottery in the municipality of Caçapava do Sul (RS). The article presents the extended matrix with 20 environmental conditions, 9 of which are from the anthropic environment and the others are classified in the biophysical environment, combining the physical and biotic environmental in a single group. It presents 11 impactful activities with 25 environmental impacts generated. It only looks at the importance criterion. The matrix does not put numbers only colors indicating the importance of the impact (red for very important, yellow for little important and white for non-existent impact). The differential of the work is to have, in the matrix, a "submatrix" indicating the degree to which each impacting activity influences the generation of each of the environmental impacts generated. This gradation can be classified as: very significant, significant, little significant or irrelevant. The article does not point out any disadvantages in Leopold's matrix.

Valdetaro et al. [33] used the Leopold matrix to identify and characterize, quantitatively and qualitatively, the environmental impacts of forest development plantations, in the stages of implementation, maintenance, harvesting and transportation. The article presents the reduced Leopold matrix with 27 environmental conditions, 12 of which are physical, 9 are biotic and 6

are anthropic. It totals 44 impactful activities and analyzes 6 criteria: value (positive or negative), order (direct or indirect), space (local, regional or strategic), time (short term, medium term or long term), dynamics (temporary, cyclical or permanent), plastic (reversible or irreversible). The matrix has no numeric values. The differential in the article is the way the values are placed in the matrix. Instead of putting numbers, they put 6 letters indicating the classification of each of the analyzed criteria. The article brings yet another matrix, with the same parameters, but this time with numerical values, one for each interaction. This value indicates the degree of change in environmental factors, according to the literal matrix, assessed as negligible (1 or -1), low degree (2 or -2), medium degree (3 or -3), high degree (4 or -4), very high grade (5 or -5) or 0 for non-existent impacts, with positive values indicating a positive impact and negative ones otherwise. This second matrix inserts new lines that indicate, for each environmental condition, the number of impacts, the sum of the positive values, the sum of the negative values and the total sum of the positive and negative values. The article does not point out disadvantages of the matrix.

Almeida et al. [14] used the Leopold matrix to assess the environmental impacts of the ethanol production process, even generating graphs to assist in qualitative analysis. The article uses the reduced Leopold matrix with 13 environmental conditions, 4 of which are physical, 1 is biotic and 8 is anthropic. It identifies 14 impactful activities, distributed in 10 stages and analyzes 6 criteria: value (positive or negative), order (direct or indirect), spatial (local, regional or strategic), temporal (short, medium or long term), dynamic (temporary, cyclic or permanent) and plastic (reversible or irreversible). The matrix has no numeric values. The differential at work is in the way the values appear in the matrix. 6 letters are placed indicating the classification of each of the criteria. Interaction matrix with letters is pointed out by the authors as a method derived from the Leopold Matrix. The work also includes a column related to the stages of the process. The article does not point out the disadvantages of the Leopold matrix.

Freitas et al. [34] used the Leopold matrix to quantitatively assess the environmental impacts inherent to the forest harvesting process in eucalyptus plantations. Six matrices were assembled, three for each of the harvesting modules determined by the study, the Chainsaw + GuinchoArrastador and the Chainsaw + Forwarder (term used for large vehicles used to transport wood [34]). There were three evaluators in the process and each set up their matrix. The article uses the reduced

matrix with 20 environmental conditions, being 8 from the physical environment, 9 from the biotic environment and 3 from the anthropic environment and identifies 7 impacting activities with analysis of two criteria: magnitude (with a scale of 0 to 5, being, in order, - no impact - negligible impact - low degree impact - medium degree impact - high degree impact - very high degree impact) and value (positive with the numbering of the positive or negative magnitude, with the negative sign in the magnitude). The numeric values are placed in the matrix. The differential of the work is the inclusion of columns to totalize: for each impacting activity, the total sum of positive impacts, the total sum of negative impacts and the general sum of impacts. The article does not point out the disadvantages of the Leopold matrix.

Souza et al. [35] used the Leopold matrix to assess, qualitatively, the environmental impacts arising from the manufacture of furniture at the Furniture Pole of Ubá (MG). The authors used a reduced Leopold matrix, with 25 environmental conditions, 10 from the physical environment, 7 from the biotic environment and 8 from the anthropic environment, identifying 28 impacting activities, divided into 4 phases, whose analysis was based on 6 criteria. They are: value (positive or negative), order (direct or indirect), space (local, regional or strategic), time (short term, medium term, long term), dynamic (temporary, cyclical, permanent) and plastic (reversible or irreversible). Numeric values are not placed in the matrix. The differential of the work is that, in the matrix, 6 indicative letters are placed, one for each parameter of the criteria, in relation to the impact. In addition, it has a column to indicate the phases of the project to which each of the impacting activities belongs. The article does not point out the disadvantages of the Leopold matrix.

Silva et al. [36] used the Leopold matrix to assess the environmental impacts caused by a plastic industry in its process of manufacturing waterproof clothing. The article presents the reduced Leopold matrix with 12 environmental conditions, being 3 from the physical environment, 1 from the biotic environment and 8 from the anthropic environment. It has 9 environmental impacts. The analyzed values and criteria are the same as in the standard matrix. The differential of the article is the inclusion of two columns, one indicating the average of the values and the other indicating the final index for each environmental impact analyzed. The article points out that the disadvantages of Leopold's matrix do not consider, in its analysis, indirect impacts and temporal and spatial aspects.

Vilhena et al. [37] used the Leopold matrix to evaluate the environmental impacts caused by the alteration of the relief in the construction of the access road to the surroundings of module II of the Amapá State Forest. The article presents the extended matrix, but does not consider environmental conditions, analyzing the impact on the environment as a whole. It presents 2 impacting activities and 8 impacts generated (4 for each activity). The values are placed in the matrix, which analyzes the criteria of the standard matrix (Magnitude and importance), but with parameters. The magnitude has, as a parameter, the extension (1 to 4), the periodicity (1 to 3) and intensity (1 to 3). The importance has, as a parameter, the action (1 to 4), the ignition (1 to 3) and the criticality (1 to 3). The differential of the article is a column that indicates how many points in the environment the impact happened. The authors did not point out any disadvantages of the Leopold matrix.

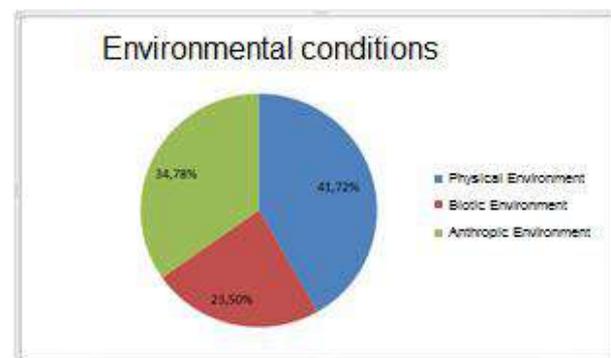
Magalhães et al. [38] analyzed the environmental impacts of paving the MG 307 highway in the municipality of Grão Mogol (MG). The article presents the extended matrix, does not define environmental conditions, but separates the environmental impacts into 11 impacts on the physical environment, 6 impacts from the biotic environment and 7 impacts from the anthropic environment, totaling 24 environmental impacts analyzed, in 3 impacting activities. It uses 6 criteria, being: nature (positive or negative), scope (local or regional), incidence (direct or indirect), temporality (temporary or permanent), reversibility (reversible or irreversible) and valuation (low, medium or high). Numerical values are not placed in the matrix, which was filled with letters referring to the criteria parameters in each interaction. No differential was identified in the matrix used in this study in comparison to the original Leopold matrix, with the exception of using letters instead of numbers, as mentioned. The authors identified a disadvantage in the use of the matrix: not considering time, as it does not take into account immediate, temporary or definitive impacts. It is also noteworthy that the authors created a matrix for each type of environment, thus not assigning values to the transversal impacts, that is, not facilitating the visualization of simultaneous impacts in different environmental conditions.

It is worth highlighting the work of Stamm [10], who makes a complete survey of the methods of assessing environmental impacts, including the Leopold matrix. The case study of the work makes an assessment of environmental impacts in the Jacuí Thermoelectric Power Plant undertaking and brings several matrices, for several suggested scenarios and situations, focusing on the matrix

that presents the sum of the averages and the totals of the environmental factors for the current scenario from the project. The Leopold matrix used contains 30 environmental conditions, 6 from the physical environment, 6 from the biotic environment and 18 from the anthropic environment, analyzing 32 impacting activities, using the criteria and values of the standard matrix, with negative and positive signs. The work has numerous differentials, and it is important to highlight the column that contains the averages and the total sum of the impact values. The work points, as a disadvantage of the Leopold matrix, the difficulty to distinguish the direct impacts from the indirect ones, the fact of not identifying the spatial aspects of the impacts, not considering the dynamics of the analyzed environmental systems, not identifying temporal characteristics and the presence of subjectivity in calculating the magnitude.

The Graph 1 contains a comparison between the percentages of environmental conditions based on their sum in each of the twenty research works described in this article.

Graph 1: Environmental conditions in the physical, biotic and anthropic environments.



Source: [The authors]

Thus, it appears that there is a predominance of the analysis of environmental impacts in physical environments, followed by those in anthropic and biotic environments, respectively, and that the referred percentages are not very different. Some are very specific to a region or a project, others really differ and must be considered and analyzed to compose the final result of this work.

Regarding the physical environment, we have the following analyzes per item:

- Soil: 18 articles analyze contamination, 10 erosion, 8 the increase in nutrients, 6 the topography change, 5 the occupation, 3 of the waste thrown to the soil and 1 deals with compaction.

- Water: 22 articles analyze water contamination, 7 its availability, 5 the increase in consumption, 4 the silting of the rivers, 3 the change in the watercourse. Many items were cited by only 1 article, they are: interference with infiltration, water catchment sites, microclimate, water recharge, flood induction, instability of structures due to contact with water and surface factors.
- Air: 15 articles analyze air contamination, 6 solid particles, 6 gases and vapors and 1 change in wind movement.
- Noise: 8 articles analyze the increase in noise in the environment.
- Others: among other factors analyzed, we have: 3 articles analyze the compromise of natural resources, 2 the temperature, 1 the contribution to recycling, 1 the energy consumed by electronic devices and lamps, 1 general physical factors and 1 the changes in food chain.
- Landscaping: 5 articles analyze landscaping in general and 4 the visual impact of the proposed project.
- Quality of Life: 3 articles analyze the impacts on the quality of life of the people involved and 3 the population growth, which can interfere with the quality of life of local communities.
- Infrastructure: 4 articles analyze the infrastructure generated, 1 the use of land, 1 the quality of open spaces and 1 the change in the way people use and occupy land.
- Cultural: 2 articles analyze changes in the cultural pattern (lifestyle) of local communities, 1 the archaeological and cultural heritage and 1 the cultural heritage of the place.
- Acceptance: some factors of acceptance of the project, by the local communities are analyzed in the articles, being an article for each factor, they are: the acceptance in general, the general evaluation of the project's interference, the olfactory comfort, the thermal comfort, the fixation of man in the countryside and the disturbance of community life.
- Other factors of great importance are also analyzed. 5 articles analyze the quality of the final product, 4 the regional development and 2 the technology generated by the project.

Regarding the biotic environment, we have the following analyzes per item:

- Vegetation: 19 articles analyze the reduction or alteration of plant biodiversity, 5 the use of spaces with native vegetation, 4 the change in the natural cycles of plants and some items were mentioned by only one article, they are: the use of native vegetation, the impact on local agriculture, the impact on an existing crop, the improvement in vegetable hygiene and the natural regeneration under planting.
- Animal: 17 articles analyze the impact on a specific animal group, 12 the decrease in diversity, 3 the occupation of habitats, 2 the change in biological functions, 1 changes in the barriers and corridors used by fauna and 1 the proliferation of disease vectors in animals (insects).

Regarding the anthropic environment, we have the following analyzes per item:

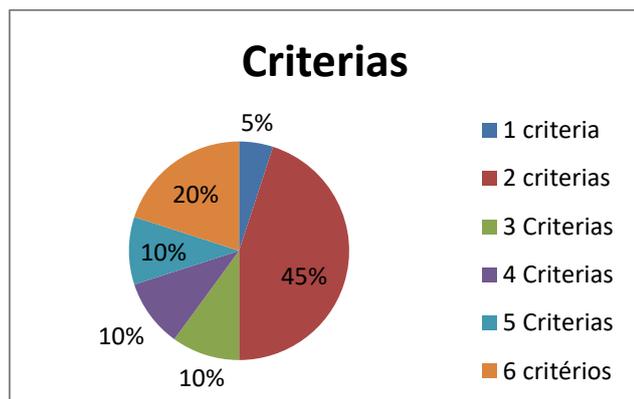
- Economy: 7 articles analyze the generation of jobs, 6 the increase in commercial activity and income, 6 the general impacts on the local economy, 5 the training of the workforce, 1 the increase in the workload and 1 the displacement of people and economic activities.
- Health: 8 articles analyze the impacts on human health and 3 the possible accidents that can occur.

The environmental impacts analyzed and their quantities are closely linked to the project, its consequent impacting activities and what it is intended to evaluate, therefore, there is no generalization of the results regarding the criteria, intensities and means where the impacts affect.

The Graph 2 contains the percentage of articles in relation to the number of criteria used. The majority (45%) strictly follow the Leopold pattern and analyze only two criteria: Magnitude and Importance. On the other hand, the sum of the other articles in which the authors choose a more careful analysis reaches 50%, using between 3 and 6 criteria.

Analyzing the criteria used, it is also verified that some criteria that are present in some works, are not considered in others. Adding the different criteria, it accounted for more than six criteria, all of which are considered relevant for this article.

Graph 2: percentage of articles by number of analyzed criteria



Source: [The authors]

The disadvantages pointed out by the authors, in the use of the Leopold matrix, numbered from 1 to 6, are listed below:

1. Does not identify indirect impacts, nor of second order;
2. Does not consider spatial or temporal characteristics;
3. Do not allows to evaluate the frequency of interactions;
4. Separate the environment in different ways, thus not assigning values to transversal impacts;
5. Not considering the dynamics of the environmental systems analyzed;
6. There is subjectivity in calculating the magnitude.

To mitigate or eliminate these disadvantages, new criteria must be included in the proposal for a new matrix. Based on the detailed survey, the proposal is that 12 criteria be taken into account, among which, the first six are listed by Almeida [14]. Are they:

- Value. Checks whether the impacting activity is beneficial or harmful. It can be qualified as "Positive", when the activity improves the quality of a condition or "Negative", when it causes damage.
- Order. It assesses whether the impact caused is the effect of an impacting activity or a secondary element of that activity. It can be classified as "Direct" when the impact is a simple cause and effect relationship, or "Indirect", when the impact comes from an action derived from the activity.
- Spatial. Indicates the coverage of the impact area. Classified as "Local", when the affected

area is in the immediate vicinity or on the same property where the impacting activity occurred. "Regional", when the impact affects areas that go beyond the immediate area of the area where the activity is carried out or "Strategic", when the project affects the community, and may have national or even international scope.

- Temporal. It deals with the time elapsed between the performance of the impacting activity and the manifestation of the analyzed effects. It can be "Short term", when the effect appears in a short period of time, to be defined according to the type of project. "Medium term", when the manifestation time is average in relation to the type of project or "long term", when the time for the effects to manifest is great in relation to the type of project.
- Dynamics. It concerns the length of time that the effects of the impact will be felt. It can be "Temporary", when the impacts are felt for a certain time. "Cyclic", when the impacts are felt in certain periods of time or times of the year and "Permanent" when the effects of the impact do not stop manifesting in a period of time acceptable to society.
- Plastic. It makes reference if when the impacting activity ends, the impacts end with it. It can be "Reversible", when the environment returns to its previous state, shortly after the end of the execution of the impacting activities or "Irreversible", when the environment does not return to its previous state after a period of time acceptable to society.

Another 5 criteria are defined by econservation (16). Are they:

- Cumulativity. Which analyzes if there is any interaction between the impacts generated by the impacting activities of the project, and may even include other projects. It can be "present", when the impact is influenced and/or influences other impacts or "absent", when the impact does not suffer or generate any effect on other impacts.
- Magnitude. Analyzes the strength of the impact. It can be "strong", when it has a big impact in absolute terms, that is, there is a big change in an environmental condition in quantitative and qualitative terms. "average", when the impact is average in absolute terms or "weak", when the impact is low in absolute terms.

- **Significance.** It deals with the perception of the community in relation to the importance of the impact caused. It can be "big" when there is a great popular sensitivity in the affected communities. "medium", when this sensitivity is medium or "small" if this sensitivity is low or none.
- **Sensitivity.** It concerns the sensitivity of the environment, according to the guidelines of the environmental diagnosis, of the area of influence of the impact. It can be "high" when there is a high sensitivity, "medium", when there is a medium sensitivity of the environment or "low", when the sensitivity is low or does not exist.
- **Conditions.** It makes a direct relationship between the impacting activity and the impact generated by it. It can be "normal", when the impact happens under normal conditions, that is, whenever the impacting activity happens, the impact also happens or "abnormal", when the impact generated only occurs under specific conditions, together with the impacting activity, for example, rainfall, or other climatic factors.

And a last criterion is defined and conceptualized by the authors, based on experience in impact assessment for proposals for action plans, which is described below.

- **Resistance.** It analyzes whether preventive or corrective measures can be taken to neutralize or minimize the effects of the impact. It can be: "irreducible", when the measures will not influence the impact. "mitigable", when the measures can reduce / circumvent the effects of the generated impact or "eliminable", when the measures completely reverse the environmental impact caused by the impacting activity.

3.1. Leopold Turbinated Matrix

Due to the high number of criteria, in the assembly of the new matrix, it was decided to place literal values, that is, non-numeric values, where each of the 12 letters used represents a parameter of the criterion according to the interaction. With this, it is estimated a considerable gain of information, without prejudice in the visualization and treatment of the data. Due to the significant increase in applications and benefits, the matrix is named "Leopold Turbinated Matrix".

The Leopold Turbinated Matrix has a column to indicate the stage of the project and another to indicate the impacting activities.

The "Order" criterion separates the direct from the indirect impacts and the "Cumulativity" criterion, shows whether there is any transversal relationship between the criteria. It is still possible to include an indicative column that contains the first order impact line, for second order impacts, eliminating the disadvantages 1 and 4 pointed out by the authors.

The "Temporal" and "Spatial" criteria, together with the "Dynamics" criterion, give temporal and spatial characteristics to the environmental impact, also showing the frequency of the impact, eliminated the disadvantages 2 and 3 pointed out by the authors.

The disadvantage 5 linked to the dynamics of the systems is solved by the automation of the Leopold Turbinated Matrix, which can be constantly fed back, including with the possibility of forecasting results as an aid to decision making by comparing scenarios.

The Subjectivity (handicap 6) can be mitigated by including the criteria of "Magnitude", "Significance", "Sensitivity", "Plastic" and "Resistance". This information can be obtained, among other strategies, from technical opinions, results from the compilation of questionnaires carried out with the local population, etc.

Many works, based on numbers, had extra columns for information on the average and sum of values. With these results, the authors pointed out the most critical impacts. In Leopold Turbinated Matrix this criticality is measured in the form of colors. Numerical values are associated with the parameters of all criteria, according to their degree of influence on environmental conditions. These values are added together and the cells, whose sum reaches more than 2/3 of the maximum possible value, are painted red, referring to critical impacts. Those, whose sum of values do not reach 1/3 of the maximum possible value, remain in white and the rest are colored in yellow, that is, between 1/3 and 2/3, alluding to the need for attention.

An example of the Leopold Turbinated Matrix (Fig. 3) shows that all the information that was missing in the matrices previously used are present in the Leopold Turbinated Matrix, eliminating the disadvantages pointed out in the studies analyzed in this article.

IV. CONCLUSION

The Leopold matrix, with or without adaptations, ones have been successfully used to analyze environmental impacts or risks with a variety of applications, although with limitations, lack of dynamics and insufficient criteria. The compilation of data gave rise

to Leopold Turbinated Matrix, a framework for the construction of the matrix, which inherited the advantages of the original standard matrix and which manages, without visually loading it, to eliminate or mitigate the disadvantages pointed out by the authors, adding various information of the analyzed criteria, bringing enormous benefits to those involved in any projects that have the potential to cause environmental impacts.

Among the main benefits are the ease of construction, the completeness of information, the identification of indirect impacts, consideration of temporal and spatial characteristics, among others.

For future work, the objective is to develop a system for creating and analyzing the matrix, aiming to provide dynamism in the process of assessing environmental impacts using Leopold Turbinated Matrix.

ETAPAS	ATIVIDADES IMPACTANTES	MEIO FÍSICO					MEIO BIÓTICO	MEIO ANTRÓPICO							
		AR		Recursos Hídricos	Recurso Edáfico	Flora / Fauna		Econômico Local	Infraestrutura	Tecnologia	Qualidade de Vida	Saúde	Desenvolvimento Regional	Paisagem	Qual. Prod. Final
		Partículas Sólidas	Gases e Vapores	Contaminação	Contaminação do Solo	Redução da Diversidade									
Demonstração 01	Atividade de Demonstração	NDLCPFRMAGM	NDLCPFRMAGM	NDLCPFRMAGM	NDLCPFRMAGM	NDLCPFRMAGM		NDLCPFRMAGM	NDLCPFRMAGM	NDLCPFRMAGM	NDLCPFRMAGM	NDLCPFRMAGM	NDLCPFRMAGM	NDLCPFRMAGM	
Demonstração 02	Duía Demonstração	NDLCPFRMAGM	NDLCPFRMAGM	NDLCPFRMAGM	NDLCPFRMAGM	NDLCPFRMAGM		NDLCPFRMAGM	NDLCPFRMAGM	NDLCPFRMAGM	NDLCPFRMAGM	NDLCPFRMAGM	NDLCPFRMAGM	NDLCPFRMAGM	

Fig.3: Leopold Turbinated Matrix

Source: [The authors]

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A study on Sound Wave Fire Extinguisher with cooling rate

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Abstract— Since the Industrial Revolution, human progress has grown quickly and the structures have become skyscrapered and their inside has gotten muddled. Another blaze concealment technique is expected to stifle or forestall fire in different situations because of the difference in putting out fires condition. The Sori Sound Engineering Research Institute (SSERI) applied a special acoustic lens to the Sound Extinguisher to focus the sound energy. The wind speed of the sound beam was estimated, when the converse stage sound was provided to the sound beam, the wind speed was lost and the sound level was decreased by around 20 dB. The characteristics of a sound beam formed by a special acoustic lens and how efficiently a sound beam transmits sound energy through experiments is investigated. Sound Fire Extinguisher utilizes acoustic focal point to limit the constriction of sound vitality and move vitality to the objective point. It can forestall blaze by bringing down surrounding temperature even before fire. In this examination, we tested to check whether the Sound Fire Extinguisher could forestall fire by bringing down the surrounding temperature. Test results show that when the Sound Fire Extinguisher sound part of a similar breeze speed is provided, the warmed silverware is cooled by 10 ~ 20% quicker than the breeze speed of 2m/s. These outcomes show that the Sound Fire Extinguisher can be utilized to forestall blaze, since the sound segment of the Sound Fire Extinguisher itself advances the encompassing warm dissemination to cool rapidly.

Keywords—Acoustic Lens, Cooling, Sound Beam, Sound Component, Sound Energy.

I. INTRODUCTION

As structures become skyscraperized, bigger, and complex, fire can prompt enormous fire. Regardless of these adjustments in the putting out fires condition, the smother technique to date stays being used of substance responses by fire quenching specialists. Another quench technique is expected to conquer the difference in putting out fires condition [1-3]. Sound Fire Extinguisher has been effectively explored as a choice to conquer the changing putting out fires condition. Sound Fire Extinguisher is a fire douser that smothers the fire by utilizing sound qualities. It is relied upon to be another putting out fires innovation that can defeat the constraint of existing fire douser that relies just upon compound response. Sound Fire Extinguisher was first discharged by US Defense Advanced Research Projects Agency (DARPA) and George Mason University students. The Sound Fire Extinguisher, which they discharged just because, is difficult to use in the putting out fires field in light of the fact that the sound vitality spreads as far as possible and doesn't convey enough vitality to the flames. In the Sori

Sound Engineering Research Institute (SSERI), an exceptional acoustic focal point was applied to improve the impediments of the recently discharged Sound Fire Extinguisher to center sound vitality forward. A unique acoustic focal point created by SSERI gathers and reverberates the sound and alters the course of the reverberation sound vitality to the front. The sound shaft that happens during the way toward unifying the sound vitality frames a breeze speed because of the transmission of an enormous sound vitality [4-6]. Sound Fire Extinguisher smothers fire by utilizing a sound part that isn't water or dousing specialist, so it can limit the harm of different gear, for example, data media transmission framework and can be completely utilized as a preventive even before blaze happens. Specifically, by applying an acoustic focal point to the Sound Fire Extinguisher, the sound part is collimated aside to annihilate it, consequently upgrading the extinguishable effectiveness and amplifying different impacts of the sound. In this paper, we looked at the cooling pace of the sharp edge and Sound Fire Extinguisher to check if the sound segment of Sound Fire

Extinguisher can forestall blaze by bringing down surrounding temperature before fire happens.



Fig. 1: Sound Fire Extinguisher from SSERI

II. MATERIALS AND METHODS

2.1 Related Terms and Theory

Combustion refers to a strong oxidation reaction in which a substance generates a rapid chemical reaction with oxygen to generate heat and light. Three factors are essential for this fire to be generated and maintained, which is called the 'third element of combustion'. The three elements of combustion are defined below, and if none of them is present, they are not burned.



Fig. 2: A flame tetrahedron

Fuel (combustible material): It is a substance that can be dehydrated in fire, divided into solid fuel, liquid fuel, and gaseous fuel. In addition, the characteristics of burning depend upon the composition of the fuel.

Heat (ignition source): In order for the substance to ignite, it must have very high heat, and the amount of heat must be moderate. The size of warmth required for combustion is split into ignition point, flash point, and combustion point.

Ignition point: The minimum temperature at which the fuel starts burning. **Flash point:** The temperature at which the fuel burns when the fuel is turned on. **Burning point:** Temperature at which fire continues to empty when fuel is burning.

Oxygen (air): The material must be supplied with oxygen to take heat. Most liquids are difficult to ignite when the oxygen content in the air is reduced to 15% or less.[7]

2.2 Sound Wave

Sound wave could be one of the potential alternatives in putting off flames. The acoustic pressure and air velocity produced from a speaker is that the main theory went to explain how sound waves put off flames. A simulation of acoustic wave was administered to review behavior acoustic wave propagation within the collimator and surrounding environment. Experiments were then conducted to review suitable acoustic wave frequency range to extinguish flame and to analyze the acoustic-flame interaction through observations from camera. Three different sources of flames were used to with three different state of fuel (solid, liquid and gas) [8]. From the primary a part of results, using a standard collimator, it had been found that acoustic wave can only extinguish gas fuel type flames at 91 Hz. Sound wave was found to be one among the alternatives in creating new method in flame extinguishing technology. There are some aspects of the combustion which will be suffering from acoustic wave . The flame Air-Fuel Ratio at the boundaries which is at the lowest lean limit of the combustion of fuels can be affected by sound wave by changing the velocity of its medium (air) [9]. Furthermore, the changes in air velocity changes also will be ready to affect the flow of the fuel round the heat source as well as increasing the convective heat transfer of the heat source and reducing the average temperature of the flame. These effects are similar to flame blow-off characteristics.

2.3 Sound Fire Extinguisher's Sound Component Collimation by Acoustic Lens

Hardware Required

- 300 Watt Speakers
- 250 Watt Amplifier
- Collimator
- Power supply unit
- High speed camera

The principle behind the extinguisher is simple: as they are mechanical pressure waves that cause vibrations in the medium in which they travel, sound waves have the potential to manipulate both burning material and the oxygen that surrounds it. If the sound could be used to

separate the two, the fire would be starved of oxygen and, accordingly, would be snuffed out. The work could potentially be applied to swarm robotics where the device would be attached to a drone to be used in situations such as large forest fires or urban blazes, thereby improving safety for firefighters.

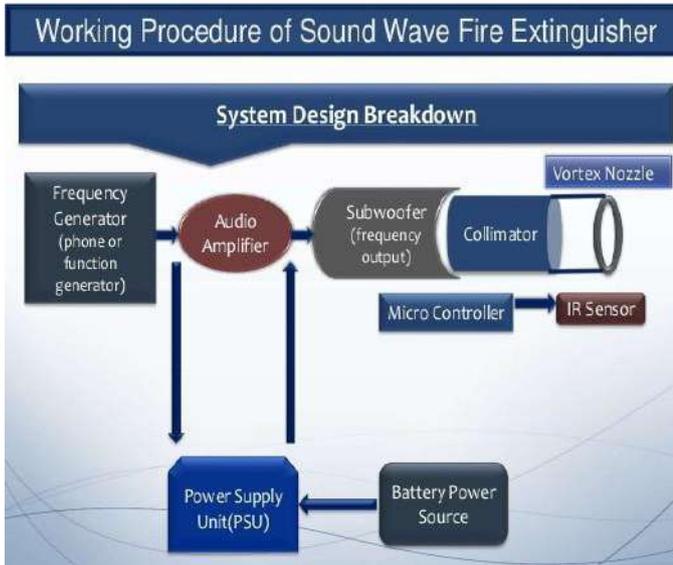


Fig 3: Block diagram

2.3.1 Acoustic Lens

An acoustic lens is a device that focuses or collimates sound energy. Generally, sound emits in equivalent energy in all directions, therefore the propagated form becomes spherical. Therefore, when the propagation distance is doubled, the propagation area is quadrupled and therefore the propagated energy is reduced to 1/4. An acoustic lens is placed on the trail of sound propagation to focus sound energy. Sounds are refracted at the interface of various mediums like other sorts of waves. When an acoustic lens with radius of curvature R is installed ahead of the oscillator, the distance F at which the sound is concentrated are often approximated as shown in equation (1) is a schematic of an acoustic lens

$$R = F \cdot (1 - \frac{1}{n}) \dots \dots \dots (1)$$

R : Radius of curvature of acoustic lens

F : Distance to focus

n : Sound velocity ratio between medium1(acoustic lens) and medium2

The fluid momentum (Navier-Stokes) equation and continuity equations are abridged to get the acoustic wave equation via the following assumptions, i.e. the fluid is compressible (density changes due to pressure variations) and there is no mean flow of the fluid [10].

The acoustic wave equation is given by:

$$\nabla \cdot \left(\frac{1}{\rho} \nabla p \right) - \frac{1}{\rho c^2} \frac{\partial^2 p}{\partial t^2} + \nabla \cdot \left[\frac{4\mu}{3\rho} \nabla \left(\frac{1}{\rho c^2} \frac{\partial p}{\partial t} \right) \right] = - \frac{\partial}{\partial t} \left(\frac{Q}{\rho} \right) + \nabla \cdot \left[\frac{4\mu}{3\rho} \nabla \left(\frac{Q}{\rho} \right) \right] \dots \dots \dots (2)$$

Where:

c= speed of sound ($\sqrt{\frac{k}{\rho}}$) in fluid motion

ρ = mean fluid density

k = bulk modulus of fluid

μ = dynamic viscosity

p = acoustic pressure

Q = mass source in the continuity equation

t = time

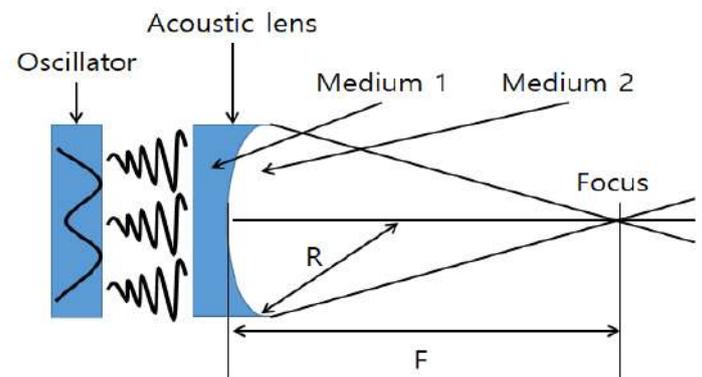


Fig 4 : Schematic of Acoustic Lens

2.3.2. Sound Component :

The point where the sound energy is concentrated through the acoustic lens is named focus. When a sound source is placed at the focus of an acoustic lens, the sound wave passing through the lens becomes a plane wave that transfers energy to a certain area. Sound extinguisher uses a special acoustic lens to collimate a sound component in order that it propagates as a plane wave. Thus, within the case of a Sound extinguisher, the sound passing through the acoustic lens minimizes attenuation and may transfer energy to the flame. Generally, in the sound field, the wind speed is not formed because the low density part and the high part of the medium particle repeatedly change and the wave is transmitted. However, Sound extinguisher uses acoustic lens to collimate the sound energy, therefore the variation of medium particle density becomes very large and wind speed is made. The portable Sound Fire Extinguisher used in the experiment has a wind speed of about 10m/s at a distance of 10cm [11-14].

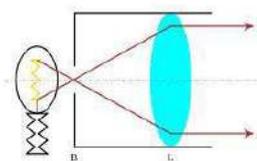


Fig 5: Collimator

III. EXPERIMENTS AND RESULTS

Experiments were administered to live the natural process from 100 °C by heating chrome steel tableware. The experiment was conducted in three cases: first, the natural process was measured with natural cooling; second, when the blade was blowing; and third, when the sound component of the Sound extinguisher was supplied. so as to match the Blade and Sound extinguisher under an equivalent conditions as possible, the space between the blade and therefore the chrome steel tableware is 50 cm, the space between the sound extinguisher and therefore the refore the stainless tableware is 90 cm and the wind speed reaching the stainless tableware is 2 m/s, respectively. The natural process of the stainless steel tableware was recorded with video using thermal imaging camera and android mobile. The temperature was measured at an equivalent position inside the tableware for every experimental cycle. At the time of the experiment, counting on the experimental environment like the ambient temperature, it's going to affect the speed of cooling the stainless tableware. additionally , measurement errors may occur counting on the situation of the thermal imaging camera. Therefore, so as to match the measured results under an equivalent environmental conditions for every experimental cycle, all the experimental tools were fixed in order that the temperature measurement positions might be an equivalent. Also, in each experimental cycle, one experimental cycle was completed within half-hour to simulate the ambient temperature. The comparison between different experimental cycles is meaningless because the experimental environment including the ambient temperature is different and therefore the temperature measurement position is slightly different. However, within the same experimental cycle, it are often said that the result's comparative measurement under an equivalent condition.

Figure 6 shows the comparison of measured temperature changes when natural cooling, wind of the blade are supplied, and sound components of the Sound extinguisher are supplied. In Figure 6, it took 82 seconds to chill the stainless tableware by natural cooling from 100 °C to 50 °C, and it took 33 seconds when the wind of the blade was

supplied. However, when the sound component of Sound extinguisher was supplied, it took 22 seconds and therefore the temperature decreased sooner . However, if the sound component of the Sound extinguisher is supplied to the heated tableware, it'll cool more quickly than when the wind of the blade are supplied. Especially, all of the eight experiments showed that the cooling effect of the Sound Fire Extinguisher's sound components was the simplest . additionally , the results of the entire experiment showed that the sound component of the Sound extinguisher was cooled 10 ~ 20% faster than when the wind of the blade were supplied.

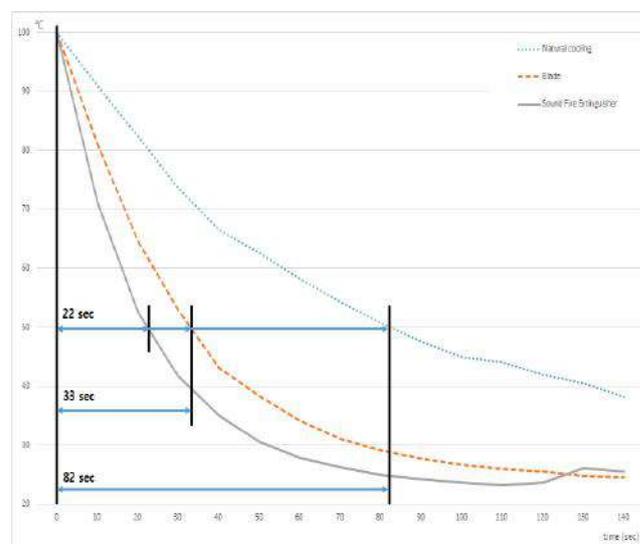


Fig.6: Temperature change measurement result

IV. CONCLUSION

It can not be overcome to overcome the fire fighting environment which was changed only by existing extinguish method which depends only on chemical reaction of fire extinguish agents. Sound Fire Extinguisher, which uses sound characteristics, can be an alternative to overcome a changed fire fighting environment. SSERI has improved its focus on sound energy in flames by applying a special acoustic lens to the existing Sound Fire Extinguisher released by DARPA and George Mason University students. In this study, we tried to verify the cooling effect of Sound extinguisher by comparing with blade. As a result of experiment that the wind speed reaching to the stainless tableware is 2m/s, the Sound Fire Extinguisher's sound component was found to cool the stainless tableware by 10 to 20% faster than when the wind of the blade were supplied. The wind of the blade simply lowers the heat by moving the air around the tableware. On the opposite hand, the sound component of the Sound extinguisher are often said to chill more quickly because it

dramatically changes the air density round the tableware to promote heat diffusion. These results show that Sound Fire Extinguisher has a high cooling effect even at the same wind speed and can be used for conflagration suppression as well as conflagration prevention. In addition, the Sound Energy Extinguisher's special acoustic lens collimates the sound energy, so we can see that the sound energy is well transmitted to the target point. Sound extinguisher are going to be ready to produce various effects counting on the sound component. Future applications of Sound Fire Extinguisher for various purposes have been studied, and we hope to be able to use Sound Fire Extinguisher in various applications in fire fighting field.

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Effect of nickel in the degradation of oil in soils contaminated with petroleum and nickel

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Abstract— *The pollution originated from the petrochemical industry is currently one of the main environmental concerns. Most of this is due to the high volume of toxic hydrocarbons that are produced and transported around the globe. However, this industry is also associated with toxic metals that are minor components of petroleum and used during refining processes. Here we have evaluated the impact of nickel in the biodegradation of crude oil in natural soils. We have assessed bacterial community profiles in these samples using ion torrent 16S rRNA gene sequencing and Real-Time PCR quantification and shotgun metagenome sequencing. We have found that the contamination with oil and nickel reduced the bacterial abundance compared with only soil. There was also an increase in the abundance of Actinobacteria. This group substituted the Proteobacteria as the dominant hydrocarbonoclastic bacteria as shown by metagenome sequencing. The presence of both contaminants also increased the removal of hydrocarbons. Thus, this indicates that the shift between Proteobacteria and Actinobacteria was beneficial to the removal of the organic pollutant.*

Keywords— *Metagenome, metal contamination, hydrocarbon remediation, Actinobacteria.*

I. INTRODUCTION

Petroleum is one of the biggest source of environmental contamination with organic and inorganic pollutants. Besides the organic compounds, elements such as vanadium, arsenic and nickel, are found between oil constituents (Hamme, Singh, & Ward, 2003). Thus, the Petrochemical Industry is considered not only a major source of organic pollutants but also metals (Nadal, Schuhmacher, & Domingo, 2007). These waste generated by the oil industry not only offers great risks to the environment but also represent a great risk to public health (Knox & Gilman, 1997). Data provided by the United States Environmental Protection Agency (USEPA, 1996, 2004) has shown an increase in metal contamination

associated with organic compounds of nearly 300% between 1994 and 2003. Besides the environmental and health hazards, the toxic and inhibitory effects of heavy metals on microbial growth require attention (Vivas, Biro, Nemeth, Barea, & Azcon, 2006). These metal ions, depending on the nature, concentration and availability will interfere with essential activities of micro-organisms in the soil and in the degradation process of organic compounds (Amor, Kennes, & Veiga, 2001).

Hydrocarbons and heavy metals are naturally found in soils in low concentrations as constituents of organic matter and minerals (Atlas, 1991). Therefore, the presence of organisms capable of metabolizing these components is widespread (Atlas, 1991). So, the exposure to

hydrocarbons, either by accidental spillage of oil, or by natural phenomena, is important for determining the time of the hydrocarbon removal process on the environment (R. G. Taketani, Franco, Rosado, van Elsas, & Elsas, 2010). The contact with hydrocarbons results in an increase in the oxidizing potential of the community of hydrocarbonoclastic microorganisms (Atlas, 1991; R. G. Taketani et al., 2010). There are three inter-related mechanisms which lead to adaptation phenomenon are: (a) induction of specific enzymes; (B) genetic changes that results in new metabolic pathways; (C) selective enrichment of microorganisms. With respect to selective enrichment, the number of different microbial populations capable of using hydrocarbons in an environment, as well as its proportion in the community increases with exposure to oil and oil products, generally, reflecting the degree of contamination (Korda, Santas, Tenente, & Santas, 1997).

Heavy metals and polycyclic aromatic hydrocarbons (PAH) have an adverse effect on the microbial community of different soils using dehydrogenase activity in relation to varying quantities of organic matter found in each soil type (Irha, Slet, & Petersell, 2003). Other studies also found a negative effect of metals in the hydrocarbon biodegradation in soil (AL-Saleh & Obuekwe, 2005; J J Kelly & Tate, 1998; John J Kelly, Ha, & Tate, 1999; Shen, Lu, Zhou, & Hong, 2005; N. F. Taketani et al., 2015).

In order to explain the inhibition of biodegradation of monoaromatic hydrocarbons by the presence of heavy metals, Amor et al., (2001) tested many heavy metals (zinc, nickel and cadmium) for inhibiting the degradation of toluene in a culture medium and obtained the result that nickel is the metal with the greater negative influence, followed by cadmium and finally zinc. This metal also promotes a delay in the biodegradation of crude oil, but changes on microbial populations suggest an adaptation to the presence of the metal in the environment (N. F. Taketani et al., 2015).

The change in populations of microorganisms by pollution or natural factors in the soil can generate changes in different levels. The degree of influence on microbial populations of the soil depends on several factors, including the ability of microorganisms to survive the disturbance and perform functions that restore ecological balance, for such a genetic and metabolic framework is necessary. When there is more than one change to the environment, the chances of survival and execution of metabolic functions by microbial populations are even more at risk (Griffiths & Philippot, 2013). However, if different taxonomic groups of microorganisms have the same metabolic potential, this metabolic redundancy

became a very important tool for environmental resilience to the different changes (Taketani et al. 2014).

The application of metagenomic tools to correlate community structure and function allows a deeper look into the functional redundancy and the response to different environmental conditions. Therefore, this study aims to unveil the relationship between microbial community structure and function and influence of nickel on the biodegradation of crude oil in the bioremediation.

II. MATERIALS AND METHODS

Environmental samples and microcosm design

In order to mimic the conditions found in an accidental spill of oil on soil samples we have used soil samples from an area of *on shore* oil extraction in the city of Carmópolis (state of Sergipe) in the northeast of Brazil (10° 38' 44.13"S, 36° 57' 41.81"W) and used crude oil obtained in the area (paraffin oil °API 24.1—average organic composition: 55.00 % saturated, 20.46 % aromatics, 24.72 % asphaltenic compounds) (N. F. Taketani et al., 2015). We have chosen to use nickel as our model heavy metal because it is common constituent of oil and is also widely used during the process of refining as a catalyst. Hence, 5.0% of crude oil and 260mg/kg of nickel chlorite were used in the microcosms. Four different treatments were applied, a control soil without oil and nickel, one containing only oil, only nickel and one containing both oil and nickel. Sterile controls containing the oil and oil+nickel were added to account for the volatilization of hydrocarbons which were not significant and are not shown. The microcosms were destructive and were set in duplicated 250ml autoclaved Erlenmeyer flasks closed with sterile hydrophobic cotton plugs. Each contained 50g of soil that was sieved in a 5mm mesh prior to utilization. Soil humidity was kept constant at 70% with addition of sterile distilled water and carbon, nitrogen and phosphorus ration (C:N:P) of the soil was 100:10:1 in the microcosms containing oil. Flasks were randomly distributed and a bench top and clustered and rearranged. Microcosms were kept at room temperature for 42 days after which samples were taken and kept at -20°C.

Analysis of total petroleum hydrocarbons from soil

The total concentration of hydrocarbons in soil was quantified using infrared spectrometry (Infracal®, model HART-T, Wilks Enterprise, Inc, Connecticut, USA) using hexane as the extractor as described previously (N. F. Taketani et al., 2015). A standard curve was constructed with a serial dilution of the same oil used in the microcosm and was measured each time the analysis was performed.

Controls using sterile soil were used to evaluate the loss of hydrocarbons due to chemical and physical processes which was below the limits of detection of the technique and was considered negligible.

Polymerase chain reaction of bacterial 16S rRNA gene.

DNA was extracted using Fast DNA spin kit for soil (MP Bio) following the manufactures' protocol. DNA quantity and quality was accessed on a NanoDrop 1000 spectrometer. The 16S rRNA gene present in the samples obtained from these microcosms was quantified by Real-time PCR as described previously (R. G. Taketani, dos Santos, van Elsas, Rosado, & Elsas, 2009) using primers P1 e P3 (Muyzer, Dewaal, & Uitterlinden, 1993). The qPCR standard curve had an R^2 of 0.99–0.96 and an efficiency of 95–105 %.

The amplification of 16S rRNA gene V6 region was amplified using the fusion primers using primer sequences described previously (Sogin et al., 2006) with the addition of barcodes and PCR conditions and purification were performed according to the protocol described by Taketani et al. (2016).

Ion torrent sequencing, sequence processing and analysis

The 16S rRNA amplicon obtained as described above was used as libraries for barcoded amplicon sequencing using ion torrent technology as described in Taketani et al. (2016). Sequences obtained were processed according to a modified version of the 454 tutorial from the Quantitative Insights Into Microbial Ecology toolkit (QIIME) (Caporaso et al., 2010) as described in Taketani et al. (2016).

Total DNA extracted from soil was sequenced using a Ion Torrent Personal Genome Machine (ThermoFisher Scientific) using a 316 chip using according to the manufactures' protocol as described previously (R. G. Taketani, Kavamura, Mendes, & Melo, 2014). The obtained sequences were uploaded to MG-RAST (Meyer et al., 2008) for quality control and annotation. Sequences were taxonomically assigned using Best Hit Classification against the M5NR database using an E-value cut-off of 10^{-5} , minimum identity of 60% and a minimum alignment of 50 bp and the functional annotation was performed by Hierarchical Classification against the Subsystems database using an E-value cut-off of 10^{-5} , minimum identity of 60% and a minimum alignment of 15 amino acids (Delmont et al., 2011). All sequences are deposited in the MG-RAST database under project number mgp857 and mgp89055.

Data Analysis

Plots were produced in MG-RAST, Excel, RStudio, using ggplot2 (Wickham, 2009) and cowplot (Wilkes, 2017) packages. 16S rRNA sequencing biom file obtained in QIIME was analyzed in phyloseq (McMurdie & Holmes, 2013), principal coordinate analysis (PCoA) and adonis was performed using the vegan package (Oksanen, 2010). Differences were tested using analysis of variance (ANOVA) followed by Tukey HSD *posthoc* test in RStudio.

III. RESULTS

Quantification of total petroleum hydrocarbons (TPH)

The quantification of TPHs present in the samples that received only oil was 42.14 ± 1.71 mg/kg which corresponds to a removal of 30.53% of the total hydrocarbons added to these samples. The treatment that also received nickel (Oil + Nickel) had concentration of 28.05 ± 2.85 mg/kg corresponding to 53.76% of removal. These indicated that the addition of nickel improved the removal of oil in these microcosms. The loss hydrocarbons due to volatilization was not statistically significant ($p > 0.05$) and is not shown.

Quantification of bacterial 16S rRNA genes

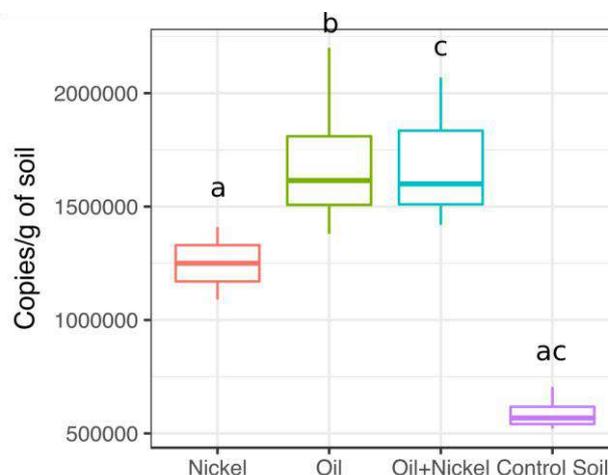


Fig. 1: Real-time PCR quantification of the bacterial 16S rRNA gene of the samples contaminated with petroleum and nickel. Letters above the indicates significant differences in Tukey's HSD *posthoc* test.

The Real-time PCR quantification of bacterial 16S rRNA genes indicated that the addition of oil increased the number of gene copies despite the co-contamination with nickel (figure 1). However, although in smaller proportion, the addition of nickel alone also increased the number of gene copies if compared to the control soil. This indicates

that the contamination with oil and hydrocarbons led to an increase in the bacterial numbers.

16S rRNA gene tags taxonomic affiliation

The taxonomic classification of 16S rRNA gene libraries obtained from the treatments indicated a distinction between them (figure 2). All samples that received the

petroleum addition had a clear increase in the abundance of Actinobacteria (figure 2A) while decreasing Acidobacteria and Proteobacteria. Samples containing nickel and oil had an even larger growth in Actinobacteria. The addition of nickel stimulated the abundance of Bacteroidetes and Firmicutes with a decline in the relative abundance of Actinobacteria.

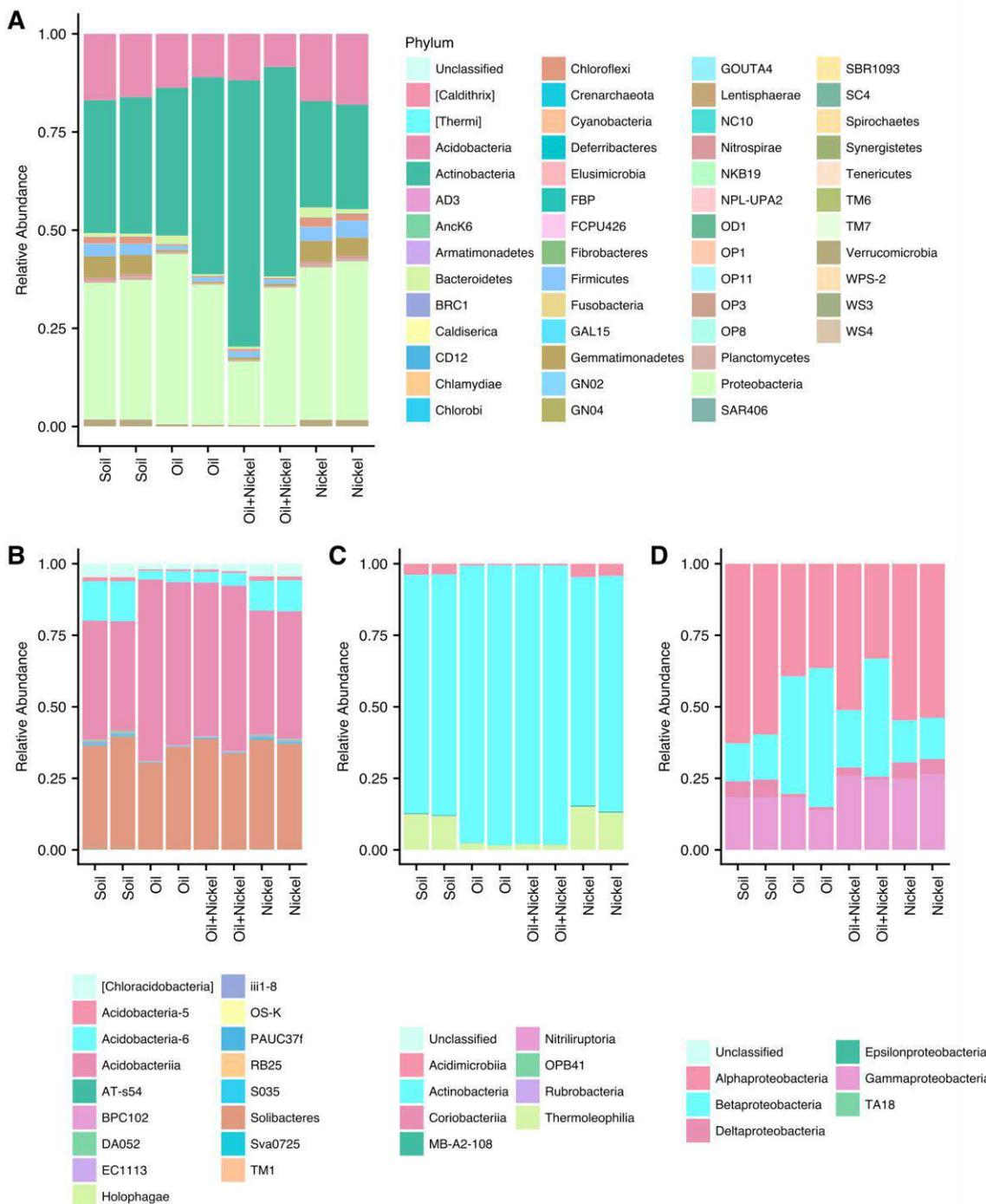


Fig.2: Bar chart of the classification of 16S rRNA gene sequences from soils. Classification was obtained in Qiime 1.9 using the Greengenes database. A. Phylum level classification. B – Class level classification of the Acidobacteria. C - Class level classification of the Actinobacteria. D. Class level classification of the Proteobacteria.

Within the Acidobacteria phylum the class Acidobacteria was positively influenced by the addition of oil while Solibacteres and Acidobacteria-6 (group 6) were negatively affected. The addition of nickel led only to minor changes in the class affiliation of the sequences due to a decrease in the relative abundance of group 6 with an increase in Acidobacteria.

Furthermore, the class Actinobacteria (phylum Actinobacteria) was the dominant class in all samples (figure 2A), however, the addition of oil has led to a reduction in the incidence of Thermoleophilia that was substituted by Actinobacteria.

The changes observed within the Proteobacteria were more pronounced between samples that received only oil and oil and nickel (figure 2B). The addition of oil and nickel led to a great increase in Gammaproteobacteria and a smaller one in Betaproteobacteria. The addition of only oil had a positive effect in the relative abundance of Betaproteobacteria in spite of Alphaproteobacteria.

Additionally, the expansion in Gammaproteobacteria was also observed in samples that received only nickel.

Alpha diversity patterns

The abundance distribution of OTUs found in each sample was used to evaluate the effects of each treatment in the diversity patterns by means of diversity indices (figure 3). The number of OTUs observed in the treatments containing nickel was similar to the control soil while both treatments that received the addition of oil had a lower number of OTUs. However, these differences were not significant according to ANOVA test. The Shannon's H' index showed the same pattern of lower diversity in the samples that received oil. This effect was confirmed by ANOVA with *posthoc* test TukeyHSD. This disagreement between both indexes indicate that besides lowering the amount of OTUs observed, the addition of oil must have changed the evenness of this OTUs leading to a higher dominance of the most frequent OTUs.

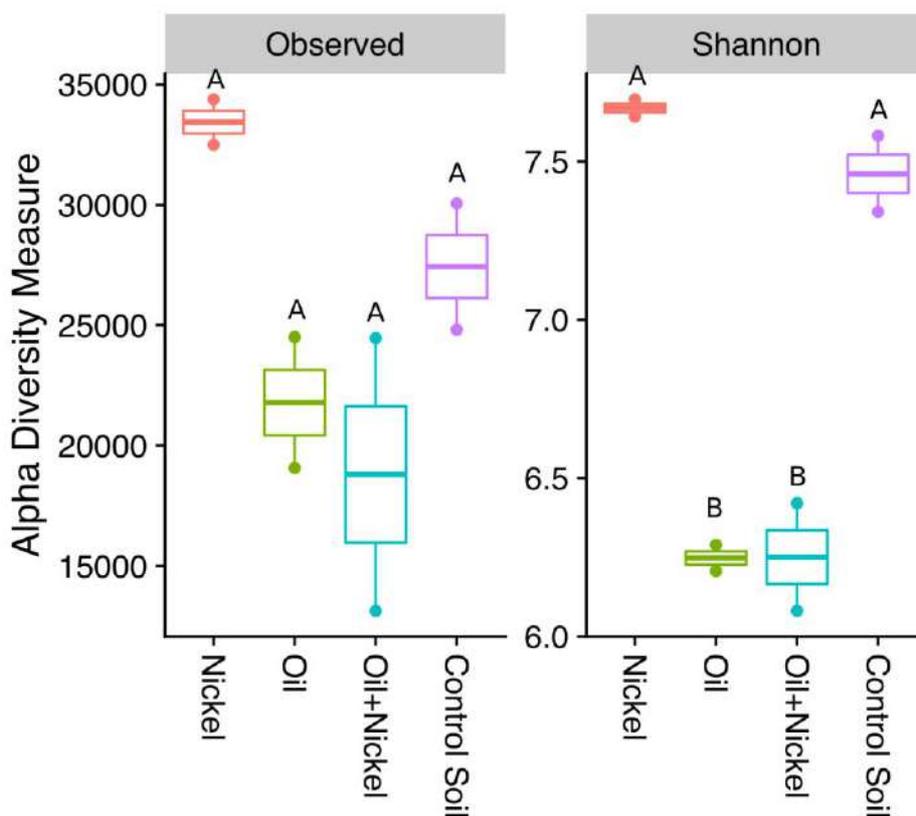


Fig.3: Alphadiversity patterns of 16S rRNA gene sequences from soils

Beta diversity patterns

To investigate the relationship between these samples and the most abundant OTUs we have applied a principal coordinate analysis (PCoA) based on a Bray-Curtis similarity index (figure 4). As observed on the previous

analysis the PCoA indicated a clear clustering of samples that did not receive oil (figure 4A). On the other hand, although the samples that had oil added did not present a tight clustering on a two-dimensional scale, they were tightly clustered on the first dimension (figure 4A, Axis.1)

which represents 71.5% of the variance observed on this samples.

Plotting the OTUs from the five most abundant orders on top of the samples (figure 4B) indicate that some of OTUs were more correlated with samples that contained oil than the ones that did not. Most of the OTUs belonging to the Burkholderiales order were highly correlated with oil samples. On the other hand, the Sphingomonadales and Xantomonadales were better correlated with samples

without oil. Nevertheless, we could not observe any taxonomy-based trend for the Acidobacteria and Actinobacteria.

The Adonis test indicated that the different treatments were significantly different ($p=0.012$, table S1) and that the addition of oil also had a significant effect over the bacterial community ($p=0.04$). The addition of nickel however did not have a significant effect over the bacterial community ($p=0.535$).

Table 1: Quantification of total petroleum hydrocarbons (TPHs) by infrared spectrometry

Treatment	Initial concentration (mg/kg)*	Final Concentration (mg/kg)	Removal (%)
Oil	60.66±1.42	42.14±1.71	30.53
Oil+Nickel	60.66±1.42	28.05±2.85	53.76

* - Initial concentration was considered the same for both treatments since it was evaluated before the addition of Nickel

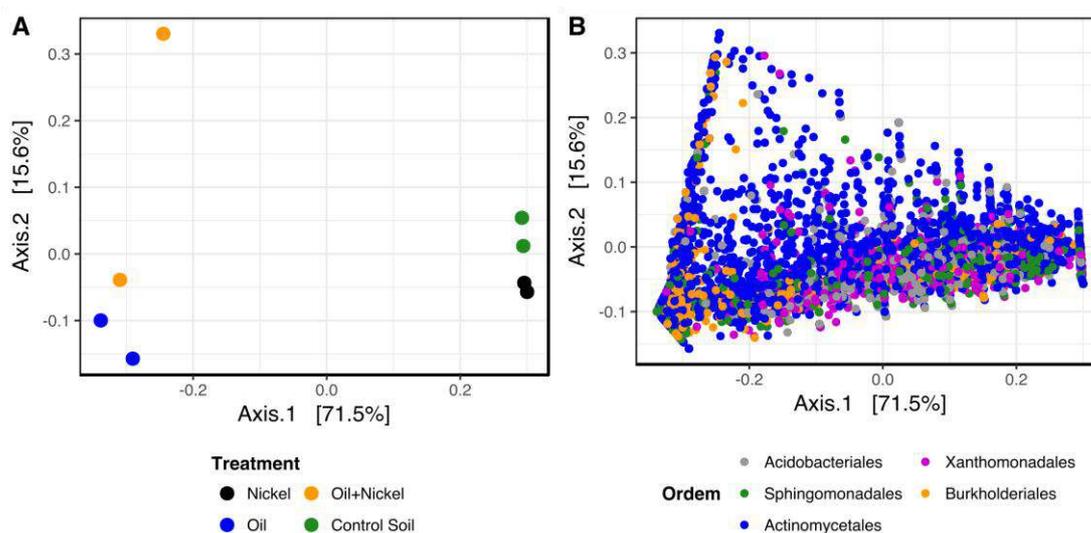


Fig.4: Principal Coordinates Analysis of 16S rRNA gene sequences from soils. A – Dots represent each sample. B – Dots represent OTUs from the five most abundant Orders.

Metagenomic profile of co-contaminated samples

The metagenomic profile of the communities was evaluated using the MG-RAST pipeline (figure S1 and S2). The taxonomic composition differed from the observed for the 16S rRNA gene, the shotgun libraries had a larger proportion of sequences derived from Proteobacteria and Actinobacteria than the 16S libraries (figure S1). The functional assignment indicated a predominance of genes related to the metabolism of Amino acids, Carbohydrates and Protein (figure S2). Comparing the taxonomic and functional affiliation of the genes indicates that there is

more functional congruence between metagenomes than taxonomic.

Functions related to the metabolism of hydrocarbons were more frequent in the metagenomes that received oil than the control soil (figure 5). Additionally, the soil co-contaminated with nickel had the highest incidence of genes related to these metabolisms. Besides the highest frequency of genes related to this metabolism, the taxonomic affiliation of these were related to sequences from Actinobacteria. Conversely, the sequences obtained from the sample contaminated only with oil were affiliated to the Proteobacteria. The only exceptions were of genes

related to benzoate degradation and salicylate and gentisate metabolism.

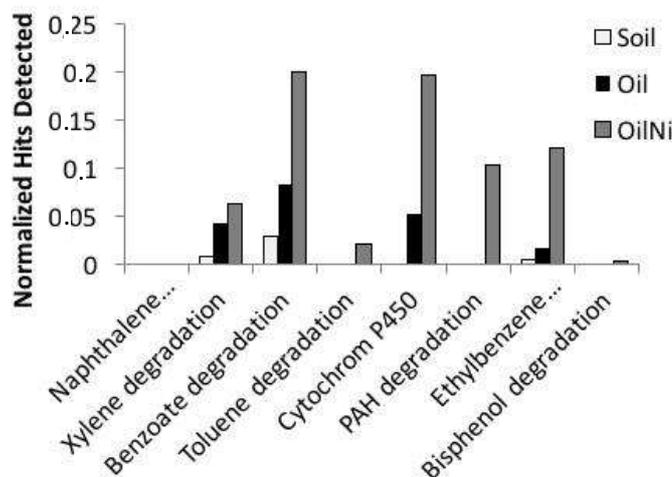


Fig.5: Number of metagenomic sequences that match genes involved in the degradation of hydrocarbons.



Fig.6: Taxonomic classification of metagenomic sequences involved in the degradation of hydrocarbons.

IV. DISCUSSION

The contamination of the environment with a heavy metal such as nickel is considered harmful both to the environment and health (USEPA, 2004). The presence of these elements together with hydrocarbons has been pointed as a disturbing factor which slow down the degradation of the organic material (Dermont, Bergeron, Mercier, & Richer-Lafèche, 2008; Muniz, 2004; Pérez-de-Mora, Engel, & Schloter, 2011; Santos-Echeandía, Prego, & Cobelo-García, 2008; Tang et al., 2010). This disturbance however as does not impede the degradation of this hydrocarbons, it slows down the initial process of degradation (N. F. Taketani et al., 2015). Yet, the participation of different populations in this process probably led to different outcomes.

The addition of nickel in high concentrations (>1.0g/kg) has been shown to promote decrease of the overall microbial richness and diversity (Li, Hu, Ma, & Wang, 2015; Markowicz, Cycoń, & Piotrowska-Seget, 2016; Remenár et al., 2017). However, our experiments with a smaller dose showed that Actinobacteria might be resistant to the presence of this metal (Li et al., 2015). Since the soil matrix is capable of binding the nickel ions and thus make it less available to the soil microorganisms, microbial communities from different soils respond differently to this stress (Li et al., 2015; N. F. Taketani et al., 2015). The soils used in this study presents high cation exchange capacity (CEC) and thus can bind high quantities of nickel (Ding, Hu, Wan, Wang, & Gao, 2016). The high CEC and moderately high concentration of nickel could lower the intensity of the disturbance caused by the toxicity of this metal if compared to the literature (Li et al., 2015; Markowicz et al., 2016; Remenár et al., 2017).

The incidence of Acidobacteria and Proteobacteria were affected by the addition of hydrocarbons, however the addition of nickel has led to different outcomes between these phyla. Proteobacteria are common players in hydrocarbon degradation and *Pseudomonas* (Oyetibo, Ilori, Obayori, & Amund, 2013) are commonly employed in bioremediation procedures (Evans et al., 2004). However, Actinobacteria are also important hydrocarbon degraders (Acosta-González, Martirani-von Abercron, Rosselló-Móra, Wittich, & Marqués, 2015; De Pasquale, Palazzolo, Lo Piccolo, & Quatrini, 2012; Ke, Luo, Wang, Luan, & Tam, 2010; Vila & Grifoll, 2009; Zeinali, Vossoughi, & Ardestani, 2007) and *Rhodococcus* are also important hydrocarbon degraders in soils (Acosta-González et al., 2015; Auffret, Yergeau, Labbé, Fayolle-Guichard, & Greer, 2014; Song et al., 2011). However, certain actinobacterial groups have been shown to be selected by high doses of nickel (Remenár et al., 2014). Hence, the

shift between these phyla are due to the addition of this metal is likely the cause of the higher degradation observed in soils with nickel.

The shift toward the increased abundance of Actinobacteria in soils co-contaminated was also confirmed by the metagenomic data. These results shown that not only these organisms were present in the samples but reads assigned as related to the metabolism of hydrocarbons were also from actinobacterial origin. This shows that these OTUs are not only present because they can withstand both contaminants but they also have the genes to degrade components of oil.

Nonetheless, our data does not indicate that the presence of this metal stimulates the oils degradation. Given the toxic nature of this elements at the concentration used in this study (260mg/kg) (USEPA, 2004) this hypothesis is very unlikely. However, the presence of this metal might eliminate some OTUs (i.e. Proteobacteria) that are sensitive to it leaving some niches open to organisms that are resistant to it (i.e. Actinobacteria) that would in the absence of nickel lose the competition for hydrocarbons. This second hypothesis is in line with the intermediate disturbance hypothesis (Wilkinson, 1999) which predicts that after a disturbance many species may migrate to the cleared niches which maximizes the diversity and potentially also increase activity.

V. CONCLUSION

In conclusion, our data has shown that the contamination of soils with hydrocarbons and nickel leads to an increased abundance of Actinobacteria and hydrocarbonoclastic (HC) genes from organisms from this phylum. Concurrently, there is also an increase in the removal of hydrocarbons in the presence of metals thus indication that this hydrocarbonoclastic Actinobacteria are responsible for the higher rate of degradation. Hence, we propose that the presence of nickel to this soil wiped some HC Proteobacteria that are better competitors in normal soil conditions leaving this niches open to colonization by other taxa in this case Actinobacteria. These HC newcomers in the absence of other competitors outperform the original populations in the removal of oil.

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Conflict of interest The authors declare that they have no conflict of interest

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Number of Hospital Beds: Population Estimate, Installed Capacity and Performed in two Mesoregions of Rio De Janeiro, Brazil, 2015

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Abstract —Introduction: Planning health resources in a continental country like Brazil demands adapting the structures to different regions and their needs. Objective: To compare the installed hospital structure (number of existing beds) with the health care parameters proposed by the Brazilian national health system (estimated beds) and the beds per activity performed in two mesoregions of the state of Rio de Janeiro in 2015. Methods: Cross-sectional analysis with data obtained from the information systems of the Brazilian national health system. Results: An excess of hospital beds was identified (208.9% of the ideal average, per activity performed), low occupancy rates (24.2% below the ideal average) and irregular distribution between the mesoregions. Conclusions: The unequal division of resources unrelated to population demands results in higher health care costs and undermines the universality of access and integrality of the care.

Keywords —Health Management, Hospital Bed Capacity, Public Administration, Public Health.

I. INTRODUCTION

The Brazilian public national health system (Unified Health System - SUS) is structured according to its doctrinal (universalization, integrality of actions and equity) and operational principles (regionalization, hierarchy, political-administrative decentralization, social control, among others), present in the Brazilian Federal Constitution of 1988 and in the Organic Health Law (Law No. 8080/90).

A little more than 25 years after the promulgation of the SUS political-legal framework, universal access to health services still has limited coverage. In the sphere of primary care, it went from 64.3% in December 2008 to 74.8% in December 2019¹. With regard to secondary care, the situation is more dramatic, especially due to an increase positively generated by the expansion of the coverage of primary care. The referral system of primary care to secondary care services or medium complexity is directly linked to the process of regionalization and hierarchy of health services and their formation in care networks. In tertiary care or high complexity, there is involvement of

high technological density and cost, being organized in networks (eg: dialysis procedures, chemotherapy, radiotherapy and hemotherapy).

In a health system, it is essential to plan the investment of resources, aiming at a greater reach of the population and the rationalization of medical assistance so that there is no waste with underutilization. However, many factors are involved in understanding the real care needs. The use of hospital beds, for example, has several variables involved: availability of beds, type of population with their age and sex distribution, payment system for hospital services, geographical distribution of beds, capacity of auxiliary services of the hospital (ambulatories, tests), number of doctors, health habits, social norms, number of private hospitals in the region, types of housing and morbidity², which makes their prediction difficult to perform.

To have an idea of the volume of hospitalization, it is necessary to analyze the number of hospitalizations and their duration, in addition to the geographic and functional relationships between population and resources³. Thus, it is essential to carry out various regional studies on other

health sectors, such as primary care, whose absence can determine the progression from simple diseases to greater complexity, with an indication for hospitalization⁴.

The universalization of health proposed by the Unified Health System is tenuous in regarding the rationalization of resources and equity of services offered in different Brazilian regions⁵. In the case of hospital admissions, there is a concentration in affiliated units, in which public spending is carried out indirectly and linked to the limitation of the local structure and costs of each type of procedure⁶. And, thus, causing unequal distribution of resources and sometimes unrelated to population needs.

In Brazil, there is a growing demand for health resources, requiring sustainable management, which seeks to optimize resources with real needs. The difficulty in analyzing the use of resources in which price determination is complex, as in health, makes the assessment of the real primordially of beds even more complicated⁷. Furthermore, idleness must be taken into account, a situation that allows adjustments for when unforeseen events occur that cause excess demand⁸.

It should be noted that access to health is an abstruse concept, which depends on the context, time, region and population, often ending up being used inappropriately⁹. The certainty of the sufficiency of beds can vary, as well as their benefit to the population, costs and quality, depending on multiple social sectors^{10,11,12}. And furthermore, the population's perception may differ from the reality, in some situations, about the real lack of hospital beds.

The existence of criteria and parameters for the production of services dates back to 1982, prior to the institutionalization of SUS, In 2015 the "Criteria and Parameters for the Planning and Programming of Health Actions and Services within the scope of the Unified Health System - SUS Parameters" were approved¹³. Three assumptions supported these parameters: the reduction of inequalities in access to health services, the reorientation to the needs of the population and regionalization.

In this context, this article aims to compare the application of SUS assistance parameters (estimated and necessary beds for the production of services performed) to the health service assistance network existing in the mesoregions of "BaixadasLitorânea" and "Norte Fluminense", in the state of Rio de Janeiro (RJ), Brazil, 2015.

II. METHODS

A cross-sectional study was conducted to compare the installed hospital structure (number of existing beds)

with the health care parameters proposed by the Brazilian national health system (estimated beds) and the beds per activity performed in two mesoregions of the state of Rio de Janeiro in 2015.

Data regarding hospital beds were obtained from the National Registry of Health Facilities (CNES). Information about the number of live births, resident population, hospital morbidity, hospital procedures and average length of stay in a hospital internment in SUS facilities were obtained from the SUS databases, especially the Hospital Information System (SIH/SUS) and the Live Birth Information System (SINASC). All data above was gathered from the month of July 2015, except for population by age group (pediatric, adult and elderly) and number of live births, which were extrapolated from 2010 to 2015 by the population growth coefficient of the municipalities in the period, due to the unavailability of this information for the year 2015.

Hospital beds were divided for analysis in the following areas: pediatric clinic, adult and elderly clinic; pediatric surgery, adult and elderly surgery; obstetrics and neonatology. The number of existing beds was then compared to the number of beds needed. The latter was calculated based on two different criteria, giving rise to different estimates:

a) By demographic criteria: calculated according to the care parameters contained in Ordinance No. 1,631 / 2015, using the following formula: No. beds by specialty = [Reference population x Hospitalization rate x Average length of stay] / 365 x occupancy rate.

As to the reference population of each type of hospital bed, were used demographic data from 2015. Regarding the rate of hospitalization and average length of stay per hospitalization, were used the minimum and maximum values recommended for each type of bed. As to the ideal occupancy rate, the range of 72% to 82% was chosen, respecting that recommended by the assistance parameters¹³.

b) Beds according to activity performed: this estimate is based on actual bed occupancy in 2015. It was calculated using the following formula: No. of beds by specialty = [Number of hospitalizations in 2015 x average of actual stay in 2015] / 365.

This estimate represents the minimum number of hospital beds that would meet the need of all activities carried out in 2015, that is, with an occupancy rate of 100%. This second criterion has the advantage of adapting to the peculiarities of each municipality because it takes into account the real activity of health services and the

disadvantage of showing a lower demand than the real one, if it the latter is not being fully met.

Were also analyzed separately each establishment that had beds registered in the National Registry of Health Establishments (CNES) to outline the hospitals' size in the mesoregions. Health establishments were classified into six types: general hospital, specialized hospital, isolated day hospital, general emergency room, specialized emergency room and isolated normal birth center. These data were exclusively based on the date of the last local update of each establishment in the national registry at the time of the survey (April 2017). In accordance with the Ministry of Health's definitions, a small hospital was considered to be one with up to 50 beds, average between 50 and 150 beds, large between 150 and 500 beds and with extra capacity the hospital above 500 beds.

Municipal Human Development Index (MHDI) data were obtained from the most recent report (2013) by the Brazilian Institute of Geography and Statistics (IBGE), to estimate the average quality of life of the locale. All information was calculated separately by municipality and later grouped into micro and mesoregions.

For the tabulation and analysis of the data were used the TabNetWin 32 3.0 software, later exported to an electronic spreadsheet. Comparisons were also made between the micro and mesoregions in search of significant discrepancies that could affect the overall assessment of results.

Finally, this article is a version of the conclusion paper presented to the discipline of Health Administration and Planning, from the sixth semester of the undergraduate medical course at the Federal University of Rio Grande do Sul (UFRGS).

III. RESULTS

The two mesoregions assessed are located in the north of the state of Rio de Janeiro (RJ) and are divided into two microregions each (Table 1). Together, they comprise 19 municipalities with an estimated total population for 2015 of 1,694,852 inhabitants (10.2% of the state total). The MHDI varied between 0.639 and 0.773, with an average of 0.711, a value considered to be high by the United Nations (UN).

Table 1 – Number of municipalities, live births, population and Municipal Human Development Index (MHDI) in “Baixadas Litorâneas” and “Norte Fluminense” mesoregions, Rio de Janeiro, 2015

	Number of municipalities	Live births	Population	Average MHDI (+DP)
Microregion Lagos	7	7,637	596,660	0.728 (0.018)
Microregion Bacia de São João	3	3,663	193,588	0.718 (0.060)
Mesoregion Baixadas Litorâneas	9	11,300	790,248	0.725 (0.032)
Microregion Campos dos Goytacazes	5	9,941	610,105	0.673 (0.031)
Microregion Macaé	4	4,800	294,499	0.723 (0.027)
Microregion Norte Fluminense	9	13,441	904,604	0.695 (0.038)
Total	19	24,741	1,694,852	0.711 (0.037)

Table 2 contains the comparison between the number of hospital beds existing, the number according to the parameters employed by SUS and the bed occupancy rate. In the two mesoregions there are a total of 3,388 beds installed, exceeding the number of necessary beds estimated by reference population ($n = 1,764 - 3,247$) and by hospital production ($n = 1,622$). According to the demographic criteria, the excess occurred in adult and obstetric surgical beds; according to the activity performed,

all types of beds installed were greater than the estimated need. This discrepancy was more accentuated in obstetric beds, which exceeded the average estimated by demography by 71.6% and by 455.9% the estimate based on the activity performed. The average occupancy rate of the beds was 47.8% and there was a large variation in the indicator between the micro-regions, with a predominance of values below the 72% recommended as the ideal minimum¹³.

Table 2 – Number of installed and estimated beds by demographic and activity performed for the aggregate of the mesoregions, and bed occupancy rate.

Type of bed	Adequacy interval by demographic criterion	Number of estimated beds by the activity performed	Number of installed beds	Percentage of beds installed in relation to the estimated activity	Bed occupancy rate
Obstetrics	241-281	81	453	555,85%	18,0%
Neonatology	55-125	42	72	172,73%	57,9%
Pediatric Clinic	191-365	165	363	219,5%	45,6%
Adult Clinic	766-1494	101	1346	133,32%	75,0%
Pediatric surgery	30-99	44	48	108,75%	92,0%
Adult Surgery	474-883	279	1106	396,07%	25,2%
Total	1764-3247	162	3388	208,94%	47,9%

Table 3 shows the comparison between the number of existing hospital beds, estimated according to population criteria and performed within each of the micro-regions. Regarding the demographic criteria, the microregions of “Baixadas Litorâneas” have a number of beds within the normal range while those of “Norte Fluminense” show an excess. On the other hand, there was

an irregular distribution of beds intra and interregionally, with no micro-region remaining within the normal range for all types of bed analyzed. When considering the hospital activity actually performed, the number of all types of beds installed in the microregions of Macaé and Lagos exceeded the estimated need.

Table 3 – Number of existing hospital beds, estimated according to population criteria and performed, according to type of bed (clinical or surgical, pediatric or adult), microregion and mesoregion.

Mesoregion	NORTE FLUMINENSE						BAIXADAS LITORÂNEAS					
	Campos de Goytacazes			Macaé			Lagos			Bacia de São João		
Type	Perfor med	Populat ion	Install ed	Perfor med	Populatio n	Install ed	Perfor med	Populat ion	Install ed	Perfor med	Populat ion	Install ed
Obstetrics	2	7(± 5)	87	4	50 (±3)	4	5	5 (±5)	61	0	2 (±2)	1
Neonatology	7	3 (± 11)			17 (±6)	2		9 (±11)	6		1 (±4)	
Pediatric Clinic	08	9 (± 31)	78	9	48 (±15)	7	2	8 (±25)	4	6	3 (±10)	4
Adult Clinic	19	24 (± 136)	88	30	177 (±58)	14	84	08 (±123)	31	7	20 (±39)	13
Pediatric surgery	5	3 (± 12)	9		11 (±6)			3 (±10)	2		(±4)	
Adult Surgery	41	50 (± 76)	69	3	112 (±33)	92	5	42 (±70)	02	9	4 (±22)	3
Total	53	27 (± 272)	.549	19	416 (±121)	46	21	86 (±244)	.056	29	78 (±80)	37

Table 4 systematizes the size of the different hospitalization units in the mesoregions. There were located 61 organizations with inpatient services, predominantly general hospitals, corresponding to 70.5% of services and 83.6% of available beds. No “specialized

emergency room” or “normal delivery center - isolated” units were found. There was a predominance of small hospitals in a percentage close to those of medium size, together representing 90% of the found services.

Table 4 - Stratification of inpatient units in relation to their size.

	Number of beds	Number of inpatient units	Small Hospital	Medium-Sized Hospital	Large Hospital	Hospital with Extra Capacity
General Hospital	3,789	43	17	20	5	1
Specialized Hospital	641	13	7	6	0	0
Isolated Day Hospital	13	2	2	0	0	0
General FirstAid	92	3	2	1	0	0
Total	4,535	61	28 (45,9%)	27 (44, 3%)	5 (8,2%)	1 (1,6%)

IV. DISCUSSION AND CONCLUSION

All types of beds installed were in larger number than those estimated by the activity performed in health services in the aggregate of the mesoregions. The total number of beds in the mesoregions was also above those estimated based on the number of inhabitants, predominantly obstetric and surgical adult. This inconsistency should increase the cost of the health service¹⁴. In the assessment by type of bed, values of adequacy, scarcity and lack of beds were irregularly distributed among the micro-regions, implying irrationality not only in the availability but also in the distribution of these beds.

The stratification of the units by the number of beds revealed a predominance of small and medium-sized hospitals, almost half having less than 50 beds. Although important to guarantee the capillarity of the health system to interior regions and the integrality of care and access to the health system, this form of organization is unsuitable for densely populated regions, such as the mesoregions under study, which cover approximately 116 inhabitants / km². Such inpatient units end up operating with low technology and resolvability and with low hospital occupancy rates, as verified in the study. The historical overvaluation of tertiary care plays an important role in the genesis of the phenomenon found, and goes back to the Basic Operating Standards NOB SUS 01/1991 and 01/1993, which led to the beginning of the SUS regionalization and decentralization process; however, many of these structures acquired an indefinite role in the

regional service network after the consolidation of the Family Health Program (PSF), sometimes overlapping with those of primary care¹⁵.

The low activity of the beds also characterizes the disuse of installed capacity and causes adversities to financial management. La Forgia and Couttolenc attest that the ideal occupancy rate for hospital beds is 75 to 85% and that Brazilian hospitals typically work below that¹⁶. In this study, SUS parameters were used, which work with a slightly lower range, between 72 and 82%. Even so, only the adult clinic beds reached the appropriate occupancy range and the occupation reached percentages as low as 18% and 25.2% in adult obstetric and surgical beds. A study that analyzed 25 hospital organizations in the country, upon finding more than 60% of hospitals operating below the parameter¹⁷, endorses the one found in this study. Other national studies indicate that small hospitals are the main responsible for this, as they work with only 32.8% of occupation in the country on average¹⁸.

This work has some limitations inherent to ecological studies, given that the aggregated information may not be true for the individual level. In addition, the high average MHDI, population density and the proximity to the metropolitan region impact on the ability to generalize data to the national level, especially considering the high inequality in the country. The authors believe that the discrepancy between the number of beds proposed and used reflects a low rate of hospital occupancy that may be even more significant in less populated regions, suggesting the need for further studies.

On the other hand, the study allowed an in-depth analysis of the infrastructure of these mesoregions, unveiling important weaknesses to be considered by managers, for the construction of a regionalized and hierarchical health care network encompassing hospital establishments in size and services adequate to the needs of the population.

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Law, Geography and Insurance: Establishment of Socio-Environmental Protection as a Standard for Government and Industry

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Abstract— *The authors have proposed a fusion of Brazilian environmental law to US jurisprudence, and, financial risk management practices. The immediate goal was to bring together concepts and processes to suggest remedies for the dam tailings crisis in Brazil. The method used was called GeoLaw. This method has been employed in insurance strategies, combined with an in-depth discussion of geodetic data. However, the broader aim was to provide useful models to address issues of climate change resilience. Consequently, specific policies and technological systems were examined. This facilitated implementation of cohesive socio-environmental justice for vulnerable populations and ecosystems, on a global scale. Means were suggested to better predict disaster risks. These strategies, consequently, had significant implications regarding insurance. The concepts of Geographic Law (GeoLaw) were introduced as a means towards greater effectiveness in decision making.*

Keywords— *EcoLaw, Geodetics, Geographic Information Systems, Insurance, Environment.*

I. INTRODUCTION

It is estimated that 80% of data currently produced is accompanied by a geospatial component of geolocation (Robinson 2016). Geospatial information and intelligence have been referred to as "paladins of a New Age" (Santos 2017). This technology continues to stimulate creation of new professions with new skills focused on Geographic Information Systems (GIS). In addition, the US Department of Labor Statistics projects that jobs related to GIS will grow by 29% between 2014 and 2024, at a much faster pace than the expected average for all other professions. This highlights the fundamental importance of georeferencing and regulation of spatial data infrastructure systems for strategic governance decisions. This includes analysis related to territorial planning, at all scales, and to policies with socio-environmental impacts. Cartography is an ancient practice. For millennia human societies have sought to identify references which depicted their own relationship to the environment and to other groups of people. As those tools improved, increasingly complex societal patterns emerged. With passage of each century, mapping was applied to virtually every issue.

Therefore, geographic processes can be applied in contemporary society to major infrastructure projects. This utilization can take various forms, such as detailed examination of generating energy by means of a dam, or more specifically, determination of management strategies to deal with accumulation of rejected minerals in mining production. Mapping is fundamental to aid public managers in the most diverse spheres of administration. Three researchers take an expansive view of cartological relevance, "Maps for ecosystem services (ES) are made for a broad set of purposes including advocacy (awareness raising, justification, decision support), ecosystem assessment, priority setting, instrument design, ecosystem accounting, economic liability and scientific spatial analysis (Jacobs et al. 2017)."

Geospatial technology is crucial for design of environmental policy and prevention of risks associated with a given enterprise. It follows that data collected for maps, and its quality, is critical. (Jacobs et al. 2017). When using GIS, typography is combined with other types of data and contextual information. The map itself is not the whole of the process, but the central tool of quantification (Jacobs et al. 2017). Most countries have laws that plan land use and occupation, but often do

not take into consideration geography concepts and techniques to establish legal categories that can be clear, sufficient and enforceable for legal categories to comply with, such as judges, public prosecutors, builders, insurance companies and ordinary citizens. In the case of Brazil, laws dealing with land use and occupation planning in cities and metropolitan regions exist, as well as an environmental licensing procedure that requires in-depth study to predict environmental impacts, to propose mitigation solutions and to reduce risks to communities and nature, such as dams and large-scale mining. This is critical, especially in the current context of a climate change process where climate dynamics are changing and we increasingly need to develop resilient structures and resilience-based legislation, which is of direct concern to insurance companies that can afford the costs of possible disasters.

When planning involves economic development, it should be preceded by exact surveying. This would be combined with knowledge of applicable legal rules of the jurisdiction. This is necessary both for government, in the implementation of its public actions, and for private investors. A joinder of GIS with law and financial risk management constitutes creation of a new field of knowledge. This innovation connects geodetic data directly to political, bureaucratic and insurance functions. On a more activist front, the new field can advocate environmental, ecological, and territorial justice. This perspective, that distributive justice emerges from pressure upon legislative decision making, is not new. Furthermore, questions whether (and how) that concept can be related to environmental and urban planning has been extensively researched. This fact is borne out by abundant empirical evidence and bibliographical production, especially on the origins of the environmental justice movement, (Bullard 2000; Taylor 2000; Walker and Bickerstaff 2000; Cole and Foster 2001; Martinez-Alier 2003; Mitchell and Dorling 2003; Bryant and Hockman 2005; Walker and Bulkeley 2006; Ascelrad 2010).

The argument states that poorly conceived and inconsistently implemented ecological initiatives can generate unequal distribution of burdens and benefits, geographically and among population groups (Lazarus 1993; Ascelrad 2010). Land occupation may constitute a relevant mechanism to remedy, or to reinforce, socio-spatial inequalities (Been 1992; Arnold 1999; Fernandes 2007). It must also be noted that risk inherent within such injustice has gone generally unrecognized by the insurance investment sector. For example, a low-end estimate of unaccounted financial services liability due to climate change impact (closely associated in this research with

lack of societal resilience) is a staggering \$2.4 trillion (Goldstein et al. 2019). In Brazil, there is a legislation known as the City Statute Law, which mandates obligation to use geographic data to identify areas at risk. This same law directs municipalities to adopt comprehensive development. Risk mapping is also mandatory. The major problem faced by Brazil in the various regions is the low rate of compliance to these rules.

Well-designed legislation is not sufficient for disaster prevention. However, a combination of law and geography efforts could produce what we call GeoLaw, legal instruments and data that can assist in legal and administrative decision making. Understanding geodetics will allow more effective modeling. This approach will highlight ecosystem dynamics and their association with equitable conceptualization of loss prevention (Kretsch 2016). In this paper, analysis of these practices will be accomplished by evaluation of Brazilian case studies. But the true impact is contained in potential utilization of these principals across the globe, in response to distributive issues linked to climate change. Furthermore, a geodetic summary of socio-political impact, using the framework described above, would provide an objective instrument for comparing losses and defining indemnification. For example, water contamination can cause serious damage to vulnerable populations because of that community's dependence on the free benefits of nature. Concepts of ecosystem services and proper compensation are related to progressive "greening" of the law in correcting such situations.

It is necessary to understand such scenarios involve complex socio-ecological systems, which require a broad interdisciplinary analysis. Therefore, an adaptive model is needed. Development of flexible and effective governance strategies are a crucial component in managing insidious environmental problems. This calls for systematic integrated resource categorization, cross-functional bureaucratic units, producing analytics-based outcomes (Groninger et al. 2016).

II. METHODOLOGY

We use a comparative methodology between Brazilian and North American cases, applying principles of geography and legal parameters to make intervention in nature safer, in order to cause less damage and expand the scope of benefits for the parties. Thinking about the following parameters:

- the main environmental risks;
- the main environmental conflicts;

- the main environmental susceptibilities and social vulnerabilities;
- the measures taken by the public authorities of the States to mitigate risks;
- principles and recommendations for fairer public policies and whose interventions in nature are less harmful.

Thus, as a basis for our investigation we think of the laws of the largest countries in the American continent, the United States of America and Brazil, making a comparison in legislative terms, although at first we can identify substantial differences in the institutionality of both countries, as well as similarities.

Then, we reflect on the responsibility model of both countries and the impact that these interventions can cause and we seek to formulate a proposal for an instrument that could make problems and solutions more predictable through what we call here GeoLaw, principles of geography through geolocation and law working together to present decision makers and public policy makers with better conditions for those decisions.

Land Demarcation, geography and Law: paths for a Geo-Law

GIS and financial risk management tools can prevent or resolve conflicts. Among these conflicts we can mention the lack of regularization in certain portions of land, the inertia of the public power in not allowing the construction in places that present risks, the authorization of mining enterprises without a geographical and legal study that can mitigate as much as possible. the risk of vulnerable communities and cities and the lack of regularization of empty spaces in urban regions. There many more, like these: Boundary conflicts, Inheritance conflicts, ownership conflicts due to legal pluralism, ownership conflicts due to lack of land registration, ownership conflicts between state and private/common/collective owners, Multiple sales/allocations of land, Limited access to land due to discrimination by law, custom or practise, peaceful, informal land acquisitions without evictions, violent land acquisitions, included clashes and wars over land, evictions by landowners, illegal evictions by state officials acting without mandate, market evictions and distortion of local land market/values, disputes over the payment for using/buying land, disputes over the value of land, Conflicts between human/cultural and natural use (flora and fauna), destruction of property (Wehrmann, 2008).

The object of study where we can cross legal, geographic and insurance knowledge is certainly the land and its demarcation, in which we adopted Platt's (2014) notions about land. A very pragmatic view of geography and law is Platt's (2014, 42), in which he states the following: Geography focuses on the substance of what we do with the bits and pieces of the earth that happen to fall under the ownership or concern of "stakeholders" (e.g., individuals, companies, nonprofit organizations, or governments). Law is concerned with the process by which those stakeholders are permitted to engage in various uses while minimizing adverse effects on each other or the wider public. This is a way to think about structuring a Geo-Law that can give more certainty than uncertainty or bring decisions closer to a safe space. Law ends up being a complex mosaic of rules, both in Brazil and in the United States, including a series of spheres and roles of actors that have an interest in certain processes. Among these we can mention, especially in relation to the United States, but which can be applied to Brazil, although the federative model is in both, they are of different scopes:

1. Constitutions (federal and state);
2. Legislative acts (also known as statutes or legislation);
3. Judicial decisions in court cases (also known as case law);
4. Administrative regulations issued by regulatory agencies.

An important detail in relation to the United States is the high level of autonomy of states vis-à-vis the central government, notably in relation to legislative production, and regulations and laws may change from state to state. Brazil has a federation with more centralizing characteristics, with national laws that regulate the use and occupation of land, as well as distinct responsibilities in relation to the implementation of an urban policy. advance due to the lack of structure, especially of specialized personnel to implement and monitor the results.

Addressing geography first, it is particularly suited to adjudicate ownership and registration of real property, and, assessment of parcel boundaries. It follows that the quality and accuracy of said geographic information must be as reliable as possible. If visuals are of poor resolution or material is not updated, higher costs and procedural delays will occur. Those legal consequences bring the discussion to financial risk management. The field of insurance is extremely facile in securing

rights. The field may be separated into three parts, underwriting and claims; asset management and cash reserve allocation; investment. Underwriting is important because it standardizes contractual obligation of parties and rationalizes judicial standards. Asset management is necessary for its functionality of indemnifying losses and solidifying a market structure to secure real property. Investment is very effective at bringing pressure upon ecologically insensitive companies and limiting underhanded tactics. Investors tend to demand ethical compliance.

All this supports a super-discipline that employs law, geography and insurance. Its strength is bringing accountability to public management questions. It is essential to create an infrastructure reliant on this agglomeration of statute, GIS, and financial remuneration to redress socio-environmental vulnerabilities. Risks increase for these investors regarding the installation, for example, of large works such as dams or even large mining involving various groups of people who are indirectly and directly affected by possible damage resulting from disasters such as Mariana, Brumadinho and Belo Monte Hydroelectric with its impacts on the environment. In addition, cities and communities need to be prepared for possible problems.

Another important relationship between geography and law is in the field of geography's perception of environmental laws, in that field Thompson, Shelley and Wije (1997) already set a parameter for this stating that "Geographic information systems and other technological advances in the process of geographical such impacts need to be predicted and measured to provide, for example, security for investors and companies, taking into account the safety of the business and the possible human and nature hazards. Clay and Berkovitz (2012) also helps us to realize that geography brings us understanding of other demarcations, which may be social or legal, what kind of drafting is performed, where it is done, income, state budget Americans, for example, among other important variables for understanding various dynamics.

It is important to highlight that the mapping that demarcates lands, areas, territories is involved in three relevant factors: scale, projection and symbolism (Santos, 2015). The scale will determine how much detail is desired on the map which means that the larger scale more detailed it will be the closer it is to the represented reality; the projection concerns the level of detail inserted in the representation; and symbolism is the meaning of this cartography for the development of public policies and even investments.

Geography helps in determining responsibilities. Biger (1988) already pointed to the necessity of approximation of geography and the legal field to analyze the case of rivers as a border demarcation between countries, since for the jurist could be well defined the question, but for the geographer the river dynamics could change which causes legal repercussions in the definition of land demarcation.

In the case of Brazil, there is a very advanced legislation known as the City Statute, Law n. 10.257/2001, which provides in its text the obligation to use geographic data, obtained through maps that can effectively demonstrate the areas of risk. This same law establishes that cities need to have master plans and according to the Brazilian constitution these plans are mandatory for cities with a population larger than 20 thousand inhabitants. Risk mapping is also mandatory, which means that occupying territories must be classified according to the level of risks so that we know what can be occupied and how it should be occupied. The major problem faced by Brazil in the various regions is the low rate of compliance with what is foreseen in these master plans, as well as the non-obligation of these plans for smaller regions, such as the cities of minas gerais state that are exposed to tailings dams. which expose people and nature to great risks. Failure to comply with these plans is a cause of the proliferation of irregular occupations in areas exposed to landslides, contamination and flooding. However, we ended up with another law known as the metropolis statute (n. 13.089/2015), which regulates the operation of regions formed by two or more cities, because the point that required the geo referencing of the spaces occupied between cities was not approved.

In the American case, there is the American City Plan (Farvacq and McAuslan 1992), and as the Brazilian plans they are not mandatory in their fulfillment, but they are parameters for judicial and administrative demands. It is important to mention that since the nineties of the last century there has been a search for reform of the law, striving for clearer laws in the United States. Nevertheless, the discussion about georeferencing as a right of every citizen and a duty of public entities that has this responsibility is not yet institutionalized. However, Arnold (2007) states that geographic delimitation is fundamental and lists the uses of this process for soil management in the United States:

- mitigation of droughts and floods
- purification of air and water
- generation and preservation of soils and renewal of their fertility

- detoxification and decomposition of wastes
- pollination of crops and natural vegetation
- dispersal of seeds
- cycling and movement of nutrients
- control of the vast majority of potential agricultural pests
- maintenance of biodiversity
- protection of coastal shores from erosion by waves
- protection from the sun's harmful ultraviolet rays
- partial stabilization of climate
- moderation of weather extremes and their impact.

The legal culture of each country will define how this obligation can be implemented. We think that the observed experiences, especially in Brazil, and the presence of the obligatory of these devices do not guarantee the effectiveness of these planning instruments. Kayden (2000, 446–447) highlights how she understands the perspective of regulating land use and occupation, “land-use planning is a process conducted by public officials to analyze and recommend in a comprehensive manner, from social, economic, environmental infrastructure capacity, aesthetic, and other relevant aspects, the best present and future uses of geographically specified land areas”. However, this understanding does not explain the finalistic content of geography in this process, which is to act directly on the best use of soil, whether in an environmental dimension, in an urban dimension, or in the prevention of risks through the intervention, for example, of enterprises. The geography and the data produced are seen as important in the planning process and the law is the one that calls the public authorities' responsibility in establishing this regulation of land use and occupation and its effective compliance as necessary in the prevention of disasters that may be empowered by climate change. The fact is that land use directly affects the ecological services provided by ecosystems (Arnold 2007), there is a causal link that becomes clearer when thinking about a resilient city model.

Similar legislation in the United States requires comprehensive municipal planning. But in the American case, there is much less clarity. Nevertheless, discussion about geo-referencing by public entities has been ongoing. The legal culture of each country will define implementation of GIS. But the realities in both cases are the same. Land use directly affects social and ecological services (Arnold 2007). In summary, disaster prevention is a process which combines law, geography and insurance reform. Understanding geodetics will allow

more effective modeling. This approach will highlight ecosystem dynamics and their association with equitable conceptualization of loss prevention (Kretsch 2016).

III. DISCUSSION

Realistic Perceptions of Security

Stability is the most marked feature of capitalism and enriches insurance companies because peace of mind carries a high premium. But is this attitude justified by experience? The discussion up to this point has dealt with societal willingness to take certain risks, while underestimating others. The reason for this paradox rests in the misapprehension of the true peril of climate change. Comfortable traditional assurances carry the day. But the age is tumultuous (Bauman 1999), and certainty inaccessible due to baffling scientific and technological progress.

This scenario gives little credence to the notion that science will be able to offer humanity anything like a carefree existence. Inaccurate perceptions may offer a degree of security, but with unintended consequences. It is as if humanity were being offered a "black box" package of solutions. These philosophical palliatives resemble chemotherapy, where the cure would be nearly as debilitating as the disease. When this reasoning is viewed through the prism of industrialization, a cultural ambivalence can be detected. This situation is often referred to as technological optimism. That term can be defined as an opaqueness in, or absence of, cognition that development has a downside. Take Brazilian mining, which offers undoubtable benefit but also devastation of ecosystems and vulnerable populations. Overtly negative elements of progress must be neutralized, or at least minimized. This requires an intellectual balance be struck between technological optimism and acceptable risk. Regarding infrastructure activities, ventures will have inherent danger. But public officials, businesspeople and citizens could act as a control to excess, if knowledge acquisition is the rule.

Experience of past events is used by actuaries in the insurance field as key indicators. Furthermore, strict liability laws in the US have become more stringent by recognizing that environment and industry coexist. So, progressive altering of the relationship between traditional ideas of industrial progress and ecological protection is possible. Institutionalization of these concepts has taken the form of several entities creating standards regarding erection of dams and buildings, paving of streets, and development of sanitation systems. These criteria may be used for general construction projects. But the focus

of this paper concerns use in those enterprises associated with mineral tailings dams.

The Current Situation

The diurnal cycle of Brazilian public administration, specifically in the municipalities, has produced a federation model with legislative and administrative autonomy which lacks planning. This situation has generated pressure on the judiciary to standardize administrative rules surrounding such issues as licensing. The novelty of climate change, and its sequelae, has confronted the Brazilian administrative hierarchy with major disasters, whose complexity assumes ever-greater proportions. A train of circumstances follow which are very detrimental to vulnerable people and the environment. Large multinational corporations aggravate this situation with ill-conceived ventures. This is exacerbated, in the Brazilian case, with those corporations intimate association within the lattice of public power. The result is a very strong lobby in support of dubious industrial construction projects.

The Mariana Disaster

Minas Gerais is one of the biggest Brazilian states that became known around the world after the rupture of reject dams, caused by mining. The first accident was Mariana. The dam was owned by Samarco, a joint venture of the Vale and Anglo-Australian BHP Billiton corporations. The waste barrier failed in November 2015. In its wake, it left a legacy of 19 deaths and massive contamination. The ecological impact is difficult to quantify. An estimated release 50 million cubic meters occurred (Oliveira et al. 2018).

It is certain this was the most destructive disaster attributable to Brazilian mining. The mud spread through the Rio Doce basin on its path to the sea, eventually reaching the Abrolhos archipelago. The supply of water to regional cities and ecosystems along and the basin, and those further afield, were fouled by the sludge. This was a tragedy for local communities that relied on fishing and agriculture. Figure 1 shows the course of the mud. It traveled about 700 kilometers (437.5 miles) to the sea. Nearby villages were simply obliterated by the rolling force. This disaster accelerated various civil conflicts which existed due to Vale corporation mining activities. Figure 2 illustrates a survey of the more serious social conflicts.



Fig.1: Path of the Mud

Source:

https://brasil.elpais.com/brasil/2015/11/10/politica/1447117167_264357.html



Fig.2: Conflicts Generated by Vale Activities

Source: <https://diplomatie.org.br/mapa-conflitos-mineracao-extrativista-vale-brasil/>



Fig.3: Barrage of the Fundão dam has covered more than 600 km - Gesteira (above), rural district of Barra Longa.

Source: Felipe Werneck/ASCOM-IBAMA

Brazilian law prosecutes this sort of offense through administrative, criminal and civil statutes. Therefore, the company was fined by relevant environmental agencies, with action pending for environmental crimes covered by the 1988 legislation (discussed above). The Brazilian judiciary is hyper-bureaucratized, so decades may pass before resolution of cumulative damages. Moreover, company directors were absolved of intentional homicide in the 19 deaths because the company issued prior warning. That ruling may be appealed. If viewed from an insurance standpoint, more preventive measures may have been obtained. There are a growing number of insurers who underwrite Mariana-type losses. These policies include provisions which would have required directors foresee the accident itself. In this case, the reinsurer could have found the officers acted in bad faith. Coverage for errors and omissions would have been removed, exposing personal assets of the directors to forfeiture.

Aside from this scenario regarding indemnification, residents throughout the Rio Doce basin are still at risk from high-level metal contamination (Oliveira et al. 2018). In approaching this case, Brazilian law uses the theory of integral risk and objective liability (Rezende et al. 2018). These dicta concern damages caused by activities exercised through self-interest, without reference to corporate conduct (Rezende et al. 2018). They are similar to strict liability precedent, especially as interpreted in the United Kingdom (Rylands v. Fletcher). The causal relationship between harm suffered by the victim and the tort created by the agent suffices. Using this principle, it would be incumbent upon the company to take responsibility for all necessary actions in order to protect ecosystems and communities. However, arriving at correct quantification of damages is problematic. Assessment of health issues causes great difficulty because effects are often cumulative. Figures 3, 4, 5 and 6 graphically illustrate potential long-term concerns due to the magnitude of this exposure.



Fig.4: Bento Rodrigues School, district of Mariana.

Source: Rogerio Alves/ TV Senado



Fig.5: Samarco Mining Tailings Mud Trail. (above)

Source: Felipe Werneck/ASCOM-IBAMA



Figure 6. Mina Bean stream before the accident. (above)

Source: https://www.huffpostbrasil.com/entry/brumadinho-antes-depois_br_5c4ca8cde4b06ba6d3bd9509

Dam Insurance as a Measure of US Strict Liability Doctrine

The goal of this chapter will be to bring both Brazilian and US cases together to suggest remedy, employing applicable insurance language and models. It would be helpful to give a short description of the topic, before application of its tenets to the Brazilian situation. Effective insurance regulation is a preserve particular to a given state and local jurisdiction in the US. Anything can be insured for a correlative risk premium. For example, insurers will cover high hazard dams within commercial liability policies, generally, because the presumption of strict liability is so weak in the US. A “rule of thumb” definition of the subtle principle of strict liability can be summarized as entrepreneurial protection from excessive tort judgements due to practices inherent within a given enterprise. Interpretation of US cases involving dams is somewhat inconsistent because it brings up issues involving, not only strict liability, but recognition of ecological damage and its relationship to the precautionary principle.

Therefore, adjudication of environmental tort is limited by several factors in the US. When dams are considered, general precedent has been to discourage strict liability complaints on the basis that economic benefit outweighs recompense for land exploitation, and any risk encompassed therein. This attitude has tended to influence most decisions caused by dam construction and failure, though most states have strict liability statutes on their books. Consequently, the argument has been increasingly made, in conjunction with adoption of the precautionary principle as a dictum. Still, a more straight forward legal doctrine for arguing such cases has been that of negligence.

Strict liability doctrine is also more of a British concept in common law (*Rylands v. Fletcher*) than in the US. This is because benefit of doubt has traditionally been given in US law to land development. A liability insurer won a very influential Kansas Supreme Court appeal, attributable to this “manifest destiny” outlook *Lee v. Mobil Oil Corporation* (Supreme Court of Kansas 1969). The decision stated that strict liability was not pertinent to “acts of God” (flood) which cause damage to people and property. The logic was expressed that disasters were not inclusive in strict liability principal because the nature of refinery operations was not at fault (Binder 1990). This stance is supported by government due to eminent domain doctrine, a major hinderance to “GeoLaw” aims.

This doctrine of strict liability in the United States of America generally limits the potential for compensation and accident insurance that results in considerable environmental damage as in the Brazilian and American cases mentioned above. It is important to think about the extent of the damage, the possibility of recovering the affected environmental resources and human lives that have been injured or lost, as well as what would be the measure that would bring a balanced cost benefit to the parties, whoever they are (Oxford University Press 1992). A big problem is precisely to calculate the damage itself, which also occurs in Brazil that adopts this doctrine, and there is no need to value life and ecosystems lost in some disaster.

Another issue to be faced, which we want to avoid with the GeoLaw model, is the difficulty of holding companies and limited liability to account, as well as the difficulty of reaching individuals and shareholders, although the environmental damage, depending on its extent, could until justifying the breaking of this inaccessibility to the components of the limited corporation (Dent 1991). Dent defends in his important article “the social importance and immense costs of pollution make environmental law an ideal arena for reconsidering theories of limited liability for tort” (Dent 1991, 151).

Lawson believes that this doctrine of strict responsibility needs to survive as long as the following points are found in the case to be analyzed or judged: “the defendant must have been said to bring the ‘thing’ which has caused damage to the claimant on the defendant’s land, the thing must be something that is likely to do mischief if it escapes, the thing must be a non-natural use of land, and finally, the thing must escape. It is implied that the absence of proof of any of the aforementioned elements will amount to a shortcoming in establishing liability under strict liability principle.” (Lawson 2017,79) These fundamentals would apply to the cases exposed here, with emphasis on the rupture of ore tailings dams in Brazil.

In the tort law, we can also consider that is also an instrument of environmental policy, serving as a prevention of new environmental damage, as well as a compensatory mechanism for the victims (Abelkop 2009). Courts are important in the current context with innovative measures to solve future environmental problems that extend beyond what they are used to facing (Abelkop 2009).

However, the growth of the field of environmental law has replaced or even acted in partnership with other doctrines, but according to Lathan “the complexities of many modern

environmental harms and the current or perceived inadequacies of the common law, however, have led policy makers such as Congress to enact wide-ranging laws that provide legal remedies.” (Lathan et al 2011, 737). So, it is necessary to analyze on a case-by-case basis, but establish a preventive mechanism that could be GeoLaw as an alternative for monitoring large potentially polluting projects.

Wagner points out that “however, the collectivization of liability to the benefit of both victims and tortfeasors might continue to play a role in cases of major catastrophes, if only on an ad-hoc basis.” (Wagner 2006, 290). Interesting that he cites the case of 11 of September in which a fund was set up to repair the damage caused. The fund combines the low thresholds for liability typical of no-fault plans with the full compensation principle typical of tort remedies. He believes that future catastrophes, such as those related to the environment, may follow the same path of forming a fund to repair victims, which does not guarantee a complete indemnity of the damages (Wagner 2006; Witt et al 1983). As for the implementation of the Principle of Absolute Responsibility as a legal aspect in the Environmental Law System, Ulfah (2018) understands that two aspects need to be taken into account:

1. contains the interest to utilize various mixed tools of compliance to realize the channeling for environmental risk risks (liability) as well as fund management for the prevention of environmental risks encountered (Trust funds for environmental risks management).
2. has meaning giving obligation to each party to manage environmental risk (risk assessment), while application of Mechanism of Insurance Service as instrument of law compliance and environmental management have role to realize the application of Absolute Responsibility Principle through process of transfer Guarantee of coverage and management of funding to anticipate various environmental risks.

Post consent monitoring and periodic inspections also become fundamental mechanisms for reducing costs and preventing major damage, where the GeoLaw tool can act in our understanding. This is an issue to be checked when holding accountability, the elaboration of protocols and compliance with government regulations must also be attested. The American government has established procedures in this regard (EPA; Martin 2009). Omg (2011, 717) already understood that

inserting rules of environmental regulation in corporate governance would be an interesting way with cost benefit since it would act preventively. So, the question he asked was: what are the main benefits and costs that can derive from the inclusion of environmental interests within corporate governance law?

1. There will be greater scope for shareholder action to ensure directors’ haccount- ability. However, if shareholders do not take the responsibility to act, then it may prove difficult to hold company directors accountable for their actions or omissions, even when these are clearly not within the company’s or even shareholders’ interests.
2. The need to prepare environmental and social audit reports on the company’s impact on the environment and society will increase company directors’ reporting burdens. On the other hand, the company thereby obtains a better picture of its overall social and environmental impacts and is thus able to take steps to reduce these impacts, often to its own economic and public relations benefit.
3. The scope and extent of company directors’ xfiduciary duties will be increased but uncertain due to the inclusion of environmental considerations within the corporate governance matrix.

Power of the Purse

Insurance investment decisions in the US, as elsewhere, can greatly influence corporate environmental awareness. When discussing “insurance”, it is important to note that there are three sectors of the industry, underwriting and claims (retail); asset management and reserve allocation (solvency/profit analysis); investment (hedge funds, stock/bond portfolios, etc.). A scenario may therefore pose the question whether, and how, increased disclosure from companies engaged in operations prone to strict liability will further ESG (Environmental Social Governance) targets. Fortunately, a current news article illustrates just that sort of influence regarding Brazilian dams. Although the investment players are nominally European, the multinational character of asset management makes it very pertinent to events that could take place in the US. The story concerns two huge investors, The Church of England and Sweden National Pension Funds. After the Mariana and Brumadinho accidents, these two bodies requested specific business operations information from those constructing dam tailings worldwide (Lewis 2019).

This data would then be collated to determine mining companies' ecological sensitivity. After receiving these disclosures from the miners, the evaluation process would entail rating disaster exposure criteria against ESG standards. A firm called Ceres has formulated methodology to do this. It employs componential subcategories. For example, "Governance" would be listed as a heading, under which "Board Oversight", "Management Accountability", and "Public Policy [adherence]" would be grouped then scored on a hierarchal scale (Ceres 2019). Disclosure respondents would then be "graded" by their sensitivity to sustainability, resilience, worker and community safety, and, other factors. According to The Church of England, 200 of the 665 miners contacted have disclosed operational details. In addition to probable application of a scoring methodology, as discussed above, "global review is now being led by the Swiss former Environment Minister, Professor Bruno Oberle, that is co-convened by the International Council of Mining & Metals (ICMM), The Principles for Responsible Investment (PRI) and the United Nations. (Church of England 2019)."

Innovative Indemnification of Climate Change Losses

To quote a current news article, "It's important for companies to consider alternative futures including ones that are not good for their business businesses will have to confront accelerating climate change (Drugmand 2018, 2)." There are forecasts, relevant to our subject of dam tailings, that are based on already occurring effects. For example, "companies in the Colorado River Basin use that analysis [alternative futures] to drive their strategy", and more than 70 serious water risks to the Basin were reported in 2017 alone (Carbon Disclosure Project 2018). Furthermore "[b]y the end of this century, potential damage costs in some industries could tally in the hundreds of billions of dollars annually (Carbon Disclosure Project 2018)." Estimates of worldwide exposure to these risks lie in a range from billions to trillions of US dollars. Lack of response by insurers to deal with the threat can be attributed to the fact that ecosystem alterations are not immediately obvious, but part of massive shifts in global weather patterns. Plans for anticipatory funding of cash reserves to account for such types of unprecedented risk are not widespread. The insurance culture militates against the perception of drastic moves. Therefore, connection of disaster incidence with trends requiring fundamental adjustment of capital asset organization is viewed as speculation by this conservative industry.

The new paradigm doesn't fit into traditional loss analysis practices. A recent paper on the topic argues these "blind spots" defy logic (Goldstein et al. 2019). Still the fact remains

that "short-term extreme weather events like hurricanes and longer-term impacts such as prolonged heat, droughts causing water shortages, and other climate-driven operational challenges are realities that companies must manage (Drugmand 2018, 1)."

If those who specialize in US financial risk management are hesitant to accept climate change, how much more so would be constructors of Amazonian dam tailings. Insurance coverage for those endeavors is ignored due to attitudes prevalent throughout the Brazilian business community, which are akin to those of US insurance professionals. Each ethos discounts environmental risk as insubstantial. However, there are ways to introduce the concept for wider acceptance. A new underwriting and claims model may bridge this gap, while providing US insurers with limitation of overhead costs. In other parts of the world this is already practiced through predictive, or "indexed", analytics.

This process is the main feature of "microinsurance". It is an innovative strategy to extend adequate coverage for climate risk, and other perils, to vulnerable populations. This empowering financial underwriting product is closely allied with already extant indigenous self-help relationships. The innovation involves formalizing those self-help arrangement through adaptive business models. The tool for achieving this is price indexing of likely events. Predictive analytics software is used to value various probable events. A fund is established through insurers, NGOs, and governments which pays out directly in the case of a disaster event. In this way the costly bureaucracy of individual claims administration is bypassed.

Jurisprudence: The Role of Law

When any dam rupture occurs, it is assumed that the cause is inherent to the activity itself. Research points in this direction (Machado 2007). There are two primary possibilities regarding these disasters, either ceasing mineral exploitation within vulnerable regions or mitigation of such occurrences by indexing risk. The first option would totally prohibit industrial contact with ecosystems that are rich in biodiversity and whose inhabitants lack resiliency. The latter choice would allow development while minimizing incidence factors. This would involve creation of schedules listing compensation levels for communities effected by government sanctioned mining projects. This mechanism would also be triggered in situations where a containment dam had already been deactivated with no further exploration. Lingering toxins could still be present at the site because of cumulative damage. Minas Gerais is experiencing this problem. With lawsuits

pending, it is essential that judges, prosecutors, and officials address: containment of tailings from the mining activity; ecosystems impact; surface and underground reservoirs; planning for protection of human lives and ecosystems; inclusive resident participation; evacuation plans.

In Brazil, the National Mining Agency (NMA) is tasked to oversee mineral extraction. The organization has little bureaucratic support. The National Policy on Dam Safety (NPDS) was written to insure prevention of accidents through periodic monitoring (Statute 12.334 of 2010). The NPDS established an institutional design imposing obligations upon private initiative, to guarantee respect of public interest. For the purposes of this paper, Article 3 of the final document is most instructive.

The objective of article 3 was to mandate observance of standards to reduce accidents and their consequences. Mining companies were required to describe infill, business operations, deactivation procedures, and, future use. This process was envisioned as an integral part of all planning phases. Furthermore, promotion of follow-up actions were to be categorized. Collection of data was to aid public supervision and correction of security actions. Common language was to be used in specifications, allowing standardization of adequacy parameters. This was all designed to promote a culture supporting dam safety and risk management. Reticence in NPDS adoption has necessitated creation of pressure groups, outside of government. It is very difficult for law professionals, alone, to fully understand complexities of mining operations and environmental sequelae of accidents. Formation of an interdisciplinary group of geodetics, juridical, and financial risk professionals could effect the decision-making process, involving a so-called "GeoLaw" approach.

Application of GeoLaw concepts possesses many variables. In these cases GIS mapping tools could be widely employed toward planning, disaster risk prevention and management (Haklay et al. 2014). The novelty lies precisely in aligning mapping with the application of law and financial risk management. Collection of social data could also chart repercussions of disaster in relation to vulnerable populations and ecosystems. This would support technical analysis in the effort to avoid future recurrence. Indexing techniques for indemnification could be developed (Solden and Lord 2018).

Participation of vulnerable populations is key. Charettes and other interactive measures must precede the construction and monitoring loop. A recent study proposed GIS assistance,

through the Public Participation Geographic information System (PPGIS), in the schematic stage of projects (Giné et al. 2019).

Georeferenced data collection from non-expert users would engage public temporal-spatial participation by those in protected areas (Giné et al. 2019). Survey of opinions and ideas of inhabitants would also be possible, along with analysis of scenarios to balance conservation and land use (Giné et al. 2019). Capabilities of PPGIS can generate indexes from nested data, illustrating a variety of permutations collected from crowdsourcing and crowdsensing (Giné et al. 2019). This could serve as a model for population participation with the ability to provide policy makers with accurate, real-time results. However, these innovations are not embraced by those in power. Tragic consequences for this deficiency of compassion were visible when the Brumadinho tailings dam failed, making it impossible to evacuate as a wave of mud quickly covered people and vehicles desperate to escape. It has been written that, even though we live in a moment of technological wonders, the challenge is to insert them into the daily life of the decision makers (Marchezini et al. 2017).

The question must be posed whether such an effort could prevent future disasters. It is commonly agreed that legal proceedings are painful in their duration. If the types of individual and collective agreements discussed above were made before tragedy occurred, the Mariana and Brumadinho imbroglios could easily have been avoided. Cooperation between public-interest attorneys, government prosecutors and bureaucrats, and associations defending residents of those regions looks more attractive with hindsight. Monitoring of dams in Brazil can still be ineffectual (Carneiro 2019), using outdated equipment and methods. This is added to manifold problems of National Policy on Dam Safety (NPDS) implementation. It is inescapable to conclude that the probability of further tragedies, given lack of preparedness by state and industry, remains high.

IV. RESULTS

A Model for GeoLaw Application

Extreme events must be mitigated so that, if they occur, there is as little damage as possible. It seems that the challenge is how to quantify such damage. This is because mineral extraction can cause imperceptible harm initially, but is prodigious in its sequelae. Thus, it is difficult to predict all the variables that can generate contamination, or other deleterious effects,

to the environment and human society. Naturally, multiple uncertainties and conflicts exist at the junction between complex social and biophysical systems. It is therefore crucial that a formal governance model integrate public oversight, local initiative, and (because mining ventures possess cumulative harm characteristics) transparent implementation of remedies. Current Brazilian bureaucratic mechanisms lack these adaptive, integrated, and participatory qualities. The scenarios presented above indicate the population was not consulted before or during the project. Regarding Brumadinho, absence of contingency plans and exposure of corporate employees to excessive risk, illustrate this planning deficiency.

In both dam rupture circumstances, it has been argued that employment of spatial analysis would provide verification of the environmental injustice that harmed fishermen, riverside communities and the city dwellers through waterborne contamination by heavy metals. This would confirm the thesis of scholars concerning spatial disposition of these enterprises, (Martinez-Alier 2007); (Ascelrad 2009). Urban populations were better able to mitigate the disaster but were not completely unharmed, especially in terms of water resources. Requisite to building a model that involves geography and law is equitable access to information, in order to understand the extent of potential risks. In this way vulnerable populations and ecosystems would be in the future. It has thus been argued that neither government nor state supported corporations were properly prepared for disaster, because they suffered the same lack of tools to ascertain risk. This situation led to proposals to unify territorial and environmental justice through application of geoprocessing techniques, enabling easy access to data for everyone. To facilitate this, the “JustSide Cyted” project is

building a platform to concentrate geographic information to assist in decision making, when planning environmental intervention actions such as mining. But this does not apply just to planning but also to court decisions, by assisting judges and prosecutors to fairly adjudicate indemnification of torts. State and corporate responsibility would be the result, thus insuring the Mariana and Brumadinho tragedies will not be repeated.

The Model Flowchart

A diagram (Figure 7) illustrates combination of mapping principles with those of law and engineering. This model may also encompass public administration, relative to planning and monitoring environmental projects. Professionals from various fields would be utilized. It will be important that legislation establish the use of mapping to inform and support decision-makers. Nested information will provide details of many variables, such as location, soil type, topography, and applicable legislation. Geolocation would thus proceed to mapping consistent with cartological attributes, accomplished using software such as *gvSIG*. This type of mapping must be mandatory and, if not done properly, would be archived or interrupted. Access would be given to public or private users. Those entities could request more information, amend the map, and make relevant decisions by reviewing output. If the analytics were positive, the project would be authorized. And, if results were negative, work would be terminated. The “GeoLaw” movement aims to develop growth of interrelationship between geographic mapping, and statute. Such a protocol would include, for example, analysis of the merit of a lawsuit. All this technology would have but one goal, to tackle territorial and environmental injustice.

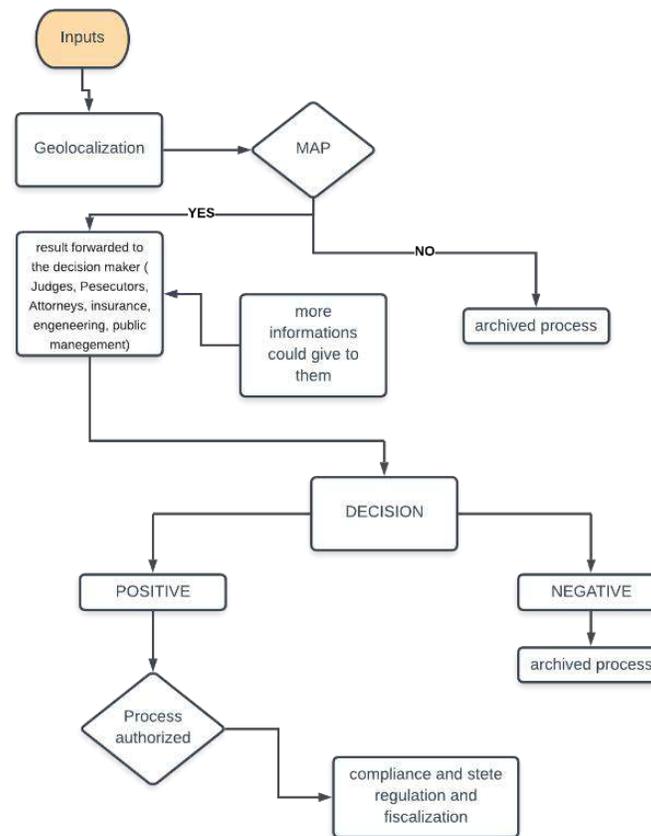


Fig.7: Model Diagram Found.

Source: Author

V. CONCLUSIONS

The disasters in Brazil are emblematic of wider socio-environmental concerns. Employment of GeoLaw modalities can mitigate conflict in better management of tailings dams, but also in general practice. The new field can apply safety parameters to any industrial venture which involves ecosystems and vulnerable populations. This paper has proposed fundamental changes in current behavior, subordinating project conception and operation to legal, geographical, and indemnification strategies. With these three components in place, those in power will be held accountable for their actions, due to availability and transparency of information. This concept defines the goal of “GeoLaw”. Information and variables inherent within that system will continue to evolve, presenting as yet unknown possibilities. The most crucial potential of this interdisciplinary effort may well be more comprehensive tracking of climate change effects. The true destiny of

“GeoLaw” lay in this broad issue, magnifying remedies far beyond those proposed for Mariana and Brumadinho.

This essay has proposed a new methodology to improve the construction process of dams for ore mining tailings. Furthermore, this approach could also be applied to other enterprises. The conclusion may be drawn that certain economic means and technologies are particularly suited for advocating equality of resource distribution. Use of GIS can help to open information access resulting in public transparency and identification of problems within a given geodetic region. Exacerbation of societal imbalances through land use, mining operations, and valuation of environmental services can be better understood through that process. Planning of equitable public services, such as availability of sanitation and water, can also be enhanced. Nigerian government policy is illustrative of GIS impact. The technology was used to identify subtle exploitation of nomadic culture (Gagnol and Afane 2010). Acquiring such

information requires proper design of GIS apparatus. For example, legal precedents flowing from a land use decision will be interpreted and codified. If land distribution addresses the reality of a situation, and its spatial dynamics, it would follow precedent and encourage fair legal, regulatory, and financial strategies. On the other hand, lack of such machinery would perpetuate dysfunction, accelerating inequality and injustice (Pereira et al. 2017).

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Biometrics and Election Fraud

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Abstract— As we are moving towards the digital world. Then there is also need for all services to be on digital platform. That's why the people are dependent on the digital platform because digital platform gives more facilities to the people. It reduce the travelling time as well as the waiting time also. As biometrics is very powerful tool now a day. Every where digitization is used know like in the government and private sector. By seeing the demand of this “why should not election be digital?” . Here in this paper we will discuss the need of the advance voting system. By which many things are controlled first and for most there is no any fraud in this method secondly the paper work is reduced and many more things like counting, cost, time all are saved. Biometric have physiolocial as well as behavioural characteristics by which identification of the person is done. Where no two person can have same physiological and behavioral characteristics .By which identification can be done easily. There is no prior need for Voting list generation because every people have there own identity like aadhaar card , driving liecence etc . By the help of these identity they can cast there vote and good accuracy is achieved and voting percentage is achieved. And every person have there right to cate there vote in favour of its representative so that they can get good facilities in future

Keywords— *Biometrics, Election Fraud, voting list.*

I. INTRODUCTION

A human being can be identified or verified with the help of the different physiological and behavioural characters like face, iris, walking, voice and signature etc. Behavioural can be called as soft biometric. They are used for characteristic difference in human being with the help of this we have less discrimination influence as matched to biometric character from the given input .The character for identification depends on different factors.

Biometric is greek word and where

- i. Bio means “ life” as well as
- ii. Metric means “ biological characters” or in other words

ie biometric means , “life charecterstics” or iin other words the application of arithmetical analysis tobiological data.

But now a day,this technology is used most widely because in government and private sectors this technology is used for the identification and for avoiding harm to any organization .Here in this paper we will discus the problem related to voting system .Presently EVM(electronic voting machine) are used now a day but still there are many issues regarding it. The purpose of this paper is to reduce the work load and

fraud that is caused by the election or voting process. My contribution to this paper is that we advance voting system in which there is no need of voter list preparation that could be done at a time only by the help of different identity proof like aadhaar card, driving licence and voter identity etc. The person who is eligible can caste there vote and rest are not eligible. This help to reduce the work, less time is used, cost is reduced and most and for most fraud that caused in election is neglected.

There are some list of attack

- (a) Client side attack
- (b) Host side attack
- (c) Eavesdropping side
- (d) Repudiation side
- (e) Trojan side horse attack.

1.2 Classification of Biometrics

1.2.1 Physiological Biometrics

1.2.2 Behavioral Biometrics

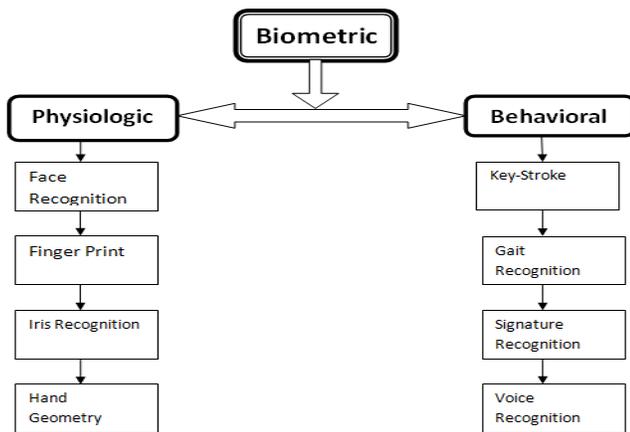


Fig .1.2n: categorization of Biometrics

1.2.1 Physiological Biometrics

Face recognition, finger print, iris knowledge, retina knowledge, hand geometry, or DNA deoxyribonucleic acid etc. are the examples of physiological biometrics.

1.2.1.1 Finger Print Recognition

Presently one day we have various sorts of biometrics yet in Biometric attributes, unique mark is regard as a matter of first importance pragmatic. Unique finger impression acknowledgment need a few activities than client, doesn't take other data like biometrics of the hand, and gives a moderately decent exhibition. Also, unique mark is the most generally perceived accreditation Techniques, in light of the fact that the sensors utilized are ease.

(a) Ridge finishing (b) Bifurcation (c) Short Ridge (Dot)

Essentially, Fingerprint acknowledgment is utilized for recognizable proof in which we separate highlights and Match the thumb mark around the primary concern, as the mesh (curve, circle, lines and so on) end, edge finishing, short edge and bifurcation. Since fingers are so much mileage from cuts and consumes, programming must be fit to do picture reconstructing. The issue of utilizing this framework is capacity of a biometric gadget to be reliable, all things considered, circumstance.

1.2.1.2 Iris Recognition

The person iris is an angular component between black part and cornea. Iris is an inward part of the person's body. In the iris of the human eye, there are five separations of the line like the tissues. These tissues are very complicated and are underlay in different forms.

Iris-based recognition is the most widely used biometrics amongst various biometric techniques by the help of iris scan we can get the user by matching the iris by our data base. Same is used in the aadhaar card.

1.2.1.3 Hand Geometry Recognition

Basically Hand geometry consists of two sides; one is Palm side and Dorsum side or top side or back side of the hand. Hand Geometry recognition is the method of individual authentication is existing from twenty years. To achieve individual authentication, a system may assess either physical characteristics of the fingers or the hands.

It provide three services, Verification, Classification and Identification Without hand geometry we can't make out an individual. The system tries to recognize the individual or reject access.

1.2.1.4 Face Recognition

Face is our primary focal point of identification in social gathering, denotes a significant job in communicating personality and feelings. We can learn a huge number of faces Identify natural countenances initially considerably after a long period of time. Due to the progressions in exhibition, mature age and significant changes in face occurs, for example, specs, facial hair or changes because of enormous changes in phenominal incitement, neck solid.

The initial phase in recognizing human face is to gain the qualities identified with the face Images. With the goal that someone else could effectively recognize the face. This depends on how the face is highlighted can be estimated. On the off chance that such a volume is conceivable, at that point a PC has been given a lot of highlights, at that point it ought to have the option to perceive the face. Throughout the previous work the result shows that specific facial highlights are utilized by people.

1.2.2 Behavioral Biometrics

Behavioral biometrics is related to behavior, nature and expression of human or, individual like heat of the body.

1.2.2.2 Keystroke Recognition

Keystroke is a method of identification of person, in keystroke people used to type something on console with the help of keyboard. In this method person pressing of key and releasing of key is seen and stored in data base While to generate a profile a client need to type same phrase many time. Future login details are estimated against the profile which, the current case is that it can perceive a similar

client's keystrokes with 99% rightness, utilizing what is recognized is a " social biometric".

1.2.2.3 Signature Recognition

Biometric signature recognition systems will determine the movement of signing.. Handwritten signature is one of the widely used methods for identity verification. In the form of a form of permission and authentication, especially in the the banks signature place a very important role because by that identification of people is to reduce the risk.

Handwriting is a thing that vary from individual to individuals and consists of alphabetic characters on the surface in relation to a particular words. Signatures of the same individual can be different with situation and state of mind. Handwritten signature is a form of classification for a individual. Signatures are collection of special characters and therefore most of the time they can be unreadable.

1.2.2.4 Gait Recognition

Step is one of the biometrics that is disparate from the conventional biometrics Gait alludes to a manner by which an individual strolls, and is one of the little biometric attributes that can be utilized to recognize individuals a good ways off. Hence, this trademark is entirely reasonable in perception situations where the uniqueness of an individual can be furtively settled.

In count, it has been found that strides are trademark by which an individual is perceived and that can even uncover a person's sex. Then again, in contrast to biometrics for example, fingerprints and palm-prints, step acknowledgment requires no contact with a catch gadget as a step can be caught in a separation as a low goals picture grouping. Stride acknowledgment is essentially separated into two kinds: (a) Model based and (b) without model acknowledgment. In model-based acknowledgment, specialists use data assembled from the human body, particularly from the joints, to build a model for acknowledgment. All in all,model-based methodology is view and scale invariant. To accumulate these walk data, a high nature of the step groupings is required. In this manner, a portion of the model-based acknowledgment frameworks require multi-camera for gathering the data .

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II. HOW BIOMETRICS COULD HELP IN ENHANCEMENT OF ELECTION SECURITY

Now as demand of the digital things are growing day by day .All the things are moving to the digital platform like E-commerce , E-banking , E-learning etc. In India we have system from 1950's.Firstly we using balleot paper for voting .Now days we are using EVM(electronic voting machine) with the help of EVM many efforts of the people is reduced. Like firstly in ballot paper enormous amount of paper is used for voting but EVM replaced most of the paper work .With the help of the electronic voting machine there is very less need of paper work for voting purpose. But there are still many issues related to electronic voting system.

III. ISSUES RELATED TO E-ELECTION AND PAPER BASED VOTER REGISTRATION

The use of EVM (electronic voting machine) has reduced the cost and man power work for the election system. While there are many issues with the EVM. There is no restriction to voters which means that single voter can caste vote for all the people in the electron list. Where it is right of citizen of India to vote and select there representative for them.To raise there voice in the favour of themselves.so that good facality could be provided to them .But still there are many cases where fraud comes infront of people now a days in the electronic voting system. To promote the voting system there are some methods through which fraud of the voting can be stopped and work load is reduced and voting percentage can be increased.

In paper based system only the eligible people can caste vote as citizen of India and should attain age ofd 18+. After that ballot paper are deposited in the ballot sealed box.Once the election is finished the boxes are opened and counted by the authorized people .All transparency is maintained during this process. But all these things are done by human being.

Human being can undergo different errors like error in counting that is by mistake not by his/her intension that may result in fraud to the other candidate. One person is allowed to caste only one vote of his own in the participation of election work. This is for all the people he may be candidate who is representative or any party member .All the party and people who are involving in election want result in their favour .These things comes in notice of administrators the EVM came to existence.

IV. PRESENT TECHNOLOGY

In present technology the voter registration or enrollment process is done before the person starts voting. And there are also many issues related like some of their name is wrong, photo appearing in list do not match with the candidate to whom it belong .Like the opposing party want other voter who are not favour of him that their vote would be cancelled. But this is not a correct way .All the people have their own right to vote and choose their representative .Hence we can use the advance system for it. That will make all the work to flow in a correct way. In advance system there is no need to enroll before the voting that work can be done at the same time with the help of the different identity card which are now in use .Like aadhaar card, driving licence, voting card etc.

V. PROPOSED METHOD

In this method in advance voter registration different organization has to come up with the other organization with the help of this it can be implemented .They should have to share their data with the other organization and maintain the unauthorized access of the data by the unauthorized user. So that data remain unaffected and things remain confidential. Biometrics is the technology with the help of which people physiological character are used to identify the people. Some of the method have been discussed above by which the human can be identified unique. we take example of driving licence the DL is issued only to the people who attain the age of 18 same for voting system. And a new identity card that is called addhar card work as identifying the person because for every person there is a unique ID associated with it.If the data of both the department is combined then there is no need for the voting enrolment anybody can go and cast their vote. With the help of this paperwork can be reduced to null. Because all of the record is in the computer system and fraud is reduced to zero. Because there is unique ID for all

the people, Due to which only one person can cast only one vote and all the voting process work can be done in effective way. By the help of this all the people can choose their representative and this fraud system can be count to zero.

6.1 FEW STEPS FOR BIOMETRIC TECHNOLOGY CAN BE HELPFUL IN ELECTION

- I. No more than one registration and no duplicate record-Biometric identification is unique and cannot be registered again if one's it is registered. Duplication becomes out of range. The duplication or fraud is automatically removed by itself.
- II. Multiple voting- Multiple voting cannot be done by any individual because there is only one unique identity given to per person that why more than one vote cannot be casted by a person.
- III. Registration Rate-With the help of the biometric other formalities can be skipped like documents that are needed at the time of registration .With the help of this idea more people can be brought to election process and which would result in the increment of percentage in voting system.

VI. WHY BIOMETRICS FOR ELECTION?

Biometric is a emerging technology that is now implemented from lower level to the higher level security system. Including financial ,military and government system are using these technology .Voter registration is a large scale process because there are many user or people for whom identification is needed .The identification method have three characteristics that is fast, efficient, and reliable. Biometric have all the three characteristics but biometric also have some drawback as well.

7.1.DRAWBACK OF BIOMETRIC

1. People become afraid as their biometric is collected.
2. Voter registration is a costly process in terms of time and resources.
3. People whose identification suffers with injury or disease example scars, skin disease, finger print etc.
4. As use of biometric is more used day by day in bank government and privacy sectors that's why there is chance for losing of data. That can harm the people and organization as well.

VII. WORKING

As we have discussed above that there is no need of preparing voter list. Now with advance voting system we will directly generate the voter list according to the people coming for casting their votes. Firstly we will make the collaboration with the other organization to access the data of people. Then we design a portal to access their data base. After that by their unique identify or by biometric feature we will get access to their profile and then allowing them to cast their vote. This can also be done with the help of electronic device as now day people are dependent on electronic work with which they can perform their voting work. This can be done by using his/her unique identity. If he/she is eligible for voting then he/she can cast their vote. By the help of this time, cost and work is reduced.

VIII. CONCLUSION

Due to the arising situation there is increasing need to control the fraud that take place in election. Because every candidate want to win the election that why they wants to do fraud with other in such situation this platform is very useful. Because with the help of this platform “ No one is able to cast more than one vote”. And with this more accuracy is achieved and people have their right to elect/select their own representative. So that their needs can be taken up to the government. And more facilities can be provided to them. This result in high accuracy rate and zero fraud.

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Beck Anxiety Inventory: A Correlation of Social and Obstetric Factors in High-Risk Pregnant Women in Recife, PE, Brazil

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Abstract— *The present study aims to correlate social and obstetric factors with Beck anxiety inventory in high-risk pregnant women. This is a field research, a cross-sectional study of quantitative descriptive approach. The sample consisted of 112 pregnant women met in high-risk services in a maternity hospital in the city of Recife-PE, Brazil. Beck Anxiety Inventory (BAI), and sociodemographic and obstetric questionnaires were used. The data were analyzed descriptively and inferentially. There was need to use univariate Poisson regression model and two multivariate models, one for each dependent variable. The independent variables were selected if they presented $p < 0.20$ (significant at 20%) in univariate regressions, being presented as tables. The adjustment of univariate and multivariate Poisson regressions with the variables selected in the bivariate study with $p < 0.20$ for the proportion of patients with the presence of anxiety, emphasizing that, of the 6 variables included in the model, only religion was significant at 5% and, the values and intervals for the ratios between prevalence allow estimating that: the probability of a patient in the population selected to have anxiety is higher if the patient has no religion in relation to Catholics. There is need to develop strategies for prevention, diagnosis and treatment of anxiety disorder in pregnant women, since its development can affect the health of women and babies irreversibly, both psychologically and physically. Relaxation techniques can be stimulated as a way to improve the physical and mental condition of pregnant women, seeking a better quality of life and healthy evolution of pregnancy.*

Keywords— *Anxiety, Pregnant Women, Women's Health, High-Risk, Maternal-Fetal Relations.*

I. INTRODUCTION

Pregnancy is a physiological phenomenon of women, characterized by the time of development of the embryo in the uterus, from conception to birth, lasting around 41 weeks. Women and health teams should understand this period as part of a life experience that involves physical and emotional changes. However, due to some risk factors, which may be due to lifestyle practice or pre-existing comorbidities, some pregnant women may have a higher probability of unfavorable evolution of pregnancy, which may reach the mother and fetus, thus characterizing a high-risk pregnancy [1, 2].

The difficulties of coping with physical, hormonal, psychological and social changes in pregnant women can generate damage in the health of the woman, the baby and significantly affect the relationship with her partner. Therefore, the mental health of pregnant women and puerperal women has been addressed because of the presence of anxiety disorders during the gestational phase [3].

Anxiety is defined as an unpleasant emotional state accompanied by somatic discomfort, which is related to fear, especially in relation to the future. Discomfort is often reported as physical sensations such as “butterflies in the stomach”, “tight chest”, and pointed out with involvement of biological or muscular arousal (tachycardia, increased respiratory frequency and depth, sweating and tremors), behavioral changes (difficulty concentrating and social interaction, etc.) [2].

Brazil is the country with the highest rate of people with anxiety disorders in the world and the fifth in cases of depression. According to estimates by the World Health Organization (WHO), 9.3% of Brazilians have some anxiety disorder, whose triggering factors include socioeconomic (poverty and unemployment), and environmental factors, such as lifestyle in large cities [4].

Epidemiological research data in the general population revealed that women of reproductive age have a significantly higher risk than men of developing a lifelong anxiety disorder [5]. It is estimated that 20% of women present anxiety symptoms during pregnancy and, due to its frequent confusion with organic problems, and because women are ashamed to present these complaints, anxiety is underdiagnosed during the pregnancy phase [6].

Given the high anxiety rate in pregnant women, Aaron Beck, considered one of the most influential psychotherapists of all time, created an inventory consisting of a self-report scale to discern common anxiety symptoms. In view of the above, the present study aims to

correlate social and obstetric factors with Beck anxiety inventory in high-risk pregnant women.

II. METHODS

This is a field research, cross-sectional study with a quantitative approach instrument of the data descriptive type. It seeks to correlate social and obstetric factors with Beck anxiety inventory.

Pregnant women aged over 18 years met in high-risk care services at the Maternity of the Agamenon Magalhães Hospital (HAM) were included; puerperal women, pregnant women with any previous mental disorder and/or with hearing impairment unable to read were excluded.

The research was a census and the study population consisted of 126 pregnant women referred to the high-risk sector of the institution. However, only 112 pregnant women could be interviewed, excluding: 8 for refusal to participate in the study, 3 for abandoning the institution, 1 for having a previous diagnosis of mental disorder and 2 for being underage.

The study was carried out at the HAM Maternity, located in the III Health District of the City of Recife-PE, being a reference in high-risk care in the Maternity service.

Data collection was performed through visits from April to June 2016, after approval by the Research Ethics Committee (REC) of HAM under the CAAE n. 53579916.2.0000.5197. It was preceded by the signing of the Informed Consent Form (ICF) by the study subjects. The research is part of a study of the Residency Completion Work (RCW), entitled: ASSOCIATION BETWEEN SELF-ESTEEM AND ANXIETY LEVELS IN HIGH-RISK PREGNANT WOMEN IN A REFERENCE MATERNITY IN THE CITY OF RECIFE, PERNAMBUCO, BRAZIL, authored by: Liniker Scolfild Rodrigues da Silva. The same seeks to meet the recommendations of Resolution 466/12 of the National Health Council/Ministry of Health (CNS/MS).

The women were approached after admission to the high-risk sector in the maternity of the HAM, being offered explanations about the participation in the study, its risks and benefits, confidentiality, as well as their withdrawal during the process of questioning related to the collection instruments. The Beck Anxiety Inventory (BAI) or Beck Anxiety Scale (BAS) was applied, created by Aaron Beck, considered one of the most influential psychotherapists of all time and who transformed psychiatry and psychology around the world. His cognitive therapy proved to be invaluable in the treatment of a wide

variety of disorders [7]. It was validated for Brazil by Cunha in 2001 [8].

This instrument is ideal for application in psychiatric patients, although it has been used in clinic and research with non-psychiatric patients and in the general population. It is based on a self-report scale proposed by Beck to discern common symptoms of anxiety. It corresponds to a scale in which the total score is the sum of scores from (0 to 63) with 21 items in total, through the following questions: “Not at all (It doesn’t bother me)”;

“Mildly (It didn’t bother me much)”;

“Moderately (It wasn’t pleasant at times)”;

and “Severely (It bothered me a lot)”. The results can be: 0 to 9 – minimal anxiety; 10 to 16 – mild anxiety; 17 to 29 – moderate anxiety; and 30 to 63 – severe anxiety [9].

Then, a checklist questionnaire was applied to the Sociodemographic and Obstetric Data Collection (SODC) for the analysis of biopsychosocial factors, elaborated by the researchers of this research.

The data were analyzed descriptively and inferentially. To evaluate the percentages of unsatisfactory self-esteem, a univariate Poisson regression model and two multivariate models were adjusted, one for each dependent variable. The independent variables were selected if they presented $p < 0.20$ (significant to 20%) univariate regressions. The program used for data typing and the elaboration of statistical calculations was the Statistical Package for the Social Sciences (SPSS) version 23.0.

III. RESULTS

Upon assessing social characteristics, among the interviewees, the age group between 21 and 25 years predominated, corresponding to 43 (38.4%). Regarding marital status, 40 (36.7%) were married and 38 (33.9%) were in stable union /living together. Regarding the level of education of the women in the study, 47 (42.0%) reported having complete secondary education. When asked about family income, 53 (47.3%) receive one minimum wage, while only 3 (2.7%) have a family income above three minimum wages. Regarding housing, 92 (82.1%) reside in urban areas and 102 (91.1%) live at a house. Regarding social distribution according to occupation and its type, 76 (67.9%) have some occupation and among the types, there was a predominance of “Housekeeper” with 45 (40.2%). Regarding the variable religion, 57 (50.9%) claimed to be evangelical.

In relation to the health distribution of the interviewees, there was a higher prevalence in the variable of patients of preterm gestational age (< 34 weeks), 60

(53.6%). Regarding the number of pregnancies, there was a slight difference between the variables, with a tie between first and second pregnancy with 28 (25.0%). Regarding the number of deliveries, there was also a slight difference between the variables, with a tie in the variables 0 and 1 deliveries, with 28 (25%). When asked about the number of abortions, 80 (71.4%) reported never having had an abortion.

Regarding the delivery route of previous pregnancies, the vaginal route presented the highest percentage of the non-choice of this route with 58 (51.8%) reporting that it was not the delivery route, and when questioned about the number of vaginal deliveries, the number of 1 delivery predominated with 33 (29.5%). Also, on this variable, as the number of deliveries increases, the number of vaginal deliveries decreases. Regarding cesarean surgery, 58 (51.8%) chose it as a way of delivery and, concerning the number of cesarean deliveries, the number of 1 delivery predominated with 42 (37.5%), reducing the prevalence with the increase in the number of deliveries.

Regarding pregnancy planning, 73 (65.2%) reported that the pregnancy was undesired/unplanned. Regarding the reason that the pregnant women were admitted to the high-risk sector, a higher frequency of the variable single preterm pregnancy was observed with 71 (63.4%), followed by urinary tract infection with 49 (43.8%) and gestational systolic arterial hypertension with 32 (28.6%).

Table 1 shows the results of the adjustment of univariate and multivariate Poisson regressions with the variables selected in the bivariate study with $p < 0.20$ for the proportion of patients with the presence of anxiety, emphasizing that, of the 6 variables included in the model, only religion was significant at 5% and the values and intervals for the ratios between prevalence allowed estimating that: the probability of a patient in the population selected to have anxiety is higher if the patient has no religion in relation to Catholics.

Table. 1: Results of univariate and bivariate Poisson regressions for the proportion of high-risk pregnant women with anxiety in the maternity ward of the HAM. Recife, PE, Brazil. 2016.

Variable	Univariate		Multivariate (Adjusted)	
	PR (95% CI)	P value	PR (95% CI)	P value
Education		0.065		0.305
Up to primary education	1.33 (0.98 - 1.79)		1.18 (0.86 - 1.64)	
Secondary/higher education	1.00		1.00	
Family income (MW†)		0.164		0.382
Less than one	1.48 (0.97 - 2.27)	0.071	1.31 (0.81 - 2.12)	0.270
One	1.35 (0.94 - 1.96)	0.109	1.28 (0.89 - 1.83)	0.183
More than one	1.00		1.00	
Occupation		0.172		0.780
Yes	1.00		1.00	
No	1.23 (0.91 - 1.65)		1.04 (0.77 - 1.40)	
Religion		0.029*		0.036*
Catholic	1.00		1.00	
Evangelical	0.85 (0.60 - 1.21)		0.90 (0.63 - 1.30)	0.592
No religion	1.42 (1.04 - 1.94)		1.38 (0.97 - 1.95)	0.073
Previous vaginal deliveries		0.107		0.234
Yes	1.28 (0.95 - 1.73)		1.20 (0.89 - 1.63)	
No	1.00		1.00	
Type of pregnancy		0.163		0.581
Desired / Planned	1.00		1.00	
Undesired / Unplanned	1.28 (0.90 - 1.82)		1.11 (0.77 - 1.58)	

Source: Created by the authors.

(*) Significant at 5%. (†) Minimum Wage.

IV. DISCUSSION

The results of the present study revealed that anxiety is present more frequently in younger women, corroborating the study by Silva et al., [6], who observed a 35% higher risk for younger pregnant women, which can be explained by the lower maturity of younger mothers in coping with difficulties and changes in the period of pregnancy. Regarding marital status, in the present study, the number of women married/in stable union and family income of one minimum wage predominated, a result also found in the study by Santos et al., [10], but, in their study, there was no significant difference between socioeconomic statuses, which was also found in the present study.

Regarding education, anxiety disorder is more frequent in pregnant women who have complete secondary education in relation to women with higher education, corroborating the study by Santos et al., [10], who found that the group with primary education had higher levels of depression when compared to the secondary education group.

Furthermore, Silva et al., [6], state in their study that low schooling influences the ability to solve problems, affecting the psychological state and consequently raising the risk for developing anxiety disorder. When questioned about the type of occupation, in our study, women who reported being "housekeepers" prevailed, corroborating the study by Candido, et al., [2], who found that the vast

majority of women did not work outside the home, caring for the home and children.

Regarding the health status of pregnant women, the present study revealed a higher anxiety index among women who were in their first and second pregnancy, which corroborates the study by Arrais, Araujo and Schiavo [11], stating that primigravidas may be more likely to develop anxiety and depression symptoms.

Concerning the number of abortions suffered, the vast majority reported having never faced the experience, which corroborates the finding of Santos et al., [10], but their study unveiled that women who reported previous abortions presented more depressive symptoms in relation to the group that did not report experience with abortion, thus reaffirming that this variable is related to the symptomatological development of depression.

In relation to the delivery route, there was a higher prevalence of cesarean surgery, and, when the vaginal delivery route was chosen, as the number of deliveries increased, its prevalence decreased. This corroborates the finding in the study by Kottwitz, Gouveia and Gonçalves [12], which before the birth of the child, most women chose the vaginal route, however, when asked what they would prefer for a next pregnancy, there was an increase in the preference for cesarean surgery.

Concerning pregnancy planning, in the present study, most women did not plan pregnancy, corroborating

the finding of Santos, et al., [10], whose study revealed that 81.5% of the interviewees did not plan pregnancy, which suggests non-adherence to family planning proposed by primary health care, aimed mainly at younger, low-income women, which contributes to health promotion, helping users with information necessary to choose an appropriate contraceptive method according to Bezerra et al., [13].

Regarding the health of pregnant women and the reasons that led to hospitalization in the high-risk sector, the present study observed the high rate of reports of preterm pregnancy, which corroborates the study by Belfort, et al., [14] who confirmed that psychological factors are associated with low birth weight. Souza et al., [15], investigated in their study the endocrine and psychological factors that raise the incidence of prematurity. Scientific evidence suggests that anxiety increases the secretion of the corticotrophin-releasing hormone (CRH), which interacts with prostaglandins and oxytocin, which are mediators of uterine contraction, consequently increasing the risk of premature labor and the rates of preterm newborns.

Among all variables in a bivariate study, only religion was significant, estimating that it is less likely for women to develop anxiety in the group that reported having religion. Corroborating the studies of Gonçalves et al., [16]; and Seniccate; Azevedo and Barros [17]; and Hefti [18], presenting a significant result and demonstrating that the relationship between religion and mental health evidences, in general, a lower prevalence of mood and anxiety disorders when subjects engage with religious practices, because such practices provide greater psychological well-being.

V. CONCLUSION

The results of the present study revealed a negative influence of anxiety in the interviewees, significantly influencing the health of pregnant women and fetuses. Younger women, with lower education level and lower family income, are more likely to develop anxiety disorder during pregnancy. Nevertheless, women who have religious practice are less likely to develop anxiety, taking into account the well-being reported. In the evaluation of the main reason that led to the hospitalization of pregnant women in the high-risk sector, preterm pregnancy prevailed, reaffirming that the health of the fetus is strongly influenced by the mother's health.

Thus, there is need to develop strategies for prevention, diagnosis, and treatment of anxiety disorder in pregnant women, since its development can affect the health of women and babies irreversibly, both

psychologically and physically. Since this public needs more attention from health professionals, this diagnosis can be made in primary health care, aiming to prevent the hospitalization of pregnant women in high-risk units.

Pregnancy, even when in a good process of evolution, can cause anxiety in pregnant women, when the degree of psychic status of a high-risk pregnant woman is evaluated, the possibility of developing the disorder is even greater. Therefore, nurses and their respective staff play a fundamental role in interventions in high-risk pregnant women. Relaxation techniques can be stimulated as a way to improve the physical and mental condition of pregnant women, seeking a better quality of life and healthy evolution of pregnancy.

It is essential that there be more researches focused on the impact that anxiety disorder generates in pregnant women, seeking improvement in women's health care and reduction of prematurity rates.

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Wealth of “New Economy” Organizations: A Historical Outline

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Abstract— This article brings up the term “New Economy” which is the concept of doing business in the digital era, when the exchange value is information, when distances do not exist and almost everything is just a click away. In this scenario, organizations stop acting in isolation and start acting in synergy, partnership, and with the ability to join companies from different sectors to generate an independent business. In times of organizations of the “New Economy” it is important to consider wealth in two aspects: tangible (with its quantifiable assets) and intangible (brands, prestige, reliability, knowledge). Since with the acceleration of the technology application and development of information, the intangible started to configure a portion of great value in organizations, mainly the journalistic ones that adhered to a new way of distribution and circulation of information through cyberspace and cyberculture, a change that gives it an intangible asset of extreme potential for generating future benefits, called wealth. Within this perspective, organizations, especially journalistic ones, have sought and have sought new ways to survive in the digital environment, since the new value chain of the digital age is different from the traditional one, being the keyword sharing. Thus, to substantiate this article, the various cases of the thesis Business model and management for news portals of the “New Economy” were used as a basis to portray what happened in the journalistic industry. It is concluded that the future of the newspaper is intrinsically linked to digital media, which requires an increasingly intelligent and collaborative environment, with the active participation of all agents involved, which further corroborates the supremacy of intangible wealth.

Keyword— Journalistic organizations, tangible asset, intangible asset and goodwill.

Resumo— Este artigo traz à tona o termo “nova economia” que é o conceito de fazer negócios na era digital, cujo valor de troca é a informação, onde distâncias não existem e quase tudo está a um clique. Neste cenário as organizações deixam de agir isoladamente para atuar em sinergia, parceria, com capacidade de juntar empresas de diversos setores para gerar um negócio independente. Em tempos de organizações da “nova economia” é importante considerar a riqueza sob dois aspectos: tangível (com seus ativos quantificáveis) e intangível (marcas, prestígio, confiabilidade, conhecimento), já que com a aceleração da aplicação da tecnologia e desenvolvimento de informação, o intangível passou a configurar uma parcela de grande valor nas organizações, principalmente as jornalísticas que aderiram a uma nova maneira de distribuição e circulação de informações através do ciberespaço e da cibercultura, mudança esta que lhe confere um ativo intangível de extremo potencial de geração de benefícios futuros, chamado de riqueza. Dentro desta perspectiva, as organizações, principalmente as jornalísticas, buscaram e têm buscado novos caminhos para sobreviver no ambiente digital, pois a nova cadeia de valor da era digital é totalmente distinta da tradicional, sendo a palavra-chave compartilhamento. Desta forma, no sentido de consubstanciar este artigo foram utilizados os diversos casos da tese Modelo de negócio e gestão para portais de notícias da “Nova Economia”: proposta conceitual, como fundamentação para retratar o que

ocorreu na indústria jornalística. Conclui-se que o futuro do jornal está intrinsecamente ligado aos meios digitais, o que exige um ambiente cada vez mais inteligente e colaborativo, com a participação ativa de todos os agentes envolvidos, o que corrobora ainda mais a supremacia da riqueza intangível.

Palavras-chave— organizações jornalísticas, riqueza tangível, riqueza intangível e goodwill.

I. INITIAL CONSIDERATIONS

From the '80s, with the emergence of the computer; and from the '90s, with the popularization of the internet, cyberspace and consequently cyberculture emerged, representing a milestone in the transformations that occurred in the journalistic industry and, also, for the establishment of the concept of “New Economy”. According to Nassif (2000, p. 11), the term “New Economy” refers to companies that stop acting in isolation to act in "synergy, partnership, the ability to join companies from different sectors to generate an independent business".

The concept of “New Economy” goes beyond technological aspects related only to the internet; also involving the relations between human beings, organizations and society, and all possibilities of network interconnection (TAPSCOTT, 1997).

“New Economy” is the new concept of doing business in the digital age, when exchange value is information and the grantee of the reward is the customer. Based on the real-time concept of the internet, where distances do not exist and almost everything is just a click away. This new reality exhibits the importance of reviewing the relationship policies between the company and the customer.

Also called the digital economy, internet economy or web economy, the term “New Economy” can mean “digital networks and communication infrastructures that provide a global platform from which individuals and organizations interact, communicate, collaborate and dig for information”(SIQUEIRA E CRISPIM, 2012, p. 11).

The existence of virtual communities can germinate in environments of this order, open and porous, as well as the most recent views of the meaning of organizations, which can be considered as “organic and dynamic processes in which new elements constantly enter the scene” (SANTAELLA, 2010, p. 278).

Tangible asset and intangible asset

In times of “New Economy” organizations, how can we measure wealth, since one part is tangible with its quantifiable assets and another large part is intangible, as they represent brands, prestige, reliability, and knowledge? It is extremely important to consider wealth in two aspects: tangibleasset and intangibleasset.

A tangible asset is the result of the relationship between income, costs, and expenses over a given period. In this way, it is possible to quantify the result for a given period by directly assessing how the wealth of the business has changed. Such behavior of the mutation of the tangible asset can be understood in figure 01:

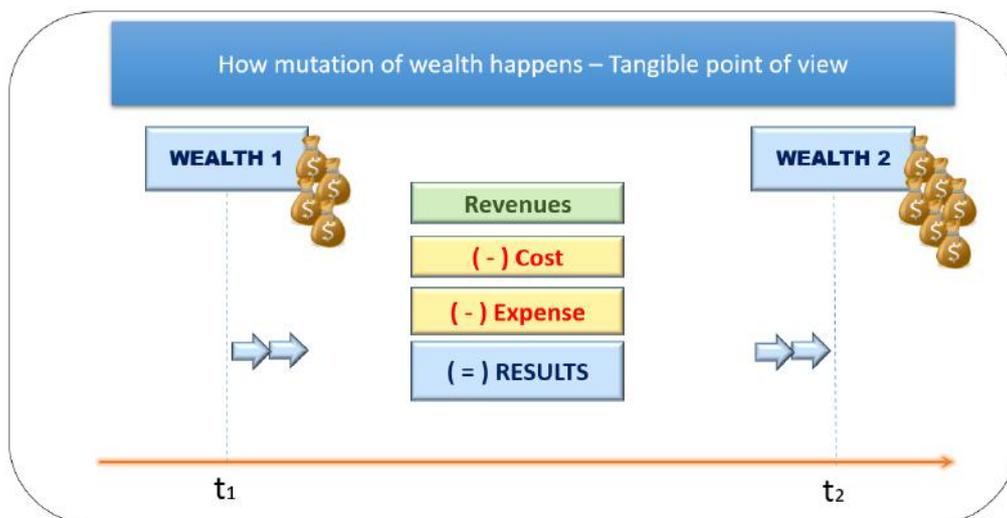


Fig.1: Mutation of wealth in the tangible view

Fonte: Rodrigues (2017)

In a given initial period of time t_1 , there is wealth 1. With the development of activities by the organization, there is a comparison between revenues (sales/services) and costs, and expenses acquired in a given period to which the result name. This economic result will alter wealth for a later time t_2 , generating wealth 2.

With the acceleration of the technology application, development of information and, consequently, generation of knowledge in companies, the intangible began to configure a portion of greater value in the company, as points out Ludwig (1997):

Therefore, information starts to figure as the main economic asset in that it is the fundamental ingredient in the generation of knowledge [...]. Companies are now worth more for the knowledge they hold or commercialize than for their physical assets [...]. With the advent of the digital civilization, intangible becomes the most valuable part of a company (our translation. LUDWIG, 1997, p. 11).

Intangible asset means the value of a company due to the specific knowledge it has concerning a product or process. This appreciation or recognition of a company's intangible asset as a representation of its greatest asset is a new business concept, the result of the advent of the digital age (KAYO, 2002).

Iudícibus et al (2005) point out that constant changes have generated a dynamic and competitive environment, in which wealth is no longer centered on physical benefits, but on intellectual capital and intangible assets. This means that administrators need to generate better and better results.

The world is going through a very complex phase. A great technological advance, provided by information technology and the telecommunications industry, allowed a great evolution of science, generating new estates and services. Simultaneously, there is a high-risk increase, due to the growing insecurity, terrorism, and abrupt fluctuations in the exchange rate, in the prices of production inputs and the shares of companies (our translation. IUDÍCIBUS et al, 2005, p. 11).

Indeed, as Oliveira (1999, p.125) understands, the formation of intangibles is “the central idea, the gene”, of knowledge-centered companies:

Companies that will operate in this new environment, whatever their form of organization, virtual organizations or economic networks, share the same logic as the knowledge economy: ideas, knowledge, the ability to process information, and other intangibles - such as human capital, goodwill with customers - generate wealth much faster and at a much lower cost than tangible assets did (our translation. OLIVEIRA, 1999, p. 125).

In this context, in which companies need to seek new ways of generating value, what will define the effective value of the company is the best interaction between tangible and intangible assets since it is difficult to dissociate from each other (PEREZ and FAMÁ, 2006).

Authors such as Kayo (2002), Lev (2001), Stewart (1998) have asserted that the generation of wealth in companies would be directly related to intangible assets, as these assets would be responsible for superior economic performance and the generation of value for shareholders. The same authors also emphasize that a greater presence of intangible assets, which is not accounted for, could explain the gaps between the market value of companies and the value reflected by traditional accounting: the term known as goodwill.

Quantifying this intangible value, which is the gap between a company's balance sheet and its market value – goodwill – is one of the biggest challenges nowadays, especially for companies that have the high technical knowledge, as explained by Catelli (2001):

It is the goodwill that constitutes, mainly, the ability of the company, as a subsystem, to interact effectively with the environment macrosystem. It is this capacity that leads to the right decisions, by which the company, in the present, anticipates the future creation of value in some way, increasing the value of its assets (our translation. CATELLI, 2001, p. 31).

In the digital world scenario, it is possible to highlight several examples of companies with this profile: Instagram, which was acquired by Facebook for a billion dollars in 2012, with only 13 employees (FERNÁNDEZ, 2017); Snapchat, which refused an offer of US\$3 billion; and Facebook, which bought WhatsApp for US\$19 billion (COSTA, 2014).

According to Moreno (2016), Airbnb – an online community market for people to advertise, discover and book accommodation around the world – raised in 2016 enough money to make new investments and pursue new growth opportunities, after becoming the third most valuable startup in the world, \$30 billion according to The New York Times, behind only Uber and Xiaomi.

Founded in 2008, Airbnb was largely rejected at the beginning, but in 2017 it became a giant. At some points in its trajectory, such as in June 2016, it has presented a higher market value than traditional Brazilian companies such as Petrobras and Vale. According to information from the Wall Street Journal, the company

generated revenues of US\$340 million and cash of US\$2.2 billion in the third quarter of 2015 (BORNELI, 2015).

In 2019 alone, Airbnb moved R\$10.5 billion in Brazil, considering not only the accommodation but the entire chain that involves this type of tourism, such as commerce and local restaurants. The future of Airbnb, as well as shared hosting platforms, will depend on its ability to adapt to the post-Covid world.

In 2020, according to the CB insights website, startups valued at more than 1 billion dollars, called unicorns, were classified according to the table below, with Airbnb in 6th place:

Table.1: Global Unicorn Club: Private Companies Valued at \$1B+

	Referenciamento	Company	Valuation (\$)	Country	Category
1	App - TikTok	Toutiao (Bytedance)	\$75,00	China	Artificial intelligence
2	Uber China	Didi Chuxing	\$56,00	China	Auto & transportation
3	Serviços Financeiros	Stripe	\$36,00	United States	Fintech
4	Transporte Aeroespacial	SpaceX	\$36,00	United States	Other
5	Gerenciamento de dados	Palantir Technologies	\$20,00	United States	Data management & analytics
6	Compartilhamento hospedagem	Airbnb	\$18,00	United States	Travel
7	Concorrente TikTok	Kuaishou	\$18,00	China	Mobile & telecommunications
8	Serviços Financeiros	One97 Communications	\$16,00	India	Fintech
9	Serviço entrega alimentos	DoorDash	\$16,00	United States	Supply chain, logistics, & delivery
10	Jogo	Epic Games	\$17,80	United States	Other

Source: prepared by the authors, based on data from the website cbinsights.com (2020)

Thereby, it appears that the concentration of wealth of new companies in the digital age, according to the reference field in table 01, is predominantly based on intangible wealth.

Mamona (2014) mentions in the report of the examination magazine entitled *20 companies traded above their equity value on the stock exchange*, which companies were worth much more than their equity value, according to a survey by *Ativa Corretora*. The result of this survey has confirmed that the market pays much more than companies are worth, such as *Natura* in which the equity value of the share was 2.09, while the market value was 34.10, its worth was 16.3 times more.

As previously mentioned, the calculation of economic profit – that is, the economic result of companies – is represented, objectively, by the confrontations of costs and expenses with revenues that occurred in a given period and its consequent equity variation – variation in tangible asset. But it is also, subjectively represented, by variations in future flows of benefits provided by investments in intellectual capital, variation in the intangible asset.

Such intangible asset change behavior is represented by the future flow of benefits that can be seen in figure 02:

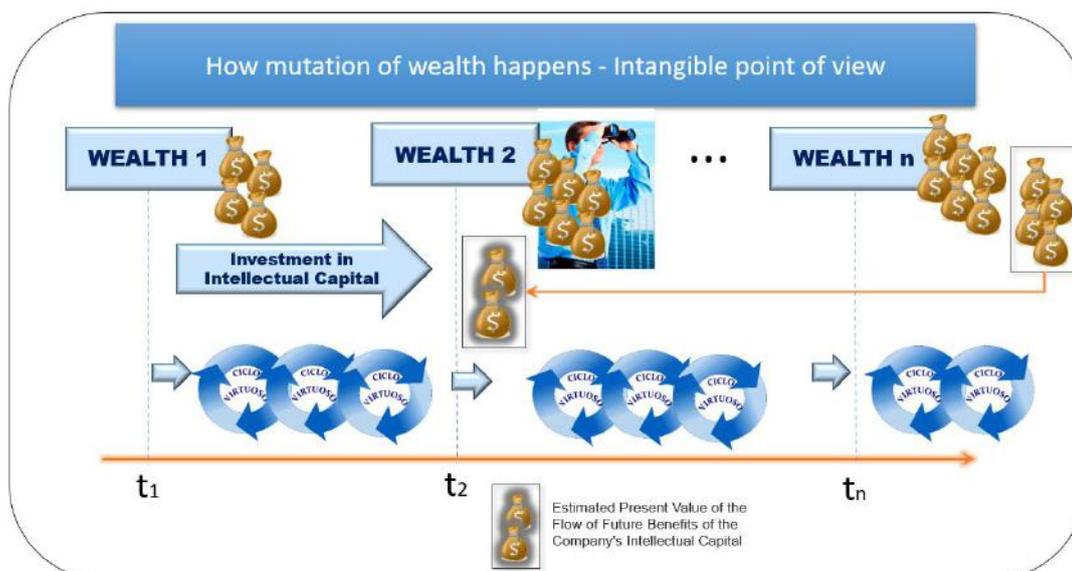


Fig.2: Mutation of wealth in intangible point of view

Fonte: Rodrigues (2017)

Figure 02 describes the variations in tangible ($t_1 \times t_2$) and intangible ($t_2 \times t_n$) asset of a supposed company that is already engaged in the “New Economy” scenario, systematically invests in its intellectual capital, which provides it in a medium-term view, a large increase in tangible asset.

The simulation in the figure above demonstrates how intellectual capital can be transformed into intangible benefits that add value to companies and can generate future profits. In this perspective, it is clear that, at some point in the long term, intellectual capital is converted into monetary value (MARTINS and ANTUNES, 2002).

Journalistic organizations, originally, had their mutation of wealth based on the generation of revenue through the sale of printed newspapers and the advertisements printed on it. With the redirection of the generation of results from tangible assets to intangible assets, journalistic organizations are being forced to adapt to a new management proposal to remain in the market.

The wealth in the newspaper industry was based on the large tangible assets of its industrial park (rotary). However, with the changes brought by technology, especially digital, these companies were and are being forced to adapt themselves. Following the “New Economy” proposal, journalistic organizations joined the use of low-value tangible assets (networks computers), creating a new way of distributing and circulating information through cyberspace and cyberculture. This

change gives them an intangible asset with extreme potential for generating future benefits, called wealth.

Transformations of the journalistic business worldwide

Of the changes in journalism resulting from the new digital era, the following stand out: rapidity in the production and transmission of news, drop in advertising revenue and content collection, loss of paying readers, among others. These changes can reveal the need to rethink the business of the newspaper industry, which is already occurring, punctually, worldwide (PENA, 2008).

The journalist Caio Túlio Costa, in his postdoctoral research at Columbia University Graduate School of Journalism, proves that there is this imperative, because what served the printed product no longer meets the digital: “newspapers need to shake up their way of relating with people and respect new ways of consuming information and related services” (COSTA, 2014, p. 55).

Costa (2014) acknowledged some attempts at changes, however, based on the old value chain of the news industry:

Its executors only transposed the old Gutenberg form, the same business of journalistic content on their websites. Second, they filled this production with advertising (or what was left of it) and, third, the product distribution started to be made through the commercialization

of digital signatures (our translation. COSTA, 2014, p. 54).

As shown in figures 03 and 04 below, the new value chain of the news industry is different from the traditional value chain. It is necessary to understand that the model has changed and that the traditional way of doing journalism is over. It is not about value or about not

making sense, we just have to understand that things have changed. The way that people are related to the news and the personal way that people became actors in the newsshow that the traditional way of doing journalism is not possible anymore. In the new value chain, inside the digital environment, it is necessary to share distribution and advertising (COSTA, 2014).

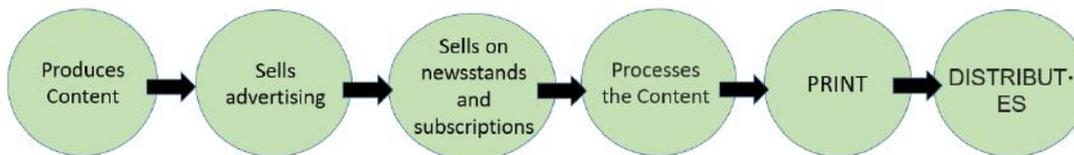


Fig.3: Classic value chain of the newspaper industry

Source: Rodrigues (2017), based on Costa's research (2014)

Figure 03 represents the traditional value chain, also called classic, which is dominated by journalists. Its content is produced by journalists who sell advertising, and the more diverse this advertising is (the less it depends on the government and companies), the less partial and the more independent journalists can be, especially from the government, companies, public causes, and public interests.

In this classic chain, journalists sell the content at newsstands or through subscriptions, process (prepress), print (even when they hire someone to print), and

distribute; it means that they hold 100% of the dominated value chain (COSTA, 2014).

In the new value chain, according to figure 04, journalists continue to produce content in the digital environment, but they no longer market advertising in the same way. In this model, several different companies can help with the marketing task: Google, Facebook, Twitter, advertising agencies – the ad networks, in other words, several companies that seek to profit from a portion of the advertising profits.

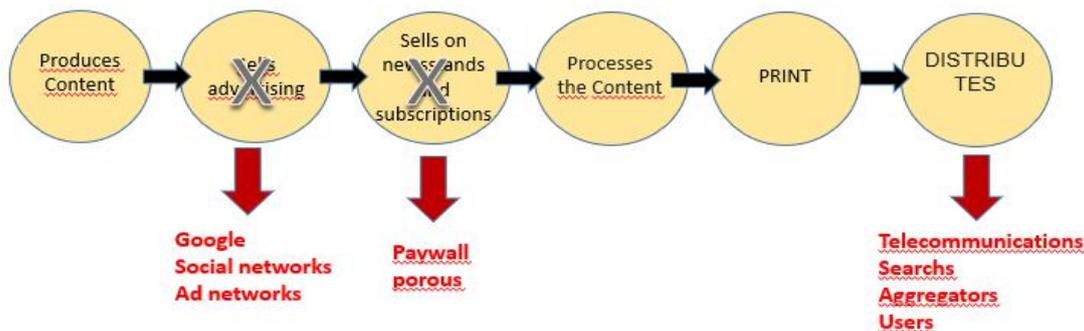


Fig.4: Value chain in the digital environment

Source: Rodrigues (2017), based on Costa's research (2014)

Single sales and subscriptions are no longer the focus of interest for these companies, however, there are still only a few cases due to the paywall and porous paywall, which are still undefined. In the value chain in the digital environment, journalists process information, do not use printing anymore and do not distribute; since those who make money (make a profit) with distribution today are telecommunications companies. There are also search

engines, mainly Google, aggregators (big portals, small ones, Facebook, Twitter, etc.), and a new and very interesting factor, the reader distributes their content. This is the new value chain in the digital environment (COSTA, 2014).

It is a fact that many things have changed in journalistic production. The keyword for this moment of change and adaptation is sharing. It is necessary to share

not only the distribution, but also the sale of advertising, for example, and in addition to giving content. And there is no point in transposing the traditional chain into the digital environment, this is not possible, as the rules are different.

Because of this scenario, currently, some companies are looking for solutions to overcome the migration from print to digital newspapers. The following cases describe the situation of some journalistic organizations that looked for new ways to try to survive in the digital environment, because “the old way has frayed

and the solution begins with the understanding of a new value chain”, as explained by Costa (2014, p. 11).

✓ CASE 1 - The New York Times

The New York Times, an American newspaper recognized worldwide for the quality of the journalism it practices, saw its operating result drops 83% in 12 years, as shown in table 02, based on Costa's research(2014):

Table.2: The New York Times economic result

Billions of US\$	2000	2012	Variations	%
TURN OVER	3,50	1,90	-1,60	-46%
OPERATING PROFIT	0,64	0,11	-0,53	-83%
NET PROFIT	0,40	0,13	-0,26	-66%
NET MARGIN	11%	7%	- 4 pp	-66%

Source: Rodrigues (2017), already published in the Annals of the 40th Intercom (2017).

It should be noted that, if the projected revenue trend continued to drop, the newspaper would not have much time to survive in the market. Advertising revenues decreased by 64% since digital media competitors concentrated in their hands the revenues from classified ads (COSTA, 2014).

For Costa (2014, p. 54) the porous payroll system, “that system which offers the reader the chance to become a paying subscriber after experience a certain amount of texts” contributed to the circulation revenue (sale of single copies and newspaper subscription) until it improved a little, around 25%.

The revenues from this system, in which the collection is only made after exceeding a certain number of articles, helped to slow down the drop in the billing of major communication vehicles, but did not prevent its decline, nor did it reverse it, according to Anderson, Bell, and Shirky (2013).

✓ CASE 2 - The Wall Street Journal

Another example is The Wall Street Journal, which, with an average circulation of 2.4 million copies on weekdays, jumped in August 2013 to an audience of 56 million people on the Internet, what is, 23 times greater online than in print.

Raju Narisetti, vice president of News Corp, the company that publishes The Wall Street Journal, said that “since the press has existed, there have never been so many people consuming we have produced, likenowadays” and

argued that the issue is not that people do not want the content of the newspaper, but it is very difficult to get money from it (COSTA, 2014).

✓ CASE 3 - Jornal do Brasil

Jornal do Brasil, one of the oldest Brazilian newspapers, founded in 1891, with an estimated debt of R\$100 million, has stopped its activities in the printed version in September 2010, continuing only in the digital version.

The vehicle, which had a daily circulation of 100,000 copies in 2007, went into decline without return, reaching 20,941 copies in March 2010, according to information from the *Folha de São Paulo* website.

O Globo, *Observatório da Imprensa*, *Carta Maior*, the portal of *Revista Negócios da Comunicação*, among other journalism and communication sites, have revealed that many years of mismanagement led the newspaper to become financially unfeasible. The successive financial crises, worsened by tax and labor liabilities, caused the vehicle to lose advertisers and readers.

It is important to note that, in February 2017, *Jornal do Brasil* - JB was purchased by a businessman who was studying the possibility of re-selling the printed vehicle, only in Rio's newsstands, with smaller circulation, to serve a specific nostalgic public of the newspaper (FOLHA DE SÃO PAULO, 2017).

✓ CASE 4 - *Jornal El País*

The Spanish newspaper El País, in the person of director Antonio Caño, declared, on March 3rd, 2016, that it was structuring itself to abandon the printed version, becoming an “essentially digital” publication and adapting to the challenges imposed by the new ways of consuming and reading information. It is a new organization, more efficient in the elaboration of content and in access to readers, as he says: “*EL PAÍS* has been restructured internally, to meet the requirements of users who increasingly access the newspaper's contents through their computers, cell phones, Smart TVs and social networks” (MANUEL, 2016, p. 02).

In an open letter, the director of El País told the newspaper staff that the transfer of readers from paper to digital is constant and that the habit of buying the newspaper on newsstand has been reduced to a minority. For him, a large part of the population, especially the younger ones, look for information in media other than printed material. However, the director understands that, these changes also have positive aspects, emphasizing that one of the most important is that millions of people around the world today show interest and have the ability to access the newspaper's content.

To meet this demand, Caño said that new work dynamics will be incorporated to increase the quality and quantity of the contents and products that *EL PAÍS* already offers, but taking these contents to mobile applications, smart TVs, or social networks. Thus, the main objective of the change is to convert *EL PAÍS* into an essentially digital newspaper, in a large platform that generates content that will be distributed.

The idea is for the newspaper to present a differentiated approach, with a newsroom without offices, open to collaboration, and the exchange of ideas, providing teams with the possibility of integration to build new stories. For director Caño, the difference is that readers become users of the site, through the cell phone or their profiles on social networks, since readers consume multimedia content more and more avidly.

Manuel (2016) has always defended the importance of not being afraid of change and the need for permanent transformation since digital culture represents a revolutionary change, where the transition from print to digital means just one of the steps that newspapers they will have to give to reach the future. The suggestion is for audiovisual and interactive journalism, a new way of communicating with a wider, varied, and different audience.

The statements of the director of *El País* are in line with the ideas of Anderson et al (2013, p. 38), that in the current scenario, companies in the journalistic area need to organize their processes given the importance of “including interactivity in graphics, giving the public direct access to a database, requesting images and information from the public, distributing materials through social networks ”; emphasizing that only through new possibilities it will be possible to guarantee the survival of journalism.

✓ CASE 5 – *Integration of O Globo, Extra e Expresso*

In early 2017, *Infoglobo* integrated the newsrooms of the newspapers *O Globo*, *Extra* and *Expresso*, while maintaining the identity of each brand. With the unification, the newspaper company tried to convey an image that is carried out “the biggest digital transformation of a journalistic publication in the country” (INFOGLOBO, 2017). However, what really happened was less than Jenkins has proposed (reference author in the convergence of media), what was already expected, since it is a journalistic company based on the traditional business model.

According to Frederic Kachar, director of *Infoglobo*, the consumer is now called 24/7, that is, 24 hours a day, seven days a week. Because life is digital and with this integration, the customer will have exclusive content at any time, in a digital environment with a more complete narrative, using all possible multimedia tools, videos, infographics, audios, besides a great text, of course.

A multiplatform, multimedia, and multi-brand editorial, and according to Juan Señor – partner at Innovation – an international media consultancy. This model is the same as that adopted by the Washington Post, The New York Times, The Boston Globe, major newspapers in the United States; which proves the statement of the executive director of ANJ Ricardo Pedreira, that the production of multimedia content for different platforms is a world trend.

✓ CASE 6 – *GDA, Grupo de Diário das Américas*

An alternative for survival in the digital world for newspaper companies, presented by Costa (2014), in his postdoctoral report, is the creation of personal networks, such as the Grupo de *Diário das Américas* - GDA, in which more than ten Latin Americans newspapers came

together to sell advertising in their editions in the United States.

According to the website www.gda.com, GDA, an exclusive consortium composed of eleven independent newspapers with more influence in Latin America, was founded in 1991 by the most traditional newspapers in the southern region, namely: *La Nación* (Argentina), *O Globo* (Brazil), *El Mercurio* (Chile), *El Tiempo* (Colombia), *La Nación* (Costa Rica), *El Universal* (Mexico), *El Comercio* (Peru), *El Nuevo Dia* (Puerto Rico), *El País* (Uruguay), *El Nacional* (Venezuela) and *La Prensa Grafica* (El Salvador).

According to information on its website, the GDA has an audience of over 5 million readers daily and 10 million on Sundays, its readers are considered highly educated individuals, with great financial resources and decision-making power. The reach of the GDA is unparalleled in Latin America, being considered as the most powerful communication resource.

Thus, the discussed cases show a small part of what is already happening regarding the adequacy and transformation of the world journalistic industry.

Jorge Nóbrega, director-general of Corporate Management of Globo Organization, highlights that the digital environment instigates to look at the media business in a new way, which requires innovative business models that collaborate for better navigation in this converging world (OSTERWALDER and PIGNEUR, 2011). Nóbrega's thinking confirms the statement of Henry Jenkins, a reference in the subject of media convergence:

Welcome to the culture of convergence, where old and new media collide, where corporate media and alternative media intersect, where the power of the media producer and the power of the consumer interact in unpredictable ways (JENKINS, 2009, p. 29).

When Santaella (2013) explains Participatory Culture from the perspective of Jenkins, she reaffirms this current scenario, emphasizing that Participatory Culture is when former consumers of the mass media become producers and consumers at the same time, in an indissoluble relationship, since consuming is also commenting, giving opinion and participating.

Interactivity has created new conditions and challenges too. One of them is the new shape for news professionals: Cyberjournalists –who are adapted to work with images, text and audio interactively; and for the

passive ex consumers of the news (former “readers”) the pompous title of citizen journalists. It is a different reality, in which Internet users are not only passive coproducers of information but also cooperative producers of “virtual worlds” (LÉVY, 1999, p. 35), as explained by Anderson *et al* (2013):

All of a sudden, everyone had a lot more freedom. News producers, advertisers, new actors and, above all, the group is formerly known as the audience, enjoy unprecedented freedom to communicate, in a restricted or wild way, without the old limitations of broadcasting models and the written press (our translation. ANDERSON *ET AL*, 2013, p. 32).

For Costa (2009), the consumer has started to have an unprecedented power which is the power of media, because he started to have an additional element of communication with his peers. It was from this idea that the term prosumer emerged, when the consumer became a producer of product reviews.

A consumer as a quality analyst of everything that is buyable, capable of interfering in the quality of a product or service, has always existed, explains Costa (2009). The difference is that before he could not make this his capacity in a public way and now, he can do it, being able to use it for good or for evil.

But at the beginning of this century, the changes accelerated a lot: convergence, interactivity, and even what many communication organizations already feared, the loss of control of centralized information, led by monopolies and oligopolies of the media power. Steven Johnson believes there is a need to assess this impact:

(...)two worse scenarios concern us now, and it is important to distinguish them. First, there is a panic that newspapers will disappear as companies. And then, there is the panic that crucial information will disappear with them, that we will suffer culturally, because newspapers will not, for a long time, be able to generate the information that we have been relying on for so many years (JOHNSON, 2009, p. 11).

Pavlik (2007) states that companies must plan very carefully the choices they are going to adopt. He notes that online news content must evolve through three steps:

The first stage involves adapting the contents of the printed newspaper for

online editing. In the second phase, the content is expanded with interactive resources, such as search engines, links, and some customization for the user who receives news. The third phase is characterized by the creation of original content (PAVLIK, 2007, p. 43).

There are universality and unanimity regarding the need for the Journalistic Industry to adapt and reinvent itself. But also, we can observe some thoughts that it must happen in a radical and fast way. However, others – with a more prudent characteristic – consider this rush and anxiety about the "obligation" newspapers have to adapt to new technologies and to meet the expectations of Internet and Social Network users, without proper planning, may

represent considerable problems, once it is not enough to simply switch from paper to digital (MELECH, 2012).

The behavior of the newspaper industry in Brazil

The *Instituto Verificador de Comunicação – IVC* – is the body responsible for certifying information about the circulation of newspapers in Brazil, distinguished by their means of publication. In Brazil, this body is also responsible for multiplatform auditing services, which include circulation and distribution of newspapers and magazines, digital publications, events, audiences on the web, including mobile devices, applications, and web radio.

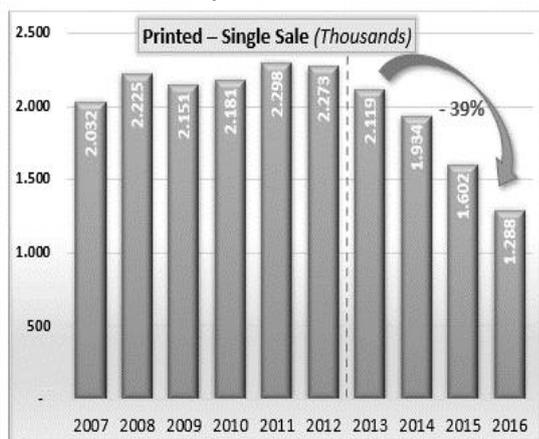
Table.3: Circulation of newspapers in Brazil from 2007 to 2016 (per day)

Circulation of Newspapers (Thousands)	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016
Printed - Single Sale	2.032	2.225	2.151	2.181	2.298	2.273	2.119	1.934	1.602	1.288
Printed - Signature	2.159	2.277	2.083	2.104	2.126	2.146	1.993	1.549	1.362	1.385
Digital	1	6	7	28	72	164	232	535	680	740

Source: Rodrigues (2017)

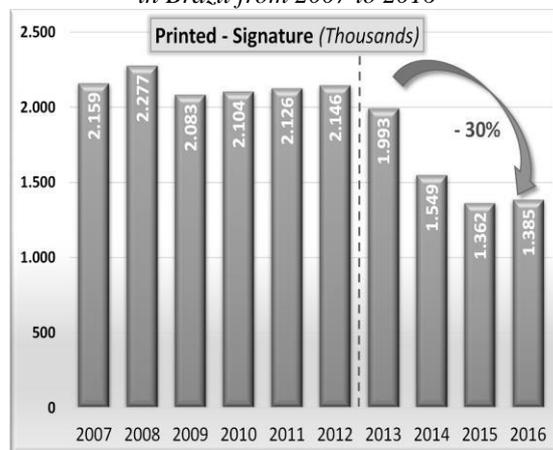
When observing the evolution from 2007 to 2016 (10 years), it is possible to see in table 03 that the circulation of newspapers in printed media suffered a great drop, both for individual sales and for subscriptions. This decline is even more evident in the last four years when circulation in printed media (single sales) dropped by 39%, and subscription sales dropped by 30%, as can be seen in charts 1 and 2 below:

Graph 1: circulation of printed newspaper (single sale) in Brazil from 2007 to 2016



Source: prepared by the author, based on IVC data

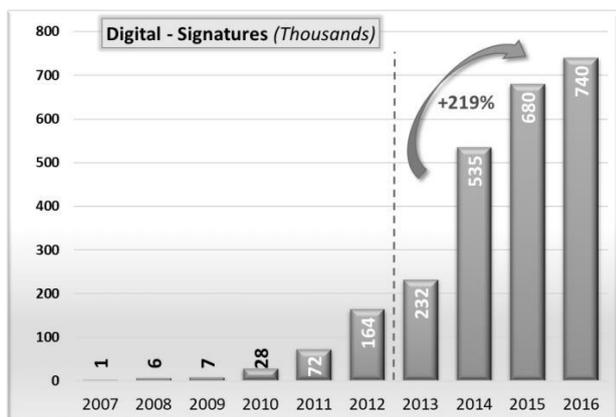
Graph 2: circulation of printed newspapers (subscriptions) in Brazil from 2007 to 2016



Source: prepared by the author, based on IVC data

On the other hand, in that same period, the circulation of newspapers in digital media showed great growth. There was also an acceleration of this growth in the last four years (from 2013 to 2016), when circulation in digital media has more than tripled, presenting an increase of 219%, as shown in graph 3:

Graph 3: circulation of digital newspapers in Brazil from 2007 to 2016



Source: Rodrigues (2017)

It would be possible to present various data on newspaper circulation, in its various means of transmission, to analyze numbers and strategies of the newspaper industry, but it was decided to focus and stick to the conclusion that the future of the newspaper is intrinsically linked to digital media.

This aggressive conclusion is associated with the aging of readers, the cost of paper, and the strong reduction of advertising funds linked to the printed media. In Brazil, for example, the printed newspaper had reduced its participation in the apportionment of the budget. This media, which held 21.73% of the investment in communication in 2001, ended up with a reduction to 12.36% in 2010. Meanwhile, the Internet, which had only 1.49% in 2003, went to 4.64% in 2009, according to information from the National Association of Newspapers - ANJ (ANJ, 2016).

According to the *ICT Household Survey*, published by the Internet Steering Committee in Brazil (CGI), there was considerable growth in the number of Internet users, reaching an estimated 102 million individuals in 2015. "This number corresponds to 58% of the Brazilian population aged 10 or over (a proportion that was 34% in 2008)" (CGI, 2016, p. 138). The survey has also revealed that 49% of the total internet users in Brazil read newspapers, magazines, or news online, in different electronic media.

Comparing the three most important newspapers in Brazil –*Globo, Estadão and Folha*–, from January 2014 to December 2015, in their various means of transmission (print, digital and hybrid), still using IVC data, it is possible to verify that there was a great increase in the

circulation of newspapers in digital media; a slight drop in hybrid signatures and a sharp drop in print circulation.

The priority for the coming years, according to the Activities Report of the National Association of Newspapers (ANJ) of 2016, is the reduction of costs and expenses, since the revenue of the newspaper companies pointed to a decrease in most cases (77%); concomitantly, 88% of newspapers reduced the number of employees between 2014 and 2015.

II. FINAL CONSIDERATIONS

Traditional business models and arrangements in the journalistic field no longer reliably reflect the need for current journalistic organizations and, thus, no longer effectively subsidize the financial aspect. These models sin, mainly, concerning the relative representations of the expenses incurred in their production processes, as well as in the form of the behavior of costs in the face of retractions and production increases.

However, the data analyzed in this article brought clearness regarding the inevitable migration in the medium of transmission and in the agents that generate the news and, in a way, even in the very characteristic of the news.

Thus, there is a real need to ensure that the journalistic organization of the new economy has economic sustainability. Based on the understanding of how value is formed and constituted in journalistic organizations in the digital age, it is considered important to seek ways to control this formation and constitution, to allow the journalistic business a constant flow of value accumulation that guarantees it the perpetuation of the business.

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Natural coagulants replacing ferric chloride for wastewater slaughterhouses treatment

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Abstract— This study purpose was to investigate the usage of two natural coagulants: Tanfloc SG® and chitosan, in order to replace the currently ferric chloride usage by the wastewater coagulation process from slaughterhouses subsequently initial treatment. Preliminary tests were accomplished to delimit the research groups of the operating parameters: pH and coagulant concentration, based on the wastewater COD diminution. Therefore, following these results, the tests were defined by a rotational central composite design (CCRD) with three central and four axial points, amounting eleven tests, demarcating the optimum operating parameters for each coagulant, which were, respectively, pH 7.0 and concentration of 200.0 mg.L⁻¹ for Tanfloc SG®, pH 4.0 and concentration of 500.0 mg.L⁻¹ for chitosan, and for ferric chloride, it was pH 4.5 and concentration of 100.0 mg.L⁻¹. Tests were managed under optimal conditions and the results suggested that the Tanfloc SG® coagulant was expressively more efficient in the secondary wastewater treatment from slaughterhouse.

Keywords— tannin; environment; clean technology; coagulation; quitosan.

I. INTRODUCTION

Slaughterhouse industries are characterized by the large effluent volume produced. Remove color, turbidity and natural organic matter is one of the various processes applied in the liquid effluents treatment, it is named coagulation (BUDD *et al.*, 2004; DA SILVA *et al.*, 2004; HASSEMER *et al.*, 2002; HUANG *et al.*, 2009; LEIKNES, 2009).

Coagulation corresponds to the colloidal dispersion destabilization, obtained by decreasing the repulsion forces between negatively charged particles adding chemical or natural coagulants (PAVANELLI, BERNARDO, 2002; SILVA, 2005).

Amongst the most applied coagulants there are two groups distinguished by its origin, being: inorganic; aluminum sulfate, ferric chloride and ferric sulfate, and organic; tannin, chitosan and natural polyelectrolytes (PAVANELLI, BERNARDO, 2002; MATOS *et al.*, 2007; BONGIOVANI *et al.*, 2010).

Inorganic coagulants present as major disadvantage: once it is applied in the effluent treatment process, traces of it might remain in the effluent (SILVA, AQUINO, SANTOS, 2007), and its accumulation may

cause damage to health and to the environment (CORAL *et al.*, 2010).

Natural products in the coagulation process is economically sustainable, since it presents efficiency in several pollutants removal, it also presents recycling possibility; residual sludge as raw material for the organic fertilizers production, with gradual and controlled nitrogen release, consequently avoiding the urea usage, which contributes to the environmental impact and costs minimization with chemical substances acquisition, which in some cases are imported (BELISÁRIO *et al.*, 2009; MANGRICH *et al.*, 2013).

Natural coagulants include tannins, which belongs to a phenolic compounds group from secondary plant metabolism, defined as water-soluble phenolic polymers capable of precipitate proteins. Tannins present high molecular weight, contain enough hydroxylphenolic groups to permit the protein cross-links formation and act in colloidal systems, neutralizing charges and forming bridges between these particles, being this process responsible for flake formation and consequent sedimentation (DESPHANDE *et al.*, 1986; HASLAM, 1966; MANGRICH *et al.*, 2013; MARTINEZ, 1996).

According to Barradas (2004) tannin is applicable over an extensive pH variation, from 4.5 to 8.0. Renewable raw material usage in the coagulation process for the effluents treatment, such as vegetal tannins, is a promising alternative presenting benefits for public health, since it does not present metal traces, plus the environmental preservation, as well as it results in less sludge mass generation, which is organic and biodegradable, facilitating its disposal in the soil (CRUZ *et al.*, 2005, BONGIOVANI *et al.*, 2010).

Regarding the coagulation treatment efficiency, according to Sánchez-Martín (2010), in studies conducted on surface water treatment pilot plant, the Tanfloc® use resulted in up to 50% of color reduction, up to 75% of surfactants removal, and organic matter removal represented by 40% decrease in COD and 60% in DBO. Pelegrino (2011) studied the tannin usage in sanitary sewage after treatment system with tannin concentration of 65 mg.L⁻¹ and 2.0 mg.L⁻¹ of cationic polymer obtaining for the parameters studied satisfactory results with turbidity reduction of 95.2%, apparent color reduction of 82.1%, total phosphorus reduction of 49.2%, COD reduction of 80.7% and total suspended solids reduction of 87.9%.

Another natural compound with coagulant capacity is chitosan, which was isolated in 1859 by heating chitin in concentrated potassium hydroxide solution, resulting in cationic polyelectrolyte acquired from the chitin deacetylation, which can be obtained from fungi, especially *Mucor* species, yeast and crustacean exoskeleton, particularly shrimp and crabs. Chitosan production can be achieved by acetyl group partial or total hydrolysis with concentrated sodium hydroxide solutions or enzymatic hydrolysis, and the different methods result in chitosans with different deacetylation degrees and molecular weight, determining its applicability (FREEPONS, 1986; TOLAIMATEA *et al.*, 2003; WESKA *et al.*, 2007; WIBOWO *et al.*, 2007; CAPELETE, 2011).

According to Renault *et al.* (2009), compared to metal salts, chitosan is more efficient at lower concentrations, producing larger flakes, favoring the sedimentation rate, the sludge volume is inferior and cause less environmental impact due to its biodegradability, however this effectiveness is restricted in a pH and concentration assortment.

Gonçalves *et al.* (2008) applied chitosan for the treatment of contaminated effluent with food coloring and perceived that decreasing the reaction pH from 7 to 6 and increasing chitosan concentration from 250 to 500 mg.L⁻¹, there was an increase in the elimination colorant from 33% to over 90%.

Laus *et al.* (2006) studied the elimination of: acidity, iron and manganese from waters polluted with coal mining using tripolyphosphate cross-linked chitosan microspheres. The achieved results were acceptable, since the microspheres facilitated in the acidity regulation (pH from 2,5 to 6,0), and were efficient in the iron and manganese removal, with 100% and 90% removal, respectively.

The present work, which practices the clean technologies usage for wastewater treatment, aimed to assess the Tanfloc SG® and chitosan natural coagulants application in ferric chloride replacement subsequently preliminary and primary treatment of industrial effluent slaughterhouse by the coagulation process.

II. MATERIAL AND METHODS

2.1 STUDY SAMPLE

The present work studied an effluent previously subjected to primary treatment in the industry static and decanter sieves, and the effluent was collected momentarily afterwards this procedure. The collections were always accomplished through morning in an attempt to greater samples composition consistency.

The collection and conditioning procedures followed NBR 9898/1987 of the Brazilian Association of Technical Standards (ABNT, 1987). The samples were conditioned in polyethylene bottles, transported immediately after collection and cooled at 4°C, for subsequent analysis.

2.2 CHEMICALS REAGENTS

Tanfloc SG® used in the tests was supplied by TANAC S.A. Other coagulants used were ferric chloride hexahydrate P.A (FeCl₃.6H₂O, Alphatec) and chitosan (Quimer). COD analysis, silver sulfate (Qhemis), potassium dichromate (Alphatec) and mercury sulfate (Qhemis) were used. Phosphorus determination, COT, nitrogen and iron, reagents sets for HACH analysis were purchased from HEXIS. The other reagents used (sulfuric acid, hydrochloric acid and sodium hydroxide) were of analytical purity.

2.3 COAGULATION PROCESS

Coagulation assays were conducted in batch mode at room temperature (25 ± 1 °C) in jar test equipment. For each coagulant investigated the assessed operating variables were coagulant concentration and reaction pH.

Coagulation process was: coagulant agent addition at the desired concentration into the effluent, with subsequent pH adjustment (sulfuric acid and sodium

hydroxide solutions were assistants to adjust the pH), at concentrations of 5; 1 and 0.1 mol.L⁻¹. In the fast stirring step, samples were agitated at 120 rpm for 3 minutes (Bongiovani *et al.*, 2010), and then the slow stirring step at 25 rpm for 60 minutes was started (Coral *et al.* 2010; Affam *et al.*, 2014). Afterwards, the agitation was interrupted and the decantation phase to form flakes initiated for a 60 minutes' period (El-Gohary *et al.*, 2009). The treated sample (supernatant) was collected for characterization analysis.

2.3.1 Preliminary Assays

Preliminary tests were performed to limited the assessment variety of the investigated operational parameters. The pH range oscillated from 3 to 11, while the coagulant concentration range alternated from 100 to 1000 mg.L⁻¹ for Tanfloc SG[®] and chitosan, and from 25 to 700 mg.L⁻¹ for chloride ferric, the values were determined by literature review. Efficiency was evaluated as a function of COD removal percentage.

2.3.2 Experimental Planning

For the optimal operational parameters determination, an experimental design was carried out for each coagulant investigated using the Rotational Composite Central Design (DCCR) 2² with 04 (four) axial points and 03 (three) central points, which resulted in a total of 11 trials for each coagulant. The response variable was the COD removal percentage, and once the optimal operating parameters (pH and coagulant concentration) were defined for each coagulant investigated, new assays were conducted under these conditions.

2.4 ANALYTICAL METHODS

Liquid effluent samples characterization analyzes (Table 1) were performed according to the methodologies described by the Standard Methods for the Examination of Water and Wastewater (APHA/AWWA/WEF, 2012).

Table 1 – Analysis for effluent characterization

Group	Analysis	Unity	Method (number)
1	Chemical oxygen demand (COD)	mg.O ₂ .L ⁻¹	Closed reflux color matching (5220D)
	Real color	mg.Pt.Co.L ⁻¹	Cobalt Platinum (2120A)
	pH	-	Potentiometric (4500 H ⁺)
	Turbidity	NTU	Nephelometric (2130B)
2	Chemical oxygen demand (DBO)	mg.L ⁻¹	Respirometric (5210D)
	Total Iron	mg.Fe.L ⁻¹	Colorimetric o-phenanthroline /8008)
	Total* Phosphorus	mg.P.L ⁻¹	Ascorbic acid (8190)
	Total Organic Carbon (COT)*	mg.C.L ⁻¹	Direct (10128)
	Ammoniacal Nitrogen*	mg.L ⁻¹	Salicylate (10031)

* kits

Group 1 analysis (Table 1) was performed in all the samples. Complementary analyzes (Group 2) were performed only in the test samples conducted under optimal operating conditions.

Colorimetric analyzes were performed on the HACH spectrophotometer model DR 2700. PH was determined by the potentiometric method on benchtop pHmeter (MS TECNOPON Instrumentation, model mPA 210). Turbidity analysis was performed by turbidimeter (Policontrol, model AP 2000). From the standard solutions

use, the results are expressed as NTU (nephelometric turbidity unit).

2.5 STATISTICAL ANALYSIS

Statistical analysis was performed using Tukey test with significance level of 95% and analysis of variance (ANOVA), using STATISTICS 7.0 program as tool.

III. RESULTS AND DISCUSSION

3.1 EFFLUENT PHYSICOCHEMICAL CHARACTERIZATION

Since it is an authentic effluent, it presents massive complexity and variability, therefore individual effluent batches were used for specific study stages. In the preliminary stage, Lot 1 was used for tests with Tanfloc SG[®], Lot 2 was used for tests with chitosan and Lot 3 was

used for tests with ferric chloride. Lot 4 was used for tests defined by the DCCR, Lot 5 was used for tests under optimal operating conditions. Each of the different lots physicochemical characterization results are presented in Table 2.

Table 2 – Physicochemical characterization of the study effluents

Parameter	Color (mg.Pt.Co L ⁻¹)	Turbidity (NTU)	pH	COD (mg.O ₂ .L ⁻¹)
Lot 1	4.050.00 ± 2.64	309.00 ± 4.58	6.58 ± 0.04	1.353.68 ± 0.02
Lot 2	3.550.00 ± 9.84	719.33 ± 8.02	6.57 ± 0.04	2.064.48 ± 0.01
Lot 3	6.700.00 ± 2.64	530.00 ± 5.50	6.46 ± 0.03	2.392.33 ± 0.01
Lot 4	3.444.00 ± 0.01	608.00 ± 4.36	6.40 ± 0.02	2.187.68 ± 0.01
Lot 5	1.850.00 ± 1.00	208.66 ± 0.57	6.54 ± 0.02	1.536.54 ± 0.003

Arithmetic means of 03 repetitions ± standard deviation

Table 2 analysis permits us to observe the dissimilarity between the different lots collected regarding the color, turbidity and COD parameters, which confirms the complexity and characteristic variability of real effluents.

3.2 PRELIMINARY ASSAYS

In the preliminary assays, which intended to limited the investigation evaluated parameters varieties, no comparison was made between the coagulants and, therefore, the different lots usage (Table 2) for Tanfloc

SG[®] (Lot 1), chitosan (Lot 2) and ferric chloride (Lot 3) did not interfere in the objective of this step.

3.2.1 Tanfloc SG[®]

COD removal percentages from preliminary tests with Tanfloc SG[®] coagulant and contour lines obtained from these results are presented, respectively, in Table 3 and Figure 1.

Table 3 –COD removal percentage with Tanfloc SG[®] coagulant

pH	COD Removal (%)					
	Tanfloc SG [®] (mg.L ⁻¹)					
	100	300	500	650	800	1.000
3,0	58,85±0,02	43,48±0,006	30,31±0,04	28,34±0,01	29,21±0,02	0,93±0,003
5,0	67,25±0,05	58,21±0,007	29,71±0,07	34,52±0,001	18,21±0,05	5,23±0,003
7,0	51,94±0,002	62,11±0,001	60,58±0,07	60,64±0,004	8,29±0,04	11,03±0,006
9,0	43,72±0,002	62,19±0,05	59,96±0,09	67,70±0,02	38,93±0,09	61,47±0,01
11,0	36,40±0,10	36,53±0,01	24,15±0,02	49,32±0,01	46,48±0,006	50,86±0,01

Arithmetic means of 03 repetitions ± standard deviation

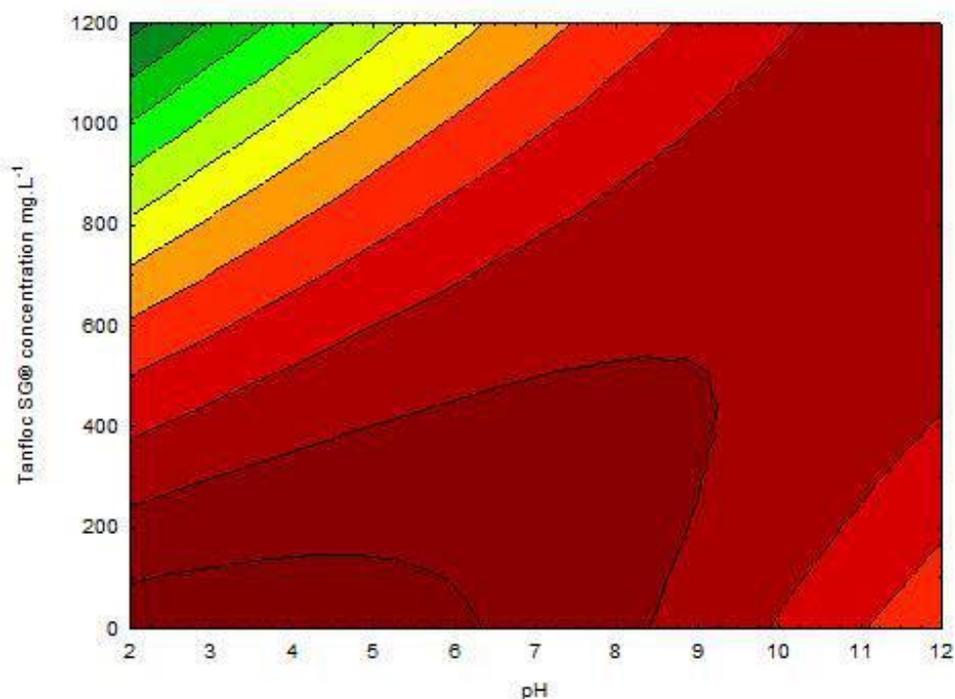


Fig.1 - Contour lines for COD removal with Tanfloc SG® coagulant

According to Figure 1 analysis, the assortments that resulted in the best COD removal efficiencies comprise the pH range between 3 and 7 and with concentrations below 200 mg.L⁻¹.

3.2.2 Chitosan

COD removal percentages in the preliminary tests with chitosan coagulant and contour lines obtained from these results are presented, respectively, in Table 4 and Figure 2.

Table 4 –COD removal percentage with chitosan coagulant

pH	COD Removal (%)					
	Chitosan (mg.L ⁻¹)					
	100	300	500	650	800	1.000
3,0	46,30±0,004	40,77±0,001	55,98±0,02	58,08±0,007	55,13±0,02	46,65±0,02
5,0	7,78±0,01	51,38±0,04	51,82±0,01	71,48±0,08	51,65±0,007	50,15±0,01
7,0	57,04±0,09	50,70±0,001	7,06±0,03	28,22±0,08	51,84±0,01	34,89±0,002
9,0	18,38±0,01	50,70±0,06	50,64±0,02	55,22±0,09	28,45±0,009	39,35±0,01
11,0	31,28±0,03	48,18±0,02	44,16±0,05	42,39±0,08	35,87±0,02	20,31±0,06

Arithmetic means of 03 repetitions ± standard deviation

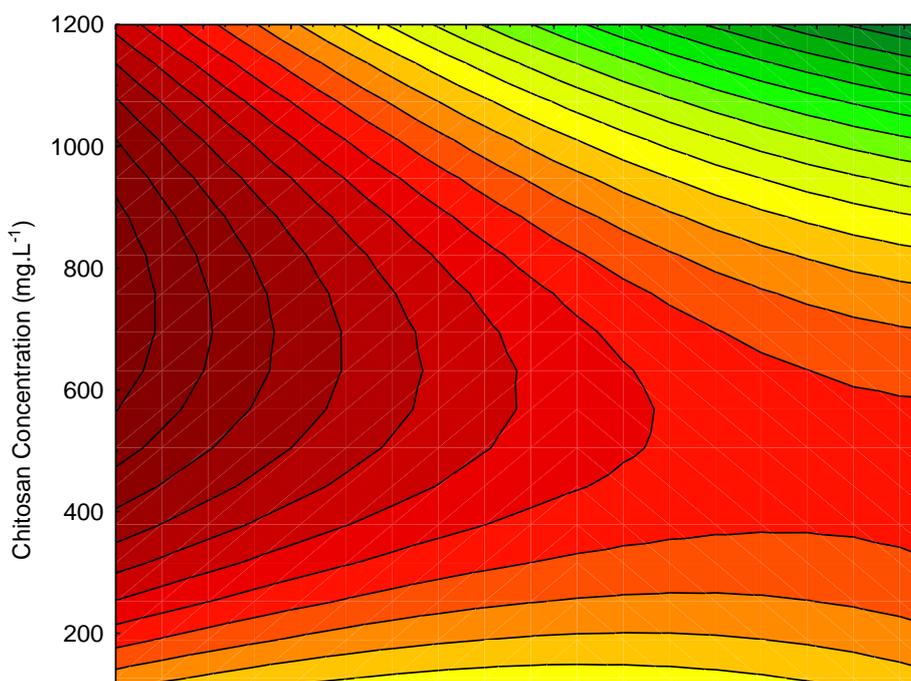


Fig.2 - Contour lines for COD removal with chitosan coagulant

From the Figure 2 analysis, the assortments that resulted in the best COD removal efficiencies include values below 4 for pH and the concentration range from 500 to 900 mg.L⁻¹.

3.2.3 Ferric Chloride

COD removal percentages for preliminary tests with ferric chloride coagulant and contour lines obtained from these results are presented, respectively, in Table 5 and Figure 3.

Table 5 – COD removal percentage with ferric chloride coagulant

pH	COD Removal (%)				
	Ferric Chloride (mg.L ⁻¹)				
	25	100	300	500	700
3,0	78,05±0,009	71,19±0,04	71,73±0,007	59,42±0,01	70,56±0,001
5,0	68,10±0,007	70,49±0,007	73,75±0,004	71,76±0,005	72,11±0,001
7,0	56,95±0,002	68,06±0,01	74,84±0,03	61,53±0,01	65,39±0,01
9,0	50,75±0,02	49,41±0,04	72,60±0,007	71,69±0,008	75,69±0,01
11,0	38,24±0,003	44,76±0,05	39,00±0,04	40,33±0,001	60,73±0,01

Arithmetic means of 03 repetitions ± standard deviation

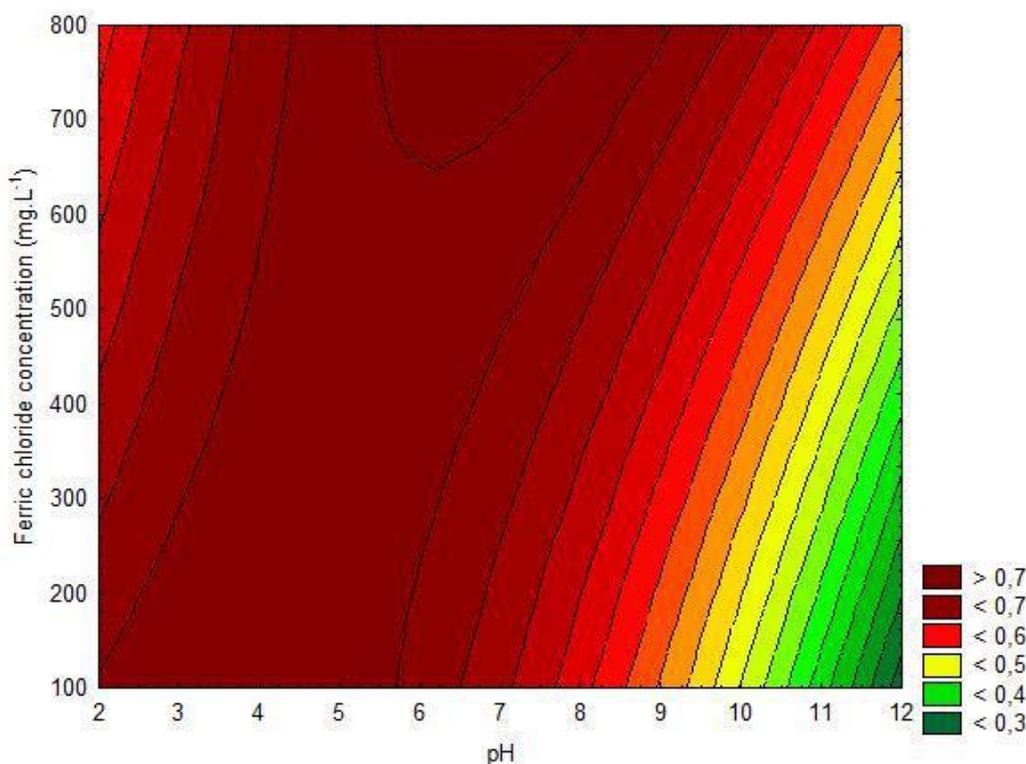


Fig.3 - Contour lines for COD removal with ferric chloride coagulant

According to Figure 3 it can be observed that the best results for COD removal were obtained in the pH range from 3 to 7 and ferric chloride concentration from 100 to 600 mg.L⁻¹.

3.3 EXPERIMENTAL PLANNING

The pH and coagulant concentration investigation varieties, determined in the preliminary tests, were applied in the DCCR, and the results obtained in these tests were used to determine the optimal operating

parameters for each of the investigated coagulants, as follows.

3.3.1 Tanfloc SG®

Table 6 presents the results obtained from the Tanfloc SG® coagulation assays performed according to the DCCR.

Table 6 – DCCR 2² planning for effluent treatment with Tanfloc SG® coagulant (actual and coded levels), and treatment efficiencies in terms of COD removal percentage.

Assay	Varieties (Level real (Codec))		COD Removal (%)
	pH	Concentration (mg.L ⁻¹)	
1	3,58(-1)	71,80(-1)	45,56 ± 0,02
2	6,42(+1)	71,80(-1)	75,18 ± 0,02
3	3,58(-1)	178,20 (+1)	51,94 ± 0,006
4	6,42(+1)	178,20 (+1)	94,56 ± 0,02
5	3,00(-1,41)	125,00(0)	56,03 ± 0,06
6	7,00(+1,41)	125,00(0)	85,11 ± 0,003

7	5,00(0)	50,00(-1,41)	48,06 ± 0,008
8	5,00(0)	200,00(+1,41)	73,76 ± 0,03
9	5,00(0)	125,00(0)	45,56 ± 0,002
10	5,00 (0)	125,00(0)	50,11 ± 0,01
11	5,00 (0)	125,00(0)	42,14 ± 0,02

From the COD removal percentage results as investigated variables function (Table 6), the response surface presented in Figure 4 was constructed.

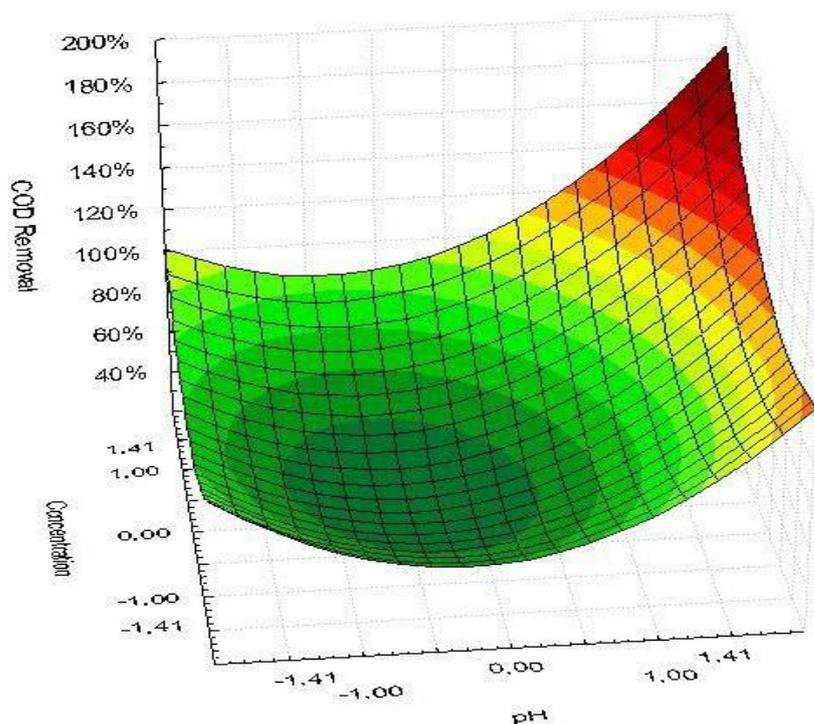


Fig.1 – COD removal response surface with Tanfloc SG® coagulant

According to the analysis in Figure 4, the highest COD removal percentages were achieved once the tests were performed at the higher variables levels, for example, at pH 7.0 and Tanfloc SG® concentration of 200 mg.L⁻¹.

Also, from the results obtained (Table 6), the regression coefficients analysis (Table 7) and the analysis

of variance (Table 8) were completed, and it was perceived that, among the conditions investigated for the variables, all of it presented significant difference between at the 5% level.

Table 7 – Studied values effects for the COD removal with Tanfloc SG® coagulant.

Factors	Effects	Regression Coefficient	Standard error	T value	p-value
Mean	45,99	45,99	3,34	13,74	0,00003
X ₁ (L)	28,30	14,15	2,05	6,89	0,00098
X ₁ (Q)	25,22	12,61	2,44	5,14	0,00361

X ₂ (L)	15,71	7,85	2,05	3,82	0,01228
X ₂ (Q)	15,66	7,83	2,44	3,19	0,02406
X ₁ X ₂	7,00	3,50	2,89	1,20	0,28122

X₁ pH; X₂ Tanfloc SG®; p≤0,05; L – linear term; Q – quadratic term; F_{cal} = 47,54; R²=94,91%.

Table 8 – Analysis of variance.

Variable Source	SQ ^a	GL ^b	QM ^c	F _{cal} (95%)	F _{tab} (95%)	p-value
Regression	0,313	5	0,062	18,661	5,050	0,003
Residue	0,017	5	0,003			
Lack of adjustment	0,013	2	0,007	6,376	9,552	
Pure error	0,003	3	0,001			
Total	0,330	10				

a = squares sum; b = freedom degrees; c = squares mean.

As the F_{cal} for regression (47.54) is highly significant and the variation explained percentage (R²) was considered good, 94.91. Observing Table 8, there is a calculated F for the regression greater than the tabulated F, however the F_{cal}/ F_{tab} ratio is not higher than 4. But, the F_{cal} for the lack of adjustment was not higher than the tabulated value, consequently the lack of adjustment is not significant, meaning that no significant terms were inserted in the residue, as it would increase the p-value. Hence the proposed quadratic model is valid, being possible to write the mathematical model in function of the significant variables, presented in Equation (1).

$$\text{COD Removal (\%)} = 45,99 + 28,30X_1 + 25,22 X_1^2 + 15,71 X_2 + 15,66 X_2^2 \tag{1}$$

being X₁ the pH and X₂ the coagulant concentration

Also according to Table 7, pH and coagulant concentration variables presented positive effects, in other words, these variables usage at higher levels results in

greater efficiency in COD removal, which confirms what was previously presented by the response surface (Figure 4).

3.3.2 Chitosan

Table 9 presents the results obtained from the chitosan coagulation assays performed according to the DCCR.

Table 9 – DCCR 2² planning for effluent treatment with chitosan coagulant (actual and coded levels), and treatment efficiencies in terms of percent COD removal.

Assay	Varieties (Level real (coded))		COD Removal (%)
	pH	Concentration	
1	2,29(-1)	558,2(-1)	51,87± 0,02
2	3,71(+1)	558,2(-1)	58,79±0,004
3	2,29(-1)	841,8 (+1)	44,76± 0,005
4	3,71(+1)	841,8 (+1)	45,65± 0,007
5	2,00(-1,41)	700,0(0)	50,09± 0,01

6	4,00(+1,41)	700,0(0)	52,04± 0,006
7	3,00(0)	500,0(-1,41)	54,88± 0,01
8	3,00(0)	900,0(+1,41)	34,64± 0,03
9	3,00(0)	700,0(0)	44,05± 0,02
10	3,00 (0)	700,0(0)	52,22± 0,02
11	3,00 (0)	700,0(0)	50,98± 0,01

From the COD removal percentage results as investigated variables function (Table 9), the response surface presented in Figure 5 was constructed.

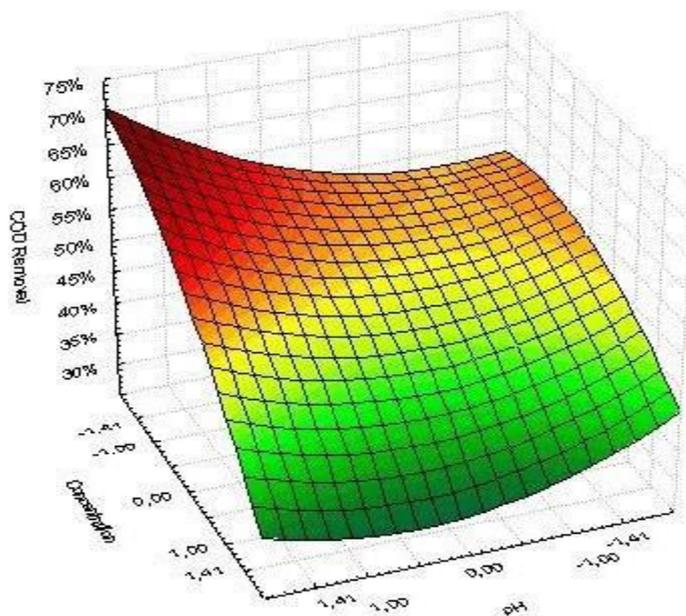


Fig.5 – COD removal response surface with chitosan coagulant

According to the analysis in Figure 5, the highest COD removal percentages occurred at levels +1.41 and -1.41 (coded level) for pH and concentration parameters, respectively, thus, for actual pH and concentration values of 4.0 and 500 mg.L⁻¹.

Also, from the results obtained (Table 9), the regression coefficients analysis was achieved, displayed in Table 10.

Table 10 – Studied value effects for COD removal with chitosan coagulant.

Factors	Effects	Regression Coefficient	Standard error	T value	p-value
Mean	48,65	48,65	1,91	25,47	0,000002
X1 (L)	2,71	1,35	1,17	1,15	0,2991
X1 (Q)	3,36	1,68	1,39	1,20	0,2826
X2 (L)	-12,08	-6,04	1,17	-5,15	0,0035
X2 (Q)	-3,67	-1,83	1,39	-1,31	0,2454
X1X2	-3,00	-1,50	1,65	-0,90	0,4060

X₁ pH; X₂ chitosan; p≤0,05; L – linear term; Q – quadratic term F_{cal}=1,34; R²=86,93%.

From Table 10 analysis it is possible to observe that none of the conditions investigated for the variables presented significant difference at 5% level. Nevertheless, it was possible to analyze that the coagulant concentration variable presented negative effect, that is, this variable increase results in lower efficiency in the COD removal percentage, which suggests lower level usage (500 mg.L⁻¹). For pH variable, the positive effect represents that this

variable increase results in greater efficiency in COD removal percentage, consequently it is recommended to use it at higher level, for example, pH 4.0.

3.3.3 Ferric Chloride

Table 11 presents the results obtained in the tests provided by the DCCR for ferric chloride coagulant.

Table 11 – DCCR 2² planning for effluent treatment with ferric chloride coagulant (actual and coded levels), and treatment efficiencies in terms of percent COD removal.

Assay	Varieties (Level real (coded))		COD Removal (%)
	pH	Concentration (mL.L ⁻¹)	
	1	3,43(-1)	
2	5,57(+1)	172,70(-1)	55,11 ± 0,003
3	3,43(-1)	527,30(+1)	32,95 ± 0,02
4	5,57(+1)	527,30(+1)	55,11 ± 0,006
5	3,00(-1,41)	350,00(0)	58,52 ± 0,009
6	6,00(+1,41)	350,00(0)	23,30 ± 0,05
7	4,50(0)	100,00(-1,41)	60,80 ± 0,003
8	4,50(0)	600,00(+1,41)	48,30 ± 0,01
9	4,50(0)	350,00(0)	47,16 ± 0,007
10	4,50 (0)	350,00(0)	56,82 ± 0,003
11	4,50 (0)	350,00(0)	46,31 ± 0,02

From the COD removal percentage results as investigated variables function (Table 11), the response surface presented in Figure 6 was constructed.

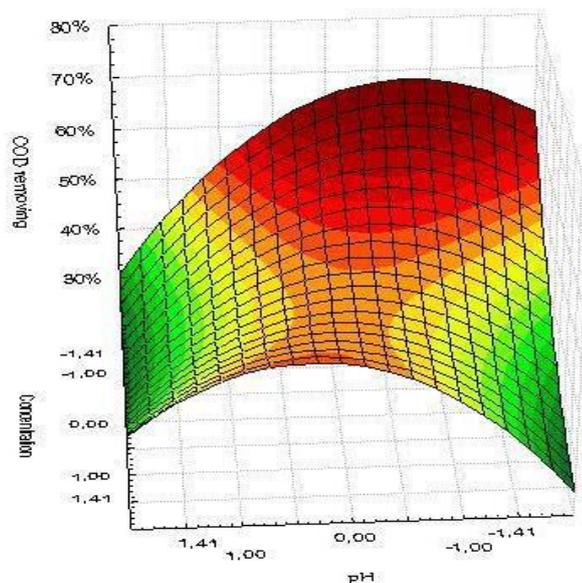


Fig.6 – COD removal response surface with ferric chloride coagulant

The levels that resulted in highest COD removal for concentration were -1.41 for the coded level related to the ferric chloride concentration of 100 mg.L⁻¹ and for the pH parameter the optimal assortment comprised the levels from 0 to -1.41.

Also, from the results obtained (Table 11), the regression coefficients analysis was performed, which is presented in Table 12.

Table 12 – Studied value effects for COD removal with ferric chloride coagulant.

Factors	Effects	Regression Coefficient	Standard Error	T value	p-value
Mean	50,09	50,09	7,90	6,33	0,29
X1 (L)	-4,12	-2,06	4,85	-0,42	0,68
X1 (Q)	-9,70	-4,85	5,78	-0,83	0,44
X2 (L)	-7,19	-3,59	4,85	-0,74	0,49
X2 (Q)	4,01	2,00	5,78	0,34	0,74
X1X2	5,53	2,76	6,84	0,40	0,70

X₁ pH; X₂ ferric chloride; p≤0,05; L – linear term; Q – quadratic term F_{cal} = 0,18; R²=28,35%.

Table 12 analysis displays that none of the investigated conditions for the variables presented significant difference at the 5% level. Thus, for the coagulant concentration, the lower level was defined as the optimal parameter (100 mg.L⁻¹) and, for pH, as it was discovered that there was no significant difference between

it, its usage was defined at the central level (pH 4.5), which represents, within the investigated range, the pH value closest to the effluent.

Therefore, as presented above, the optimal conditions defined for each of the coagulants investigated are presented in Table 13.

Table 13 – Coagulants (Tanfloc SG[®], chitosan and ferric chloride) optimal pH and concentration parameters for slaughterhouse effluent secondary treatment by coagulation.

Varieties	Tanfloc SG [®]	Chitosan	Ferric Chloride
pH	7,0	4,0	4,5
Coagulant Concentration (mg.L ⁻¹)	200,0	500,0	100,0

3.4 OPTIMAL CONDITIONS ASSAYS

Effluent samples characterizations treated by coagulation process with Tanfloc SG[®], chitosan and ferric chloride, under optimal conditions determined from the DCCR assays (Table 13), are presented below.

After the coagulation and decantation process the pH in the treated effluent was again measured to examine the pH variation with the treatment process (Table 14).

Table 14 – PH comparison before and after the treatment

Coagulant	Initial pH	Final pH
Tanfloc SG [®]	7,00 ^a ± 0,08	7,40 ^b ± 0,102
Chitosan	4,00 ^c ± 0,08	4,03 ^c ± 0,06
Ferric Chloride	4,50 ^d ± 0,08	4,63 ^d ± 0,036

* Values followed by the same letter do not differ by the Tukey test at 95% probability.

PH difference after the coagulation process was not significant for chitosan and ferric chloride, whereas for Tanfloc SG[®] the difference was significant for the effluent after the coagulation and decantation process, for example, the coagulant interferes with the effluent pH.

According to the pH of the effluents treated with three different coagulants investigated (Table 14) it can be observed that the Tanfloc SG[®] usage assembled the pH assortment from 5 to 9 established by Brazilian legislation

(BRASIL, 2011). Chitosan and ferric chloride, on the other hand, presents pH lower than the established by the Brazilian legislation, which involves the fact that it must be regulated previously its disposal.

Table 15 displays, for the tests conducted under the optimal operating conditions for each of the coagulants investigated in the present study, the COD removal percentages values, color and turbidity, phosphorus, COT and ammoniacal nitrogen.

Table 15 – COD removal percentage, color, turbidity, phosphorus, COT, ammoniacal nitrogen and DBO for effluent treatment under optimal conditions.

Removal (%)	Coagulant		
	Tanfloc SG [®]	Chitosan	Ferric Chloride
COD	73,25 ^a ± 0,006	54,49 ^b ± 0,14	46,32 ^c ± 0,07
Color	95,31 ^d ± 0,008	97,35 ^e ± 0,005	86,86 ^f ± 0,03
Turbidity	98,08 ^g ± 0,01	74,84 ^h ± 0,71	84,66 ⁱ ± 0,03
Phosphorus	27,97 ^j ± 0,33	3,14 ^k ± 0,01	61,87 ^l ± 0,16
COT	73,02 ^m ± 5,65	13,96 ⁿ ± 2,82	67,08 ^o ± 3,53
Ammoniacal Nitrogen	56,74 ^p ± 2,19	12,56 ^q ± 1,91	6,08 ^r ± 2,36

* Values followed by the same letter do not differ by the Tukey test at 95% probability.

Analysis of total iron for the effluent treated with ferric chloride resulted in $4.86 \pm 1.20 \text{ mg.L}^{-1}$, which assembles the maximum limit of 15.00 mg.L^{-1} for dissolved iron, established by current Brazilian legislation (BRAZIL, 2011).

An isolated assessment of each natural polyelectrolytes investigated in comparison to ferric chloride according to the data in Table 15 are presented below.

Tanfloc SG[®] was significantly more efficient than ferric chloride in the study effluent treatment, except for phosphorus removal.

Chitosan was significantly more efficient than ferric chloride in removing COD, color and ammoniacal nitrogen, nevertheless for turbidity, phosphorus and COT removal, ferric chloride was significantly more efficient. Besides, it presented DBO values ($20.6 \pm 0.004 \text{ mg.L}^{-1}$) within the limit established by the Brazilian legislation with maximum concentration of 50 mg.L^{-1} , and the other

coagulants studied presented values exceeding this maximum (50 mg.L^{-1}), being $121,5 \pm 0.007 \text{ mg.L}^{-1}$ for ferric chloride and $279.5 \pm 0.004 \text{ mg.L}^{-1}$ for tannin (CEMA, 2009).

Also according to the Table 14 results, once two investigated polyelectrolytes are compared, it is concluded that Tanfloc SG[®] was significantly more efficient than chitosan for all parameters evaluated, except for color removal, however, it is important to highlight that despite this, the color removal using Tanfloc SG[®], which was approximately 95%, was also satisfactory.

Overall, regarding the results presented in Table 15 and the discussion presented above, the effluent treatment with Tanfloc SG[®] coagulant occasioned treated effluent of significantly better quality than the other coagulants studied.

Table 16 displays the DBO/COD and COT/COD ratios for the effluents treated with the different coagulants investigated.

Table 16 – Ratios of DBO and COT in relation of COD

Coagulant	DBO/COD	COT/COD
Tanfloc SG [®]	0,19 ^a	0,15 ^b
Chitosan	0,03 ^c	0,71 ^d
Ferric Chloride	0,14 ^e	0,25 ^f

* Values followed by the same letter do not differ by the Tukey test at 95% probability.

DBO/COD ratio indicates the treated effluent biodegradability, defined by Alves *et al.* (2010) as the substance ability to be decomposed into simpler substances by bacteria action. According to the data presented (Table 16) Tanfloc SG[®] presented significantly higher DBO/COD ratio in comparison to the other coagulants investigated, that is, it resulted in treated effluent with greater biodegradability, which corroborates the previous conclusion; better quality effluent treated by the coagulation process with Tanfloc SG[®].

COT/COD ratio more accurately assesses the organic matter removal (VOGEL *et al.*, 2000) in the treatment. The COT is considered a direct parameter because it theoretically covers all the sample organic components, regardless its oxidation state. However, it does not measure inorganic compounds that may contribute to oxygen demand in COD analysis (Thomas *et al.*, 1999), for example, the lower the ratio, the greater the treatment efficiency with respect to the organic matter degradation. Tanfloc SG[®] presented significantly lower ratio than the other coagulants investigated (Table 16), which proves

that, in fact, Tanfloc SG[®] was more effective in removing organic matter from the effluent.

IV. CONCLUSION

It was concluded that the Tanfloc SG[®] coagulant presented an efficient and promising alternative to the ferric chloride usage for the slaughterhouse effluents treatment, with the additional advantage of being a natural agent minimizing environmental impacts since the treated effluent and the generated sludge do not present inorganic materials traces that cause, with the accumulation, irreparable damage to the environment.

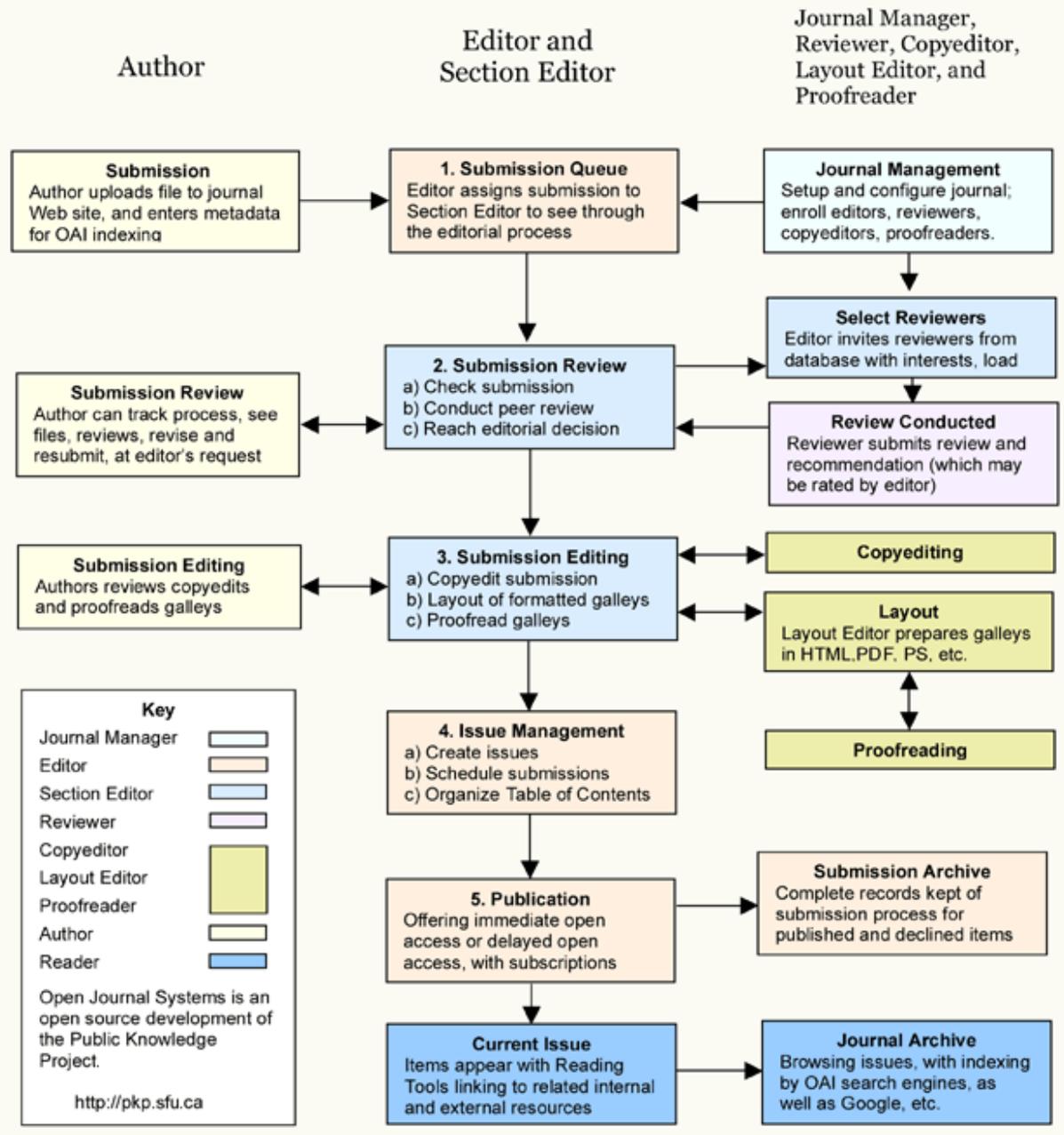
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