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FOREWORD

I am pleased to put into the hands of readers Volume-6; Issue-2: 2019 (Feb, 2019) of **"International Journal of Advanced Engineering Research and Science (IJAERS) (ISSN: 2349-6495(P) | 2456-1908(O)" ,** an international journal which publishes peer reviewed quality research papers on a wide variety of topics related to Science, Technology, Management and Humanities. Looking to the keen interest shown by the authors and readers, the editorial board has decided to release print issue also, but this decision the journal issue will be available in various library also in print and online version. This will motivate authors for quick publication of their research papers. Even with these changes our objective remains the same, that is, to encourage young researchers and academicians to think innovatively and share their research findings with others for the betterment of mankind. This journal has DOI (Digital Object Identifier) also, this will improve citation of research papers. Now journal has also been indexed in **Qualis (Interdisciplinary Area) (Brazilian system for the evaluation of periodicals, maintained by CAPES).**

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

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

With warm regards.

Dr. Swapnesh Taterh
Editor-in-Chief
Date: March, 2019

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Bromeliads Supply Chain of Paraná State - Brazil

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***Abstract*—** *Bromeliads are a group of native species of ornamental plants from Paraná Coast which have significant commercial value, however in recent decades has seen the exodus of producers in the activity. Thus, in order to support a better understanding of the current situation, it sought to identify how the production, distribution and trade processes were established in the supply chain, as well as identifying what were the strategies adopted in each segment (production, wholesale and retail) that resulted in competitive advantage in bromeliads supply chain. It was accomplished a descriptive exploratory research with different actors involved in all segments of the supply chain. It was interviewed, 19 producers distributed in 15 cities, 31 extractors in 12 cities, 18 wholesalers in 8 cities, 160 managers / owners of flowers retail businesses in 31 cities and 211 consumers of bromeliads in 51 cities. Bromeliads producers and extractors showed inadequate conditions of cultivation / extraction which resulted in lower plant quality, and for this reason in part that the high price and the fear of the mosquito that transmits dengue developed in the bromeliads, were the factors that limited the consumption. The bromeliads distribution until the consumer was made by wholesalers and retailers who had a pre-sale system, a factor that minimized the risk of leftovers and losses on the sale of bromeliads. It was not observed the adoption of shared strategies between the segments that resulted in competitive advantage in the bromeliads supply chain in Paraná State.*

***Keywords*—Bromeliads, Vegetable production, Ornamental plants, Agribusiness, Family Agriculture, Rural pluri-activity.**

I. INTRODUCTION

The production of bromeliads in Brazil with ornamental purpose is more concentrated in São Paulo State that has become the largest domestic producer, and the regions of Holambra, Atibaia and Campinas are the cities with the greatest production of bromeliads in Brazil, however although in smaller scale has been registered the appearance of new production centers in Joinville, Garuva and Gravataí (SC), Brasilia (DF), Belém (PA) and Vitória (ES) (ANACLETO; NEGRELLE, 2013th; ANACLETO et al, 2014).

Bromeliads in Paraná State initially aggregated economic importance associated strongly to the extractive activities, especially in coastal regions and at Serra do Cadeado in Ortigueira, in these places dozens of families survived for decades from the extraction of forest plants which they commercialized on the banks of the highways, situation still currently shown (ANACLETO; NEGRELLE, 2013b).

The pressure to reduce environmental damage in the forests, and the action of protection and supervision agencies as IBAMA, has raised in various cities of the state, cultivation that were benefited by the favorable climatic and soil conditions, the proximity to major consumer centers, and heavy flow of tourists in these regions. (ANACLETO et al, 2008; NEGRELLE; MITCHELL, ANACLETO, 2011).

Paraná since the 1990s has held prominent on the national scene in the bromeliads production and trade, and it was registered in 2000s the third largest production in Brazil, result from 114 producers in the activity in 32 cities that distributed 250,000 plants in Brazilian trade (BITTENCOURT et al, 2002; NEGRELLE; MITCHELL, ANACLETO, 2011).

Despite strong tradition in production and trade of bromeliads, recent studies reveal that the Paraná production has suffered a decrease in the production area, quantity produced and the number of producers, whose decline was over 60% (ANACLETO 2011; NEGRELLE; MITCHELL; ANACLETO 2011, ANACLETO; NEGRELLE, 2013b).

Bromeliads have economic, social and environmental importance in Paraná State due to the fact that families who survive from the cultivation or extraction, and the most part on them is operating in poor communities or vulnerable residents in the vicinity of forest areas

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(NEGRELLE; MITCHELL; ANACLETO, 201; ANACLETO; NEGRELLE, 2013a), and many species with ornamental potential have high aggregate financial value (MACHADO NETO et al, 2013) and may represent an important economic alternative to these families.

The bromeliads supply chain is part of the agro-industrial system of flowers and ornamental plants, according to BITTENCOURT et al., (2011) an agro-industrial system is more embracing than the supply chain.

The supply chain can be defined as a set of activities with the purpose of a production of a given product encompassing all kinds of necessary materials, from seeds, fertilizers, various machines, production structures, as well as wholesalers, retailers and distribution logistics until the finalized product reaches the final consumer.

The supply chains have a succession of processing operations, able to be separated, but at the same time they are interconnected by a technical chaining aiming to produce a product (HUGHES, 2001; CLEAR, CLEAR, HAGELAAR, 2006).

Thus, after the product being able to be sold to the consumer, the supply chain presents a series of trade and financial relations, this market flow among many inserted suppliers and customers assign to each segment the relevance in the supply chain (HUGHES 2001, BITTENCOURT et al., 2011).

Every segment of a supply chain has its own systematic, being the result of inter-relationships that are beyond economic transactions, and also add the technical, social and political relations, in which the degree of commitment among the components determines the structure and the coordination, being the governance the result of this set of reciprocal relationships, sustained on common and complementary interests of the segments within the supply chain (HUGHES, 2000 BEGNI; ESTIVALETE and PEDROZO, 2007).

The reciprocity is an essential resource for the competitiveness of a supply chain, knowledge management, production and technology should be shared on a network perspective, giving to the actors involved a competitive ability to acquire, store and renew tacit knowledge in a dynamic way, promoting that all participants of the segment and the supply chain improve with common results. (HUGHES, 2000; VASCONCELOS, MILAGRES, NASCIMENTO, 2005).

The collaborative and coordinated environment should be imperative among the segments of a supply chain, the processes must be properly articulated, in order to think together the set to be benefited. The competitiveness and sustainability of the supply chain can be sustained only if the work is guided by a governance model that benefits all segments (HUGHES, 2001; CLEAR, CLEAR, HAGELAAR, 2006).

The supply chains that involve small farmers, can be seen as tacit forms of business alliances, because their constitution and performance also depend on, the performance of each partner in the chain links, and the cooperative and reliable behavior, however, it is known that not always this occurs because, individually, the actors seek to maximize their benefits, being financial or not (BEGNI; ESTIVALETE and PEDROZO, 2007).

The conflicts can arise within a supply chain when they seek for profitability or market, contrary to the postulates of collective development, and independent the degree of coordination of a supply chain, the actors self-interest and opportunism can lead to the dismantling or weakening existing links, collapsing the model of business-type relationship "win win", when all the actors of the various segments are benefited (CLARO, CLARO, HAGELAAR, 2006; BEGNI; ESTIVALETE and PEDROZO, 2007).

The proposal of a collaborative governance model based on inter-organizational relationships, can only be applied based on a characteristics diagnosis of each chain segment, and the understanding of partnership and integration relationships among the segments. (HUGHES, 2000; BEGNI; ESTIVALETE, and PEDROZO, 2007).

Thus to understand the flowers supply chain complexity as well as the adaptability of each segment to the agribusiness system and also the external environment chain, it is decisive to conduct a situational diagnoses (HUGHES, 2001; CLARO, CLARO, HAGELAAR, 2006).

The supply chain diagnosis is a solid basis for institutional sustainability, enables the design of the behavior systematic variables in the organizational environment and it is relevant to define the future directions and strategies.

The diagnosis should identify the various actors in the production and trade process, the innovation capability, social concern with the use of environmental factors, the need for changes in infrastructure, inter-business and inter-segments relationships, the need for changes in the structure, organization and governance model (HUGHES, 2000; HUGHES, 2001; CLARO, CLARO, HAGELAAR, 2006; ANACLETO et al., 2014).

Thus, in order to support a better understanding of the current scenario of the bromeliads supply chain in Paraná State and diagnose the reasons for the exodus of the activity, it is presented the results of the research that sought to answer the following questions:

a) Identify how the production, distribution and trade processes were established, in bromeliads supply chain in Paraná State.

b) Identify in each segment which were the strategies adopted that resulted in competitive advantage to the supply chain.

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c) Discuss the implications of the reality observed in the context of bromeliads supply chain, and propose alternatives that might result in a collaborative governance model among several actors.

II. MATERIAL AND METHOD

In order to identify the existence of producers and extractors of bromeliads, it was filed a questionnaire in the central and regional departments of EMATER Paraná, SEAB (Agriculture and Supply Secretary of Paraná) and IAP (Environmental Institute of Paraná).

The retailers and wholesalers were identified in the Paraná State Trade Association and regional yellow pages, and subsequently it was carried out visits to make the interviews by accessibility and responsiveness.

Additionally, seeking to identify the involvement in bromeliads supply chain, it was also interviewed the managers of input suppliers companies (n = 6), municipal governments (n = 6), Banks and development agencies (n = 4), universities (n = 4) and non-governmental organizations (n = 4).

When we are able to identify some elements of the study target population in each segment, these indicated others who might also be interviewed and so on, in a process called "snow-ball" or self-generated sampling (KOTLER, KELLER, 2012).

The bromeliads consumer profile according to Anacleto et al. (2014) had data collection made from semi structured interviews and sampling was based on the population distribution in classes of income according to Brazil Criterion (ASSOCIAÇÃO BRASILEIRA DE EMPRESAS DE PESQUISAS, 2015).

It was classified, in this type, people who, according to ANACLETO et al., (2014), bought bromeliads at least once in the last twelve months. It was sought to investigate the bromeliad consumer profile in Paraná related to age, income, gender, as well as characterize the behavior of consumers, indicating the reasons for purchasing, preferred periods for acquisition, preferred locations for purchasing and purchasing intensity (ASSOCIAÇÃO BRASILEIRA DE EMPRESAS DE PESQUISAS, 2008). The face-to-face interviews were conducted, from visits to flower stores, at a time when people were buying bromeliads.

The data survey of all segments and consumer profile occurred from a predefined and tested script, and data collection was performed from April 2011 to October 2011, and then from June 2017 to March 2018 there was new data collection to update and supplement information, this long-term data collection was accomplished because of the depth of data collection that was intended and the high number of interviews.

The descriptive exploratory study included field visits, participant observation and semi-structured interviews in all segments, and it was performed in accordance to Negrelle and Anacleto (2012) and Anacleto and Negrelle (2013b; 2013a).

In order to identify how production, distribution and trade processes were established, in bromeliads supply chain in Paraná State, as well as identifying in each segment which were the strategies adopted that resulted in supply chain competitive advantage, it was interviewed 19 producers in 15 cities, 31 extractors in 12 cities, 18 wholesalers in 8 cities and 160 managers or owners of flowers retail establishments distributed in 31 cities and 211 consumers of bromeliads in 51 cities.

III. RESULTS

Bromeliads Production in Parana State

The bromeliad cultivation registered in Paraná was carried out by 19 small producers who lived near urban areas (n = 8) and rural areas (n = 11).

The bromeliad cultivation generated little labor offer, generally only the owner was responsible for the cultivation (n = 14) and in only two properties occurred the hiring of temporary workers to assist in the bromeliad production activity.

In all farms visited the bromeliads production was inserted in a rural pluriactivity context, encouraging small farmers to increase their family income.

The cities Guaratuba (n = 3) and Colombo (n = 3) concentrated the highest number of producers, and in other municipalities were verified isolated production areas (FIGURE 1).

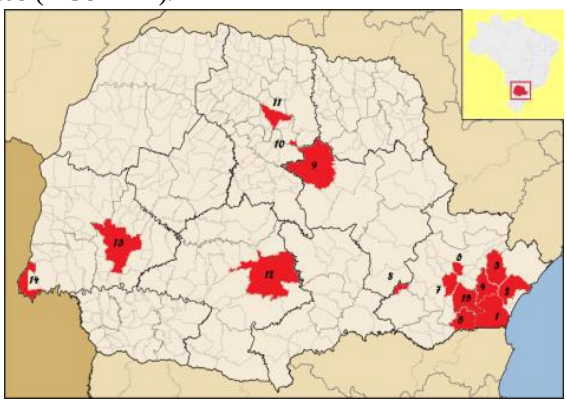

Fig.1: Cities that produce bromeliads in Paraná State: Guaratuba (1), Paranaguá (2), Morretes (3), Antonina (4), Tijucas do Sul (5), Colombo (6) Curitiba (7), Porto Amazonas (8), Ortigueira (9), Mauá da Serra (10), Apucarana (11), Guarapuava (12), Cascavel (13), Foz do Iguaçu (14) e São Jose dos Pinhais (15).

There was production of 30 species of bromeliads, from seven genres, and the Vriesia genre stood out both for greater diversity (n = 12 spp.) and more farmers who cultivate the flowers (n = 19) (Table 1).

The most part of cultivated species (n = 25) was the native species from Atlantic Forest, which according to the respondents (n = 13), due to the shape of plants and

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different colors from the traditional found in the market satisfied the consumers and facilitated trade (Table 1).

Table.1: Generality on the species and characteristics bromeliads cultivation in Paraná State.

	Vulnerability[1]	Production Unit	Producers (n)	Representativeness (%)	Cultivation Structure[2]	Used propagation[3]
Aechmea caudata Lindm.	NV	560	4	1,54	R=3/D=1	S
Aechmea chantini (Carriere)	NV	500	2	1,37	R=2	S/MP
Aechmea fasciata (Lindl.)	NV	500	2	1,37	R=2	S/DT/MP
Aechmea gamosepala W.	NV	500	2	1,37	D=2	S/DT
Aechmea nudicaulis (L)	VU	1400	5	3,85	E=1/R=2/D=2	S/DT
Aechmea ornata Baker	NV	550	4	1,51	R=2/D=2	S/DT/
Alcantarea Imperialis C. H.	EP	1200	5	3,30	E=2/R=3	S
Criptantus spp	NI	500	1	1,37	E=1	MP/DT
Guzmania blassii Rauh	EE	500	1	1,37	E=1	MP
Guzmania lingulata (L.) Mez	EE	300	1	0,82	E=1	MP
Guzmania scherzeriana M.	EE	500	1	1,37	E=1	MP
Neoregelia carolinae L. B.	NV	550	4	1,51	R=2/D=2	S/DT/MP
Neoregelia compacta (Mez) L.B.	EP	600	4	1,65	R=2/D=2	S
Neoregelia cruenta L.B.	VU	2400	9	6,61	E=2/R=2/D=4	S/DT
Nidularium innocentii Lem.	EP	3000	14	8,26	E=3/R=7/D=4	S/DT
Nidularium procerum L.	NV	2000	9	5,51	E=1/R=4/D=4	S/DT
Tillandsia stricta Solander	NV	1250	5	3,44	R=3/D=2	S
Tillandsia cyanea Linden	EE	300	1	0,82	E=1	MP
Vriesia atra Mez.	NV	600	5	1,65	R=4/D=1	S
Vriesia carinata Wawra.	NV	2500	9	6,88	E=2/R=8	S
Vriesia flammea L.B. SM	EP	850	5	2,34	E=2/R=3	S
Vriesia friburgensis Mez.	VU	680	5	1,87	R=3/D=2	S
Vriesia gigantea Gaud.	VU	1000	5	2,75	R=3/D=2	S/DT
Vriesea hieroglyphica Mor	CR	500	2	1,37	R=1/D=1	S/DT
Vriesia incurvata Gaud.	VU	6000	19	16,6	E=7/R=8/D=4	S/DT
Vriesia inflata Wawra	NV	2400	9	6,61	E=2/R=3/D=4	S
Vriesia platynema Gaud.	VU	2500	12	6,88	E=3/R=5/D=4	S/DT
Vriesia philippocoburgii W	VU	900	5	2,48	R=2	S/DT
Vriesia rodigasiana Mor.	VU	650	5	1,79	R=4/D=1	S
Vriesia splendens Len.	EE	600	4	1,65	E=2/R=2	S
		36290				

[1]Vulnerability in relation to the nature inventories: Critically Endangered (CR) *; Endangered (EP) *; Vulnerable (VU) *; Not vulnerable (NV); Exotic Species (EE); Unidentified (NI) * According to Martineli et al. (2008).

[2]Cultivation structure type: Greenhouse (E); Rustic structure (R); Cultivation under canopy (D) (NOTE * Some producers have two types of cultivation)

[3]Propagation: Seed (S), Clump Division (DT); Micro propagation (MP)

Source: Adapted from Anacleto and Negrelle (2013).

A significant portion of the total cultivated species (n = 39%) were included in IBAMA list categorized in situations of danger or vulnerability. Thus one of the highly positive factors of Paraná bromeliads production, is that the commercialization of these species resulting

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from cultivation, certainly relieves extractive pressures (Table 1).

The bromeliads cultivation in Paraná was identified in three ways (Table 1): the first kind of cultivation occurred under canopy in forest areas, it was practiced in four farms, being characterized by bromeliads cultivation in small clearings after deforestation, according to Anacleto and Negrelle (2013), this type of bromeliad cultivation is usually carried out for low-income families without possibility of investment in production structures.

The seedlings used in this kind of cultivation were harvested in forested areas and transplanted directly into the soil and remaining at this location until the bloom, when they were transferred to the final vases. The planting was done in piles containing organic fertilizer available in the properties, but there was no control on the amounts for application.

The bromeliads were not irrigated, and hand weeding was done only in the lines. The tearing caused by fall from the branches of the tree was the biggest problem of this kind of cultivation, however still according to the respondents, the bromeliads showed good acceptance by consumers.

The second type of cultivation occurred in rustic structures built with eucalyptus, bamboo or wood, and it was performed in eight properties concurrently with other kinds of crops.

The totality of the production units visited in this kind, showed problems in the production process due to the low height of the greenhouses (±170 cm), and inadequate material used in the coverage that heat a lot the production systems. The seedlings were often obtained the direct from the sprouts or seeds collection in the forest environment around the properties or from matrices available in the farm.

The main problems verified in this production system referred were the frequent damage and tearing in the leaves, small size of the plants which resulted in lower prices than those practiced by the market, being the average selling price USD 1.55 per unit.

The third kind was referring to the cultivation protected with plastic films (greenhouses), and it was practiced by nine producers, in these cases occurred the use of structures with adequate technology standard as described by Anacleto and Negrelle (2013).

Even according to Anacleto and Negrelle (2013), the seedlings used were generated by micro-propagation and additionally it was accomplished on these properties the propagation by seed mother plants.

The irrigation was performed by spraying. The weed control was manual, the pest control was performed by a broad-spectrum insecticide in monthly or biweekly applications.

The use of shading showed different shading levels (50% and 70%), the plants arising from this kind of cultivation evidenced satisfactory quality standard.

The substrate used in bromeliads crops in Paraná was in the most of cases (n = 16) prepared on the properties with materials that were available. The materials commonly used were the ground litter, sphagnum moss, pine bark, humus, carbonized rice husk, milled coconut shell, besides sheep and cattle manure and others of easily obtainment on the properties, however increased with formulated fertilizers (NPK).

The bromeliads growth fertilization occurred with the use of NPK fertilizers 10-10-10 and 4-14-8, usual average of one teaspoon per plant in monthly or bimonthly disposal on the ground.

It was not registered any kind of disease in all the farms visited. However the occurrence of pests was recorded in all visited crops (n = 19), mentioning aphids, slugs, ants, beetles, thrips, and cochineal, and on a smaller scale (n = 4 properties) beetles in the bromeliads nucleos (Metamasius calizoma and Metamasius quadrilineatus).

The preparation for the trade consisted in cleaning the vase and then the removal of old, stained or broken leaves.

Overall, the bromeliads crops in Parana, could be classified as low-tech standard and being in the most of time at odds with agronomic recommendations available in the relevant technical literature as described by Anacleto and Negrelle (2013).

The amount of plants in nurseries in Paraná available to trade was 21,360 units and the cultivation resulted in plants that met the demands required by the trade. But considering that the average cycle of bromeliads crops in Paraná producers is four years, the current production represented the inclusion of approximately 5340 units per year in the regional market, however according to Anacleto and Negrelle (2013) the amount was insufficient to meet the demand among the wholesalers and retailers interviewed, which was estimated in 27,800 units year.

The production commercialization was often made by producers in their own marketing structures in the sting sale system directly to the consumer, the rest was directed to landscapers and retailers nearby who traveled to the properties and made the acquisitions, being the average price USD 1.55 for retailers and landscapers and USD 3.01 in the sting sale system.

Bromeliads Extraction in Paraná State

The bromeliads extraction in Paraná State was identified in 12 cities encompassing 31 families. The largest number of extractors was located in Guaratuba (10), then in Ortigueira (5), Tijucas do Sul (4), Mauá da Serra (2), Reserva (2), Curitiba (1), Telêmaco Borba (1), Manoel Ribas (1), Matinhos (1), Paranaguá (1), São José dos Pinhais (1), Antonina (n=1) e Morretes (1).

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The most parto f extractors lived in nearby areas where the practiced the extraction, and the self characterized as subsistence farmers and not as extractors, since the considered the extraction of bromeliads a complementary activity income on the property.

Only thirteen extractors were owners of the land where they lived and grew and the average size of the land was about 3.0 ha. Ten of the respondents did not have the ownership of the land, being considered areas squatters with an average size of 0.7 hectares per family unit. In all cases, the properties presented environmental restrictions because they were placed in areas under protection or environmental preservation.

The collection was every fifteen days for the majority of respondents (n = 14) in a smaller scale, in a monthly basis (n = 6) or when there was demand with external orders.

The collection of bromeliads was performed an average radius between 11 and 25 km from the area of residence, and was directed only to plants with inflorescence already issued or pre-inflorescence. The activities were initiated after four a.m, even overnight with the return to their homes between three or four p.m, returning an average of 14 bromeliads, and in the end of the month each producer collected about 100 units which generated an average income of USD 128,54 per month.

After the extraction, the bromeliads were put in pots, and deposited in greenhouses until they were sold. The main form of commercialization was on the property, however it was also verified the sale to wholesalers and retailers from Curitiba, Londrina, Ponta Grossa and Telemaco Borba in Paraná State, as well as Guaramirin, Garuva and Joinville, in Santa Catarina State, and the kind of these places were garden centers (n = 8), the most cited in the selling process, followed by flower shops (n = 5).

The most part of the respondents had no collection authorization (n=28), part of them (n=5) were unaware of the need for this practice legalization, and other part (n = 5) reported that they had tried to get the license for extraction but failed due to the lack of land ownership and the small size of their properties.

The most part of the respondents (n = 21) did not have bromeliads cultivation, and, among the reasons for the absence of these crops they talked about the lack of resources for the construction of nurseries and greenhouses (n = 6), they said that the time bromeliads take to be produced is up to 4 years (n = 22) and high availability of bromeliads in the forest that in their perception did not need to cultivate because they were available for collection (n = 12) as also described by Negrelle and Anacleto (2012).

In all, it was identified 21 collected species throughout the year, being the most frequently collected: *Vriesia incurvata* commercialized by 90% of the respondents, *Nidularium innocentii* (77%), *Vriesia platynema* (67%), *Tillandzia stricta* (55%) and *Vriesia carinata* (55%).

Other species were mentioned in the extraction process in less quantity by the respondents (10% or less extractors), they are: *Aechmea caudata* Lindm., *Aechmea distichantha* Lem., *Aechmea gamosepala* Wittm., *Aechmea nudicaulis* (L.) Griseb., *Aechmea ornata* Baker, *Neoregelia cruenta* (Graham) L.B. Sm., *Nidularium procerum* Lindm., *Tillandsia usneoides* (L.) L., *Vriesea atra* Mez, *Vriesea flammea* L.B. Sm., *Vriesea* friburgensis Mez, Vriesea *gigantea* Mart. ex Schult. f., *Vriesea hieroglyphica* (Carrière) E. Morren, *Vriesea inflata* (Wawra) Wawra, *Vriesea philippocoburgii* Wawra e *Vriesea rodigasiana* E. Morren.

Bromeliad Retailer Trade in Paraná State

The retail trade promoted the link between producers and wholesalers to the final consumer, the average of bromeliads sold was 10 units per month.

The species of bromeliads most sold in the visited establishments (n = 156) was Aechmea fasciata Baker and lingulata Gusmania, and the retail stores average size was around 80m2.

The definition of retailer on the bromeliad buying reasons to resell to the consumers obeyed the main criterion of the lowest price (n = 142), then other less important factors in the perception of retailers were also reported as the quality of the flowers (n = 68), the agility of the supplier in the replacement of orders (n = 63) and it was also cited the convenience in buying the bromeliads when the supplier delivers the bromeliads in retail establishments (n = 63).

Bromeliads purchases for resale occurred commonly on a monthly basis (n = 110) and priority local to purchase bromeliads by retailers was quoted concomitantly the direct purchasing from Paraná wholesalers (n = 111), buying at Veiling from Holambra (n = 21), purchasing from São Paulo wholesalers (n = 17) and Ceasa in Campinas (n = 9). They also mentioned wholesalers from Santa Catarina and Paraná producers (n = 4).

The purchase of bromeliads from local wholesalers, besides the previously mentioned factors, also happened because the bromeliads were a part of the other products composition mix and they give discounts for volume of purchasing.

The purchase at Veiling from Holambra was made with outsourced professional, and payment of the 5% commission on the purchase volume, and the reason for outsourcing was to avoid the retailer's trip to Holambra. Another way to purchase at Veiling was in collective buying by groups of three to five retailers that reduced costs in average of 12%.

Only three retailers from Curitiba and Paranagua reported that they buy bromeliad direct from Paraná producers, and

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the species acquired were *Vriesia incurvata* Gaud, *Vriesia platynema* Gaud, *Vriesia inflate, Vriesia Wawra* and *Vriesia carinata* Wawra. Other interviewed retailers (n = 23) revealed that they did not buy bromeliads from local producers, because according to them the flowers did not look good.

Bromeliads local production only had space on the shelves according to the retailers if they showed price equal to or less than wholesalers from São Paulo State (n = 134), production quality (n = 86) and delivery capacity during the year.

The bromeliads for use in interior decoration represented 90% of total sales by retailers and the average price paid by retailers in the acquisition of plants in São Paulo depending on the species ranged from USD 2.05 to USD 3.59 the unit. The bromeliads purchased by retailers from Santa Catarina were costing on average USD 2.57 and from Paraná, from USD 1.55 to USD 2.05.

The higher cost of bromeliads acquisition was for the retailer when purchasing from wholesalers which cost on average USD 4.62, delivered in the retail store, and despite the higher price paid, thus there was no expenditure of time and travel cost to purchase elsewhere. The resale price to the final consumer was always greater than 100% of the bromeliad cost.

Bromeliads Wholesale Trade in Paraná State

The wholesalers that promoted bromeliads distribution in Paraná in the various regions of the state, the highest concentration in Paraná State was in Curitiba (n = 10), which also represented 54% of all sales of bromeliads.

It was also found and interviewed the wholesalers from São José dos Pinhais (n = 2), Porto Amazonas (n = 1), Arapongas (n = 1), Cascavel (n = 1), Foz do Iguaçu (n = 1) Morretes (n = 1) and Londrina (n = 1), the total sales volume in the State was about 18,325 bromeliads sold annually, from them 80% was related to the sale of only two species Aechmea fasciata Baker and Gusmania lingulata.

The purchase of bromeliads occurred every week for the most part of wholesalers, and São Paulo State was the main place for shopping from local wholesalers (Veiling from Holambra = 72%, Campinas producers = 22%).

Most wholesalers (n = 18) never bought bromeliad from Paraná producers, and reported the possibility of buying since the price and quality were similar to those charged by their current suppliers, in addition to ensure regular deliveries and replacement the orders in the requested deadlines.

The "Garden Centers" (n = 43%) and the flowers shops (n = 41%) were the main sales channels of wholesalers, however other segments were also cited as gardening companies (n = 5%), supermarkets (n = 5%), companies that organize events (n = 3%) and shopping centers (n = 3%).

The average price paid by wholesalers to purchase bromeliads varied from USD 2.05 to USD 3.08, and the average profit margin on sales was 100% on the purchase price. The sales were made in cash, or credit card with an average term of 30 days for payment.

The sale of bromeliads by wholesalers occurred based sales routes traveled every week or every fifteen days by the wholesalers, and sales in inner cities occurred always grounded in pre-sales by phone or Internet.

Bromeliads Consumer Profile and Behaviour in Paraná State

Women with an average age between 36 and 50 years were the majority (n = 88.7%) among consumers of bromeliads, however the most influential factor in the consumption of bromeliads is the income (Table 2), the higher the economic income the greater was the consumption of bromeliads, and the lower income classes the consumption of bromeliads was just incipient.

Table.2: bromeliads consumption in Paraná related to income

Income distribution according to Brazilian criterion		
Class	Income	% Consumption
A1	9.733	21,2
A2	6.564	28,8
B1	3.479	31,2
B2	2.013	16,5
C1	1.195	2,3
C2	726	0
D	485	0
E	277	0

The higher consumption of bromeliads in Paraná was registered in Curitiba (n = 25%), followed by Londrina (n = 16.5%), Cascavel (n = 9.9%) and Maringa (n = 9.4%), and the preferred locations for consumers to buy bromeliads was the flowers shops (n = 58%), garden centers (n = 33%) and supermarkets (n = 24.1%).

The purchase of bromeliads had three purposes, home decoration (n = 52.5%), gardens (31%) and office decoration (n = 11.8%), and the species was chosen because the beauty of the plant (n = 65.6%), strength and durability of flowers (n = 32%), probably due to the durability of the flowers the purchase was made every six months by 74.1% of respondents.

The main limiting factors to increased consumption among respondents were the price (n = 44%), take care of the plants correctly (n = 22.6%), and confirmation that in fact bromeliads do not proliferate the dengue fever mosquito (n = 18.4%).

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Other Actors in Bromeliads Supply Chain in Paraná State

Providers of supplies: A major problem reported by input suppliers to bromeliad cultivation was the absence of specific products for bromeliads culture, and the equipment or inputs or supplies used in the production of bromeliads were the same recommended for orchids since they classified as a similar culture.

The control of pests and insects is an obstacle to this culture, because there are few specific and registered products for use on ornamental bromeliads, being the closest culture with pesticide registration the pineapple culture, which is also considered a bromeliad.

IAPAR: It is an official research department related to the agribusiness from Paraná State Government, and did not develop any research related to bromeliads in the period of the field research.

IAP, EMATER, SEAB: The official institutions of Paraná State Government for the agriculture and agribusiness system in response to 42 filed questionnaires issued by interim of its regional chiefs, who in seven regions knew the occurrence of extraction, and in five regions reported the occurrence of cultivation, however made explicit difficulties in measuring in numbers the supply chain of bromeliads because the activity was not classified as a priority service.

Municipalities: Only Guaratuba (Environment Department) reported to know the situation regarding to the cultivation and extraction of bromeliads, but there was no project planned for the development of the activity.

Unions: The presidents of all the unions of producers, employers or fishing colony in Paraná Coast (n = 9) reported that they did not know the practice of extraction and cultivation of bromeliads among their members.

Trade associations: It was identified 3 associations linked to agriculture, however contacted managers informed that they did not know the practice of extraction and cultivation of bromeliads among their members.

NGO's: There was not identified in Paraná Coast any non-governmental organization that acted directly with the issue of bromeliads production or extraction.

Universidades: A Universidade Federal do Paraná e a Universidade Estadual do Paraná desenvolviam estudos botânicos, agronômicos e de comercialização de bromélias.

Banks and financial institutions: Banco do Brasil with its regional superintendency said that never received any request for funding project concerning bromeliad cultivation.

Simplified Diagram of Bromeliads Supply Chain in Paraná State

The production chain of bromeliads in the State of Paraná, presented the following flow chart:

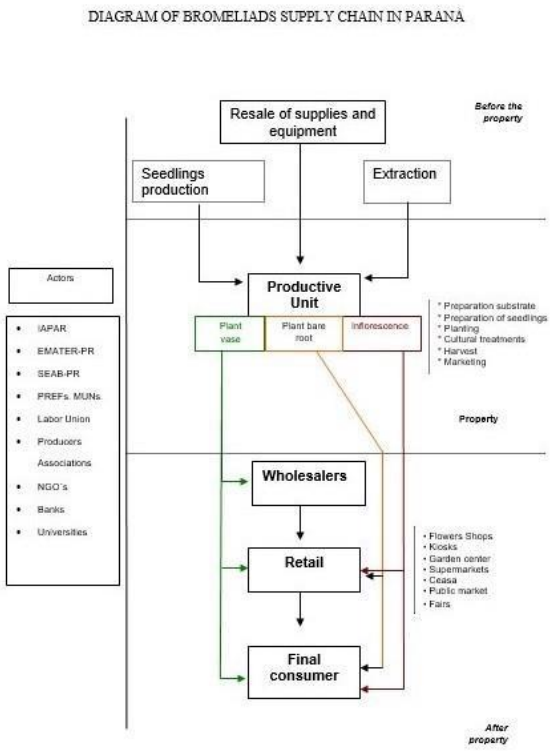

Fig.2: Simplified Diagram of Bromeliads Supply Chain In Paraná.

IV. DISCUSSION

Bromeliads besides the beauty of its inflorescences, also presents significant ecological importance in forest areas. However specifically in Paraná State it also has great economic and social importance in rural areas to small farmers and extractors in various regions that dependent on the commercialization of this species to generate income in the context of rural pluriactivity.

The extraction of bromeliads prohibition has created difficulties of maintaining these families in rural areas, due to the impossibility of economic alternatives and little capacity to invest in crops. According to Negrelle and Anacleto (2012) the extraction of bromeliads in Paraná is yet unknown and also not valued by the authorities, however, it supplies a part of the formal trade of bromeliads in Paraná establishments and in other states.

Also according to Negrelle and Anacleto (2012) the extraction of bromeliads is not prohibited by the Brazilian environmental laws, though the formalization of extraction is a process that needs regulation and standardization at a State level, a fact that has not yet been implemented in Paraná, which prevents the formalization of the extraction what prevent the extractors obtain financial income.

The condition of extractors in a short and medium term is worrying, since low-income families are prevented to extract bromeliads, and without the possibility of investment in production structures, so that determines

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the activity exodus and in many cases according to Anacleto and Negrelle (2013a) also the countryside.

In parallel with this situation, a significant portion of bromeliads producers in Paraná have difficulty in production, either for lack of cultivation process technology knowledge, inadequate production structures and disorganization of class on aspects related to marketing and access to funding resources to invest in the crops.

According to Anacleto and Negrelle (2013b), the bromeliads retail and wholesale market in Paraná follow the principles of perfect competition, bringing bromeliads from other producing regions where they receive more attractive offers and higher quality of plants.

Paraná bromeliads production competes unevenly with producers from other regions, especially from São Paulo, which are more organized and show investment capacity and large-scale production and are preferred by trade in the retail and wholesale levels. Although the Paraná production shows lower cost price than plants from other regions, the quality of regional production promotes rejection of bromeliads in the most demanding markets difficult the crops outflow.

Despite the reported difficulties, bromeliad cultivation is an economic activity that could be one of the building blocks to sustainable rural development, although, it is not considered the main economic activity it could be considered its plural character, which facilitates the association of this cultivation to other potential activities on the properties, becoming a strategic factor in enabling income in these rural properties.

The adoption of strategies associated to the plural character and use of natural resources available to producers are effective alternatives if the adoption occurs ruled in structured and planned process, however the economic issue should be considered as a prerequisite and a reference in changing condition of the reality in countryside.

It is clear that given the historical difficulties associated to bromeliads in Paraná, it can be considered that to reach the levels recommended by the sustainable rural development in a broad way in which families can be benefit economically from the resources available in the environment while that promote improvements in social conditions, it constitutes a major challenge.

The scenario portrayed in bromeliads supply chain proves to be challenging since even government agents (EMATER, SEAB) reveal do not have data and indicators on production and trade of bromeliads. However, still other government agents (IAP) promote restraint of extraction with seizures, and many restraints are close to the extractors, so the producers and extractors remain invisible to the State's actions.

Benefit from the adoption of the perfect competition model, merchants of flowers, being wholesalers or retailers, buy flowers from other regions to meet their bromeliads local demand. The consumer without access to better information eventually consumes only what is offered, and the bromeliads supply chain in Paraná, without the mediation of a party does not adopt collaborative governance models.

The scenario presented reveals that producers and extractors are the most vulnerable in all segments of the bromeliads supply chain, and apparently they have difficulties in self-organizational and in search better conditions of production and trade of their bromeliad crops.

The positive change in the scenario of bromeliads supply chain would be made easier, if there is expansion of efficiency in the crops, regarding to the produced species, production technology and preparation for trade, as well as the legalization of extraction and the transformation of extractors in bromeliad farmers.

In this context, two basic principles of the concepts of sustainable rural development deserve special attention.

First is the dialogue among several knowledge involved, when it should be considered the dialogue of producers and extractors and their real needs, with the other social actors in the supply chain, in order to promote the transformation of each situation and the ways to meet the families demands.

Second is the inclusion of intervention actions guided by the triad of sustainability, however it should expand the vision to more organized and planned concepts in economic aspects, otherwise the intervention of external social actors could be characterized in simple grant, and not basing the situation in structured and planned economic processes, results in a scenario that tends to return the genesis.

Intervention should occur in several ways, first with the market guidance to producers by the wholesale and retail segments, promoting the flow of information from the final consumer to the producer and extractor, revealing the consumers desires, what species should be produced and what periods should occur the higher crops to meet seasonal demands. This market orientation model is successful practices in other supply chains, and may be important in the prospection of bromeliads supply chain.

Producers and extractors may have better results in the activity if they have the State action, especially in vulnerable and impoverished regions. The bromeliad cultivation in Paraná, together with the transformation of the extractors on producers, extends the environmental protection levels in an indirect way, as they will promote the inclusion of a large number of plants in the regional trade and will reduce the dependence on extractive

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activities, especially in Paraná Coast and in the region of Ortigueira.

Structured intervention through incentives or subsidy in the change process could help families overcome the lack of economic resources from investment in production technology, thus they could promote forest preservation and social equity, and from this promotion it is necessary to create mechanisms that can ensure the producers "themselves" may transform their reality continuously.

The role of the State in development projects of bromeliad cultivation could result in a new and inclusive scenario that could lead to the breakup of the traditional paradigms, in synergistic actions relying on the help of research, teaching and extension promoting equity actions that consider and respect the customs, culture, knowledge and the interaction of these families to the environment where they live.

Thus, the change in the scenarios of bromeliads production and extraction, is guided by the triad of sustainable rural development, in fact could result in significant progress in mitigating the impoverishment of families involved at the same time strengthens the bromeliads supply chain.

So, it arises the need for a new management model of supply chain, which should be collaborative and conciliatory in order to the secular knowledge of these families are respected, but at the same time it should occur with a focus on dialogue with what is new, and that promotes an adjustment of bromeliads productions in Paraná that require expanded use of technology levels and more professional management in addition to production and trade.

V. CONCLUSION

Bromeliads producers and extractors showed inadequate conditions of cultivation/extraction which determined lower quality plants and less marketing potential.

Although local production is lower than the demand in Paraná, the bromeliads production in Paraná was partially deprecated by retailers and wholesalers because it do not meet the criteria required by the final consumer as price, quality of production and regular deliveries.

In both cases the distribution was based in trade in their own farms. Producers and extractors did not have a strategic model that results in competitive advantage to the bromeliads supply chain in Paraná.

The distribution of flowers until the consumer held by wholesalers and retailers occurred at an early system of pre-sales, which practically eliminated the risk of leftovers and losses on the sale of flowers, this practice associated to cost dilution with the purchase of flowers directly from the producer with low-cost were classified as significant competitive advantage to these segments.

The purchasing system in a collective way that reduced the cost and extended the profitability was reported as the main segment competitive advantage.

Consumers said that the price of bromeliads was considered high (n = 57.8%) and the fear that the dengue mosquito could develop in bromeliads (n = 34.2%) were some limits to the expansion of bromeliads consumption.

It was not observed the adoption of shared strategies among the segments that resulted in competitive advantage in bromeliads supply chain in Paraná, which demonstrates the urgent need for a new supply chain management model developed collaboratively, inspired by the sustainable management in order to consider the plurality of these properties.

There was the pre-eminent need for a management model that should emerge from a conciliatory dialogue, in which historical conditions are respected, but that is not also disregarded the economic and environmental issues, essential tool in changing and prospecting of the current scenario.

However, the real sustainability of these communities is apparently still far from being achieved, in this context, several aspects should be considered by the actors in various segments, when design a set of harmonious strategies that can lead to a designed social, ecological, and economic planning model and that promotes collaboratively the development of bromeliads supply chain in Paraná, since producers and extractors for low organizational skills are apparently not able to promote this development.

In the face of all argued above, this paper present some recommendations to the other actors involved in the promotion and development of bromeliads supply chain in Paraná, which may result in a collaborative governance model amomg various actors:

Possible contributions by State Government Agriculture System (SEAB, EMATER, IAPAR)

Promote data collection and diagnosis of expectations and needs of producers and extractors.

Promote meetings for open dialogue among the various segments of bromeliads supply chain in order to have the prospection of the supply chain.

Encourage and collaborate in the organization of formal/informal groups related to the cultivation and extraction of bromeliads in Paraná to exchange experiences.

Create processes to facilitate the legalization of existing cultivation units and promote the legalization studies of extraction practiced by small producers.

Start the process of dialogue among the actors involved in the issue of extraction in order to promote the re-reading of environmental protection legislation that at least prioritizes the repressive and punitive actions and causes the exodus.

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Promote the facilitation of the integration of bromeliads producers in the development credit lines available, as BNDES, Fundo de Amparo ao Trabalhador, Banco do Brasil and other development agencies.

Create credit line in State programs, with different proposals that could meet the special needs of producers in poor communities to improve production facilities and investment in production supplies.

Organize technical events together with other institutions aiming the debate about a strategic plan to leverage the bromeliad supply chain in Paraná.

Organize partnerships with entities such as Biology, Agronomy and Forest Engineering Regional Councils, aimed at guidance to producers on technical procedures to improve the quality of crops, as well as SEBRAE, SEAB and EMATER in order to offer training in association, organization, production control, sales techniques and land management.

Organize trade fairs or provide the commercial opportunity for bromeliads producers in existing fairs.

Promote certification feasibility study of the production coming from the State, aiming trends as socially just or ecological production among others, that could benefit low-income families and facilitate trade.

Promote wide dissemination of the correct information about bromeliads and dengue fever.

Possible Contributions by Universities

Expand research on the species of bromeliads with ornamental potential, especially in issues about improving genetic qualities of endemic plants.

Promote studies about organic cultivation and low-cost technologies in bromeliads production.

Set the issue in university environment, as scientific weeks and extension.

Offer to producers, with low-cost, support elements of productive base as soil analysis, micropropagated seedlings and courses focused on production and farm management.

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SMM: A Maturity Model of Smart Cities Based on Sustainability Indicators of the ISO 37122

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Abstract*— *Most indicators used for Smart Cities do not follow a pattern and/or are not able to be compared to each other In order to standardize the maturity evaluation of these cities, the present work aimed to propose a new framework to evaluate the maturity degree of a Smart City. The Sustainability Maturity Model (SMM) was inspired by CMMI maturity indices, by COBIT process controls and ISO 37122 indicators. Thus, the steps of the framework were developed, and a case study was carried out in a hypothetical city in order to validate it. As a result, it was observed that SMM allowed classifying the city by its maturity level based on the sustainability indicators of ISO 37122. This assessment can add value to a city aiming to become smart, and can serve as basis for applying new assessments and measuring the evolution of these environments.

Keywords*— *Smart Cities, Maturity, ISO 37122, CMMI, COBIT.

I. INTRODUCTION

Technological advances easy the development of strategies and programs to improve the life quality of the population. The inclusion of ICTs in the management of cities can facilitate the decision-making process of managers, thus creating improvements in the infrastructure and services offered to citizens and can be used as a subsidy for the creation of Smart Cities [1].

Smart Cities can have several definitions and, among them, according to [2], are communities that seek to transform life and work effectively using Information Technology. Managers from various cities around the world say their cities are smart just because they have ICT-based initiatives, which is not correct. [3].

There are maturity models that allow us to measure the degree of smartness of a city. Creating a maturity pattern presupposes enlisting requirements, analyzing, and defining data that will be required to measure the intelligence level of a Smart City.

Most indicators used in cities do not follow a pattern and/or are not able to be compared to each other. In this sense, several standards have been developed in order to provide a set of indicators as a recommendation of what to measure and how it should be measured. However, the standards do not define a target threshold or numerical value for the indicators.

Thus, in order to standardize the maturity evaluation of a Smart City, this work aims to propose a *framework* to evaluate the maturity degree of a Smart City. For this, the maturity model that served as inspiration for the development of the proposed *framework* was the CMMI - *Capability Maturity Model* [18], along with COBIT project management [20], in addition to ISO 37122 [15], thus developing the *framework Sustainability Maturity Model - SMM* of analyzes of maturity.

The proposed methodology aims to determine the level of maturity of a Smart City, describing the best practices of control of the indicators described in ISO 37122 associated with COBIT and CMMI, thus contributing to the improvement of the maturity analysis of a smart city.

The relevance of this study lies in the attempt to contribute to filling the existing gap in the standardized evaluation of a Smart City, proposing a *framework* for assessing the maturity level of a city.

This article is organized into five sections, with this first one presenting the goal of the study and its relevance. In the second part, the theoretical framework is presented, followed by the materials and methods used to achieve the proposed goal. In the fourth section, the reader is presented with the analysis of the results found and, in the

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fifth and last section, the final considerations are presented as well as suggestions for future research.

II. THEORETICAL BACKGROUND

From the emergence of the concept of smart cities, various indices, indicators, and methods were created to measure potential and evaluate cities [1]. Researchers have proposed their models based on the indicators and/or domains they found most relevant to a smart city. Some of these models present levels that serve to measure and analyze the predisposition of a city that aims to become smart [2 - 16].

Even though the issue has already been revealed as a trend towards the solution of social problems, it is perceived that there is still a limited understanding of how smart solutions will help cities to evolve as safe and efficient urban spaces [1][3].

Linked to this is the fact that the same solution and/or standard does not always apply in the same way to more than one locality since each region has its specific characteristics. Therefore, in order to measure the performance of a city, the classification attribute must be decomposed into indicators [4], because in this way the city will be able to evaluate its performance based on its reality and, consequently, adopt the best solutions according to its own demands.

Given this context, there is great variety of classification indicators, since there are several perspectives on how cities can be classified, viewed and evaluated by different social actors (being them companies, academics, political leaders and the population in general), but most of the indicators used do not follow a pattern and are not comparable over time and with each other [22]. It is necessary to understand the way of measuring the indexes of a smart city in order to avoid dubious questions in the classification of maturity levels [23].

Salient that it is not the intention of this work to approach definitions for the terms intelligent models of maturity and cities since, in the present time, it has distinct definitions that they change as the vision of each author. The focus, in this case, is the approach and contextualization of an evaluation *framework* for measuring a smart city, since it was shown the need for a standardization of a model to measure such levels [1].

Even before the production of the *framework* itself, a survey of the Maturity Measurement Models was carried out, in order to illustrate the existing gap in the evaluation of smart cities. In this way, Table 1 was developed, which illustrates the models and their respective authors. During the study process of these models, it was verified that six of them have tangible maturity models to be used to evaluate a smart city; these works are marked with an "x" in the "Relevance" column in Table 1. The other models did not continue their solutions, either because of the level of complexity or they did not become public because they were from private agencies.

Table 1: Maturity Models

MODELS	AUTHORS	RELEVANCE
Model Based On Giffinger	Giffinger et al. (2007)	
MMT	Gamma, Alvaro, and Peixoto (2012)	
SCIP	Inteli (2012)	
IDC GOVER	Clarke (2013)	
SCMM	Meijeringa, Kern and Tobi (2014)	x
WEISS - evaluative readiness	Weiss (2016)	x
SC4A	Artieda (2017)	
ESC	Junkes (2017)	
WCCD	Wccd (2017)	x
RCSC	Connected Smart Cities (2017)	
NBR ISO 37120	Nbr ISO 37120 (2017)	x
ISO 37122	ISO (2017)	x
RBCIH	Rbcih (2018)	
Br-Scmm	Moraes (2018)	
IBMCCI	Guimarães (2018)	x

The CMMI model is a precursor when it refers to maturity. It is linked to maturity levels and processes, thus serving as references to other models. It was initially developed for companies, based on the need to have a maturity model that would serve as a reference for organizations, so that these could continually evolve their processes, consecutively, increasing the quality of their products and services, obtaining greater market acceptance [18].

CMMI has a perspective on the maturity capacity of software processes. It is divided into 5 levels of maturity that show, in turn, the degree of progress an organization has at a certain moment. In addition, it has as main objective to act as a guide for the improvement of the processes of the organization, considering for this activity such as the management of software development, deadlines and costs previously established [18] [19] [20].

COBIT was created by ISACA (Information Systems Audit and Control Association), and its main objective is to generate value for the company and its processes. Accepted internationally as a good practice of control

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over IT information, COBIT is used to implement governance and improve IT controls. COBIT works by applying a variety of information control practices, ranging from planning to monitoring results. Thus, in general, COBIT begins by establishing best practices in IT governance that are in line with the company's objectives. From there, a description of the processes occurs, including planning, execution, and monitoring of IT processes. The control objectives are also established, which should be specific to the needs of each company. Also, the control objectives are established, that must be specific for the necessities of each company. The evaluation of models and processes is also important to correct nonconformities and, in general, management can be helped with a guide to good practices that helps, for example, the delegation of tasks and the evaluation of the interaction between processes [20].

ISO 37122 - INDICATORS FOR SMART CITIES is the first standard of the body directed exclusively to Smart Cities. Cities that adopt ISO 37122 will have standardized definitions and methodologies for a set of key performance indicators as tools to become more sustainable and smarter [15]. The norm takes sustainability as its general principle, as it relates to the process of change for smart cities. It is designed to help cities guide and evaluate the performance management of municipal services and all service provision, as well as the life quality of the population. ISO 37122 covers 19 thematic areas in its scope: economy, finance, education, governance, telecommunication, transport, energy, environment and climate change, urban/local agriculture and food security, urban planning, wastewater, culture, health, housing, security, leisure, population / social conditions, and solid waste. The measurement of performance occurs through 75 indicators that are typified in the standard as general and its application requirements [15]. It should be noted that cities that use ISO 37122 as a reference must report at least 50% of the indicators of this standard.

III. MATERIAL AND METHODS

The *framework* proposed to evaluate the degree of maturity of an Intelligent City was inspired by the maturity model CMMI - COBIT and ISO 37122. CMMI was based on the levels of maturity to determine the levels of maturity degree of the *framework*. With COBIT, results were planned and monitored. Finally, with ISO 37122, the indicators reported in the standard were used.

The *framework*, named *Sustainability Maturity Model* - SMM, is composed of 5 steps, as can be seen in Fig 01.

Step 1 consists of evaluating, through a questionnaire based on the indicators of ISO 37122, the city to be analyzed. The goal of this step is to demonstrate the degree of compliance with the recommendations of ISO 37122 of a smart city - according to the existing domains (Economy, People, Governance, Mobility Environment, Life). [1][15].

In step 2, COBIT is applied, through the planning and monitoring of the results obtained in step 1, in addition to CMMI, to evaluate in which level of sustainability a city is within a scale ranging from 1 to 5, being: 1 - Initial, 2 - Managed, 3 - Defined, 4 - Quantitatively Managed and 5 - In Optimization. In level 1, the city does not have or does not carry out activities or actions in this dimension using technological resources or ICTs, and in 5 the city is in optimization [1].

Table 2: Level of maturity degree based on CMMI

LEVEL	DETAILING
1- Initial (10-20)%	At this level is the stage where cities start. This phase indicates that cities plan and shape the information systems they will use to integrate their smart solutions.
2- Managed (30-40)%	At this level, cities are called efficient, seeking innovation and pioneering information technology solutions, with a greater focus on supporting decision-making for both citizens and governments using data obtained in the various domains.
3- Defined (50-60)%	At this level is the phase where data is already collected and accessible to the population through information systems, where they properly operate and where the use of cloud computing systems is verified, being integrated into the form of services and available to both citizens as well as third parties.
4- Quantitatively Managed (70-80)%	At this level, cities are at a stage of integrated resources and available in the form of services for both citizens and applications. At this stage, the use of computing aims to be available everywhere.
5- In Optimization (90-100)%	At this level cities are classified as efficient, seeking innovation and becoming pioneers in technological solutions. At this stage, they contemplate the use of the data obtained in the various domains of the city.

In Table 2 it is possible to verify the description of the 5 levels of maturity inspired by CMMI. There it is shown the representation by stages, where it is proposed to improve the capacity of smart cities through the evolution of maturity levels. Each maturity level covers a set of

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areas that must be considered in order to achieve the desired level. For example, to achieve maturity level 3, all Indicators for domains related to level 1, level 2 and level 3 should be considered.

In this first moment, it was considered that all areas will possess the same level of importance and score, because, for the city to be considered smart is observed the need for harmony among all domains.

The results may range from 1 to 5; Initial; Managed; Defined; Quantitatively Managed; Optimization.

Step 3 consists of the data analysis, where all information obtained will be validated. Step 4 is where you get the results of the city being measured; it is where the information of the maturity level of the city is obtained. Finally, in step 5 all information used and obtained to designate the degree of maturity of the city are stored for comparability and possible standardization.

It should be noted that steps 1 through 3 are referred to as internal processes, while steps 4 and 5 are external processes.

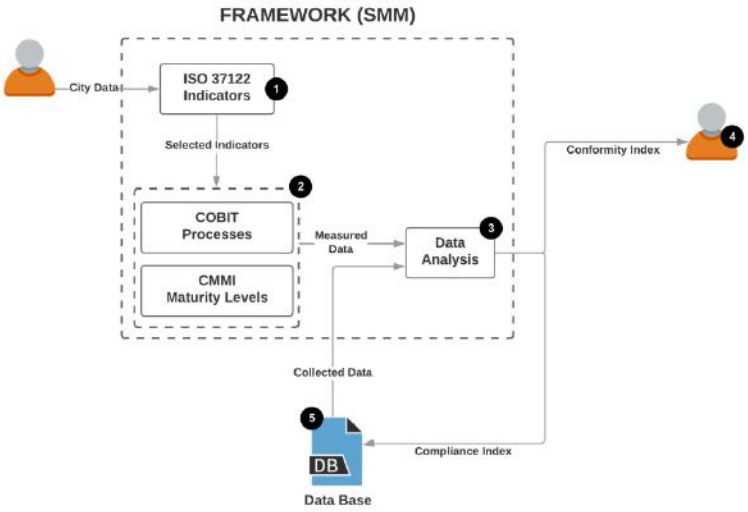

Fig. 01: SMM Framework - Sustainability Maturity Model

In order to validate the *Sustainability Maturity Model - SMM*, a case study was conducted in a hypothetical city. Initially, a questionnaire composed of six domains based on the six pillars of [3] was developed. Based on these six pillars, the nineteen thematic areas of ISO 37122 were associated and, from that point on, questions were asked corresponding to the 75 indicators based on ISO 37122.

In order to reach the research goal, a cut of the questionnaire was done, selecting 45 out of the 75 available indicators, since the norm recommends that cities that use ISO 37122 as a reference must inform at least 50% of the indicators. Table 2 shows the 45 indicators that were selected from the fields of Smart Economy, Smart People, Smart Governance, Smart Mobility, Environment, and Smart Life, as well as the answers obtained.

Table 3: General Indicators Questionnaire of ISO 37122

QUESTIONNAIRE				
Smart Economy				
1.1. Economy	**IND**	**V**	**F**	**P**
1.1.1. Are there local companies hired to provide municipal services with data and communication openly available?	1	x		1
1.1.2. Are there startups in your city?	2	x		1
1.1.3. Is there any workforce employed in Information and Communication Technologies (ICT) sector?	3	x		1
1.1.4. Is there workforce employed in the Education, Research and Development sectors?	4	x		1
1.2. Finances	**IND**	**V**	**F**	**P**
1.2.1. Is there a municipal budget for investments in innovation and smart city initiatives per year?	5	x		1
1.2.2. Is there an annual amount of tax charged from the sharing economy as a percentage of the total tax charged?	6	x		1
1.2.3. Is there any percentage of payments to the city that are electronically paid based on electronic invoices?	7	x		1
Smart People				
2.1. Education	**IND**	**V**	**F**	**P**
2.1.1. Are there databases through public libraries?	8	x		1
2.1.2. Is there in the city's population professional proficiency in one or more foreign languages?	9	x		1
2.1.3. Number of computers, laptops, tablets, or other digital learning devices available to elementary school students?	10	x		1
2.1.4. Number of computers, laptops, tablets, or other digital learning devices available to high school students?	11	x		1
2.1.5. Number of higher education institutions in Science, Technology, Engineering, and Mathematics?	12		x	0
Smart Governance				
3.1. Governance	**IND**	**V**	**F**	**P**
3.1.1. Annual number of accesses to the municipal portal of open data?	13	x		1
3.1.2. Is there a set of data offered in the municipal portal of open data?	14	x		1
3.1.3. Is there a set of municipal data available to the public?	15	x		1

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3.1.4. Is there accessible online city services?	16		x	0
3.1.5. Is there an average response time to relevant queries made through the non-emergency consultation system of the city (days)?	17		x	0
Smart Mobility				
4.1. Telecommunication	**IND**	**V**	**F**	**P**
4.1.1. Does the city's population have access to computers or other electronic devices with internet access in libraries and other public buildings?	18	x		1
4.1.2. Does the population of the city have access to broadband at sufficient speed?	19	x		1
4.1.3. Is there in the city area under a neutral/white zone / not covered by telecommunication connectivity?	20	x		1
4.1.4. Is there in the city area with Internet connectivity available to the public?	21	x		1
4.2. Transport	**IND**	**V**	**F**	**P**
4.2.1. Are there streets and paths covered by alerts and traffic information online in real time?	22	x		1
4.2.2. Is there use of transportation sharing by users in an economical way?	23	x		1
4.2.3. Are there low-emission vehicles registered in the city?	24	x		1
4.2.4. Are there bicycles available through sharing services?	25	x		1
4.2.5. Are there public transport lines equipped with real-time ICT-based system?	26	x		1
4.2.6. Is there a public transport network in the city covered by a unified payment system?	27		x	0
4.2.7. Are there public parking spaces equipped with electronic payment systems?	28		x	0
4.2.8. Are there public parking spaces equipped with real-time ICT-based availability systems?	29		x	0
4.2.9. Are there smart traffic lights?	30		x	0
4.2.10. Are there city areas mapped by real-time interactive street maps as a percentage of the total area of the city?	31		x	0
Smart Environment				
5.1. Energy	**IND**	**V**	**F**	**P**
5.1.1. Is there electrical and thermal energy (KWh) produced from wastewater treatment?	32		x	0
5.1.2. Is there electrical and thermal energy (KWh) produced from solid waste treatment?	33	x		1
5.1.3. Is there energy produced in the city using decentralized energy production systems?	34	x		1
5.1.4. In there in the city storage capacity of the power grid?	35	x		1
5.1.5. Is there public lighting power consumption?	36	x		1
5.1.6. Is there reformed public lighting?	37	x		1
5.1.7. Are there public buildings that need renovation?	38	x		1
5.2. Environment and Climatic Change	**IND**	**V**	**F**	**P**
5.2.1. Are there ecosystems mapped by remote sensing monitoring?	39	x		1
5.2.2. Is there annual monitoring of the remote sensing frequency of the ecosystem?	40	x		1
5.2.3. Are there buildings built or renovated in the last 5 years in accordance with the principles of green building?	41	x		1
5.2.4. Are there real-time ICT-based air quality monitoring stations?	42	x		1
Smart Living				
6.1. Culture	**IND**	**V**	**F**	**P**
6.1.1. Are there indicators on the number of book titles in the library?	43	x		1
6.1.2. Are there indicators on the number of eBook titles?	44	x		1
6.1.3. Are there any indicators on active library users?	45	x		0

IV. ANALYSIS, RESULTS, AND DISCUSSIONS

Following the development of *SMM* steps, as well as the application of the questionnaire, the results analysis was started. The present research made the combination between the standard and the methodology; from the application of the questionnaire cut, shown in Table 2, the result presented in Table 3 was obtained.

Table 3, presented in section III, illustrates the domains and thematic areas; questions were synthesized in numbers in the IND (indicators) column. Questions were answered as true or false, and column P represents the binary values 0 or 1, absent or present respectively, where the indicator that receives the assignment of truth is given the value 1 and the indicator that receives the assignment of false, it is given the value 0, according to Table 3.

Initially, to prevent losses and precision, the Boolean Algebra was used, that allows identifying with bigger

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easiness the number of requirements taken care of for each process and each sentence is treated as true or solely false, as Table 4. The sentence indicator "*Are there local companies hired to provide municipal services with data and communication openly available?*" was identified as a true sentence since the city met the indicator of ISO 37122. However, the sentence "*Number of higher education institutions in Science, Technology, Engineering, and Mathematics?*" was identified as a false sentence because the city does not meet the requirement.

Table 4: Values according to the nature of the sentence

Indicator		V	F
1	There are local companies contracted to provide municipal services with data and communication openly available	x	
12	Number of higher education institutions in Science, Technology		x

Table 5 illustrates a test case, assuming a hypothetical city that met the results of Table 3 in the domains: economy, people, governance, mobility, environment, and life; it is the result of the case study. Of the 75 pointers, 45 had been raised, what it is equivalent 60% of the pointers of the norm since the proper norm praises that the cities that use ISO 37122 as a reference must inform at least 50% of the pointers.

Thus, the compiled result of Table 3 is presented, where, after registration and validation of the indicators (true/false), it becomes possible to follow the city's degree of evolution. It is possible to observe that, based on the example studied, of the 45 indicators surveyed, the city has 40 Contemplated Indicators, which corresponds to 53% of the 75 General Indicators of ISO 37122.

Table 5: Result, analysis, domains, and indicators

Percentage of Maturity Level	
Contemplated indicators	40
Total of Indicators	75
General Compliance Index	53%

The individual measurement by domain is also contemplated, according to Table 6, being possible to observe the number of indexes per domain. Smart Economy has 100% of its indicators marked as true. Smart people, in turn, have 80%, while Governance has 60%, Mobility 64%, Environment 60% and finally, Smart Life has 10% of its indicators marked. Now, Table 6 presents an association of the domains validated to its indicators, associated with its thematic areas.

Table 6: Domain Compliance Index

Domains	%
1. Smart Economy	100%
2. Smart People	80%
3. Smart Governance	60%
4. Smart Mobility	64%
5. Smart Environment	60%
6. Smart Living	10%

Fig. 2 graphically illustrates the spiral result of the maturity levels evaluated, obtained from the case study of the result of Table 5. This representation is ideal to verify the expansion or retraction of each of the domains through their indicators. It is possible to see each of the domains as well as the percentage related to their degree of maturity.

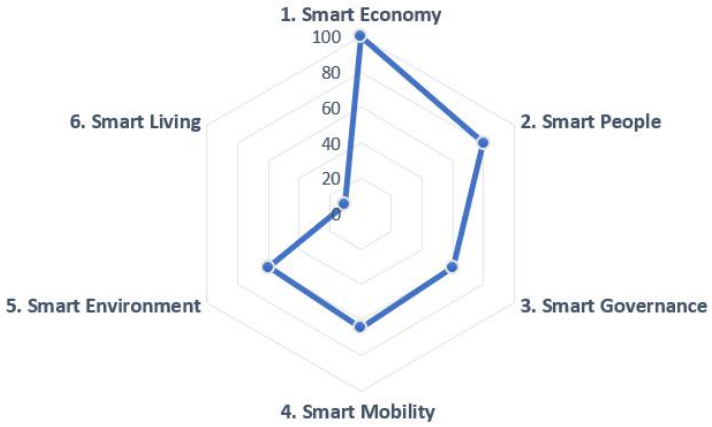

Fig 2: Maturity Analysis

Each domain, in turn, has a unique set of indicators. The calculations follow the methodology of [21]. However, in the present work, CMMI was used to measure the maturity level.

The hypothetical city, taken as a case study, illustrated in Fig. 2, obtained the result of 53% of maturity level; in this way, it is possible to associate the result found with the maturity degrees of CMMI. In the case in question, the city is at level 3; defined, since it is within the range of 50-60%, as it is possible to verify in Table 2.

After identifying the stage of the city, it is internally verified, with the management of the city, the next stage to be achieved and which competencies should be acquired in this process. This phase is important because it allows achieving success and, consequently, improvement in the quality of services [19].

V. CONCLUSION

The present study proposes a new *framework* to evaluate the degree of maturity of an Intelligent City, called *Sustainability Maturity Model* (SMM).

Several authors developed maturity models and alerted to

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the importance of investment in the development of a standard model and the importance of standardization of indicators that serve as a reference for the analysis of Smart Cities.

SMM development for smart cities maturity evaluation was based on ISO 37122 and inspired by the CMMI maturity model, as well as making use of COBIT processes.

From the application of SMM steps in a hypothetical city, it was possible to identify that the city is at maturity level 3, thus allowing managers to take measures to reach higher levels, as well as the data collected can be used for comparison with other cities using SMM. The proposed *framework* is a useful tool for any city, regardless of its size, its type, its origins, and its characteristics, since it also allows the study of each domain separately.

According to the established objective and the proposed methodology, SMM proved to be an important instrument for the evaluation of an intelligent city. It is possible, based on the analysis of its domains and indicators, to identify the level of maturity of the city to be analyzed.

With the absence of a diagnosis, actions can become disoriented, poorly prioritized, redundant, and not deliver the expected return. In this way, the application of SMM makes it possible to verify the diagnosis by domains, thus observing in which aspect the city undergoing study stands out, as well as its imbalances.

It is proven that the proposed objectives have been achieved and the results can serve as a basis for applying new assessments and evolution measurement of smart cities.

As future work prospects, we intend to use artificial intelligence techniques to consolidate the General Conformity Index.

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Critical Review of Three Selected Papers on the Design of Wind Turbine Foundations

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***Abstract*—** *Research on wind energy, as a potential substitute for fossil fuels, has gained popularity worldwide with the arising global warming, environmental issues and scarcity of fossil fuel reserves. Wind turbine is known to be a device that harnesses wind energy to produce electricity cleanly. The foundation is the main structural element needed to carry the turbine and transit static and dynamic loads into the soil. When designing wind turbine foundations, several aspects are investigated to ensure safe and economical design details such as total site investigations, different loads on the foundation, as well as creep settlement. Furthermore, factors such as strength, stiffness, stability, differential settlement, durability and economy are also considered in the foundation design process. This work aims to review different designs of wind turbine foundations installed in South Africa, Turkey and Antarctica.*

***Keywords*—Gravity foundation; Wind turbine; Wind energy; Settlement.**

I. INTRODUCTION

The foundation of turbine anchors the tower and offers stability and stiffness to the entire structure. Loubser and Jacobs (2016)utilized concrete gravity foundation, normally with a circular shape to endure multidirectional design loads.Diameter of foundation was determined depending on the type of soil underneath the base of turbine.They suggested to use rock or soil anchors to enhance stability but would result in increasing the overall cost of constructing the foundation.

Construction of wind turbines requires extensive geotechnical and geological site investigations as the soil carries the wind turbine. The significance of site investigations lies in the data they provide regarding soil conditions for designing wind turbine foundation. Cabalar *et al.* (2016) conducted field exploration to secure data on subsurface conditions in the Hasanbeyli area in Turkey. Soil specimens obtained from site were examined in the laboratory to identify physical and engineering soil properties. Their work elaborates recommendations and conclusions for constructing the turbine in Hasanbeyli and provides general methodology for designing wind turbine foundation according to engineering analysis.

Figure 1: illustrates the various components of a wind turbine system.

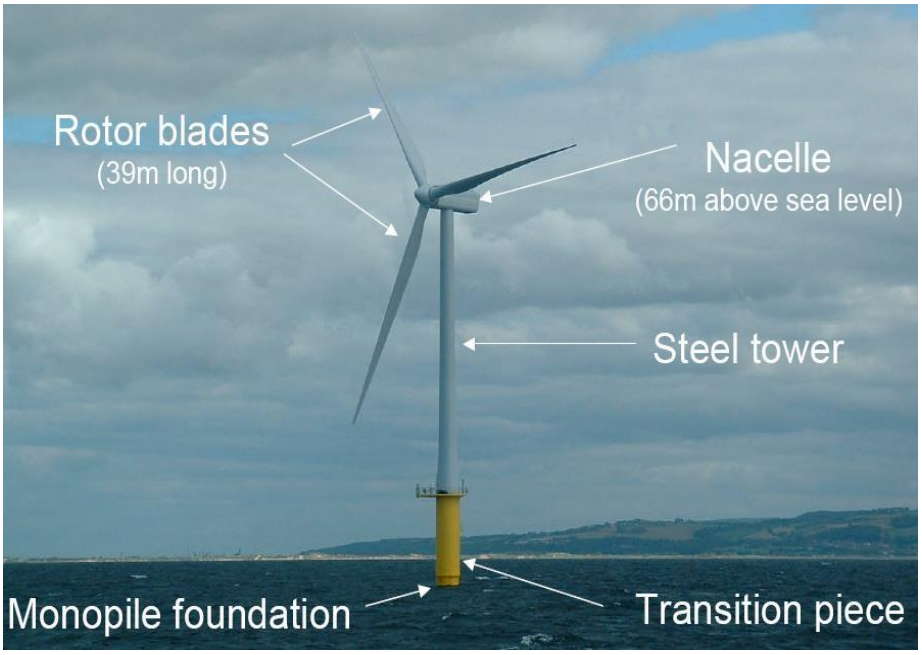

Fig.1: Components of a Wind Turbine System (Malhotraet al., 2007)

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Use of wind turbines is favoured to minimize reliance on fossil fuels to produce electricity. Oswell*et al*.(2010) studied the construction of three wind turbines at the McMurdo Station and Scott Base research facilities in Antarctica. Assuming total fossil fuel consumption couldbe decreased by 470,000 litres per year through electricity production by wind power (Oswell*et al*., 2010). Due to the different nature of the Antarctic terrain and subsurface formations, their foundation design was made to prove the possibility of building wind turbines in such areas. The foundation of the turbine was determined as multi-leg configuration placed within the permafrost at a shallow depth. Different aspects were investigated such as differential settlement of the turbines, creep of soil, long-term settlement, and emergency procedures to reduce the effect of undesirable behaviour of foundations. Their work illustrated underground conditions above which the turbines were constructed, the foundation design and performance information after a period.

Table (1) demonstrates the names and sources of the three research papers used for conducting the review.

Table.1: The three research papers used for critical review.

	Research Paper
1	Cabalar A, Uyan R and Akbulut N (2016), A Study of Foundation Design for Wind Turbines in Hasanbeyli, Turkey, Soil Mechanics and Foundation Engineering, 53(5), Available from: https://link.springer.com/article/10.1007/s11204-016-9402-8 [Accessed 5 November 2018].
2	Loubser P and Jacobs A (2016), Optimised design of wind turbine gravity foundations, Insights and Innovations in Structural Engineering, Mechanics and Computation, Available from: https://www.abt.eu/bestanden/Afbeeldingen/Actueel/Publicaties/5109-1/Wind_turbine_foundations_Axel_Jacobs_Peter_Loubser.pdf [Accessed 5 November 2018].
3	Oswell J, Mitchell M, Chalmers G and Mackinven H (2010), Design, Construction and Initial Performance of Wind Turbine Foundations in Antarctica, GEO 2010, Available from: http://pubs.aina.ucalgary.ca/cpc/CPC6-997.pdf [Accessed 5 November 2018].

1.2 Research Aims and Objectives

1.2.1 The Aim

The main aim of this work is to investigate and review the various structural designs of wind turbine foundations constructed in three locations which are Turkey, South Africa and Antarctica.

1.2.2 The Objectives

The objective of this study is to discuss and evaluate the different designs of wind turbine foundations while making direct and indirect comparisons. SWOT analysis is conducted to discuss the strengths, weaknesses, opportunities and threats of each design approach and a conclusion is drawn accordingly.

II. DISCUSSION

Cabalar *et al*.(2016)made geotechnical field investigations in Hasanbeyli area. A total of 20 boreholes with a depth of 20 meters were drilled to determine soil characteristics before constructing the turbine. After that, laboratory tests were conducted to determine soil properties which were later used as input for designing the foundation. The foundation design was mainly based on the geotechnical field conditions in the area. Analysis of foundations was conducted using SAP200 software. It involved calculation of self-weight, wind loads, and structural loads then modelling the structure with loads and conditions. Simplified approach for designing the wind turbine foundation was adopted in their study by assuming spread footing. The advantage of using this foundation type is that it depends on soil surcharge load as well as own weight to overcome overturning effect of high winds. Moreover, the upsides of using concrete in gravity foundations are its durability, strength, and ability to be casted in any shape.

The limitation of this paper is that it followed generalized approach for designing the foundation by making certain assumptions to simplify calculations. While this method can be suitable and economical for the specified area and conditions, it can be expensive especially when constructing larger wind turbines as it will require larger foundation sections. This will lead to an increase in the material cost of the foundation. Thus, efficient use of steel reinforcement as well as non-linear structural and soil modelling can enhance the economy of design.

Oswell *et al*.(2010) made an innovative design of the wind turbine foundation based on the presence of permafrost and lack of resources in Ross Island. It was designed to serve up to 20 years. The foundation system consisted of eight pre-cast concrete pads having specified dimensions. These pads are placed on a compacted fill material below ground level and then buried to increase resistance to overturning. Then, each pad was fixed to the ground by two soil ad freeze anchors. Geotechnical aspect focused on creep settlement as it was the main issue in the design process.

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Limitations of this paper lies in the design which relies on the loading scenarios given by the turbine producer instead of calculating wind, structural and own weight loads sustained by the foundation. Calculation of loads provides accurate and economical design output. In contrast, generalized loading conditions result in maximized cost as they utilize extreme loading scenarios and factor of safety values. Moreover, analysis method of the foundation was not elaborated in the paper to show the basis behind choosing the dimensions of footings. It has been proven that using advanced structural modelling and three-dimensional soils decrease material used by 30 – 40 % compared with simplified design methods (Loubser and Jacobs, 2016).

Loubser and Jacobs (2016) carried out an optimized design of the foundation using non-linear analysis and modelling which provided 7.1 % and 34.3 % savings in concrete volume and rebar, respectively compared with the simplified linear elastic design. Their design considered several factors such as bearing capacity of soil, stiffness, settlements, Factor of Safety against overturning. In addition, Euro codes 2 and 7 were used as references for concrete and geotechnical designs, respectively. The advantage of this paper is that it compared the design by non-linear approach to the linear elastic approach and summarized the results of both methods in a table showing the amount of savings in concrete and steel reinforcement. Moreover, diagrams showing models of rebar and variation of concrete stresses were clearly illustrated.

The disadvantage of this paper is that although it clearly states that non-linear approach optimizes the design of foundation, the operator refused the outcomes of this approach and requested to re-design the foundation according to the linear elastic system.

Figure (2) demonstrates the dimensions, top view and cross section of a typical foundation slab.

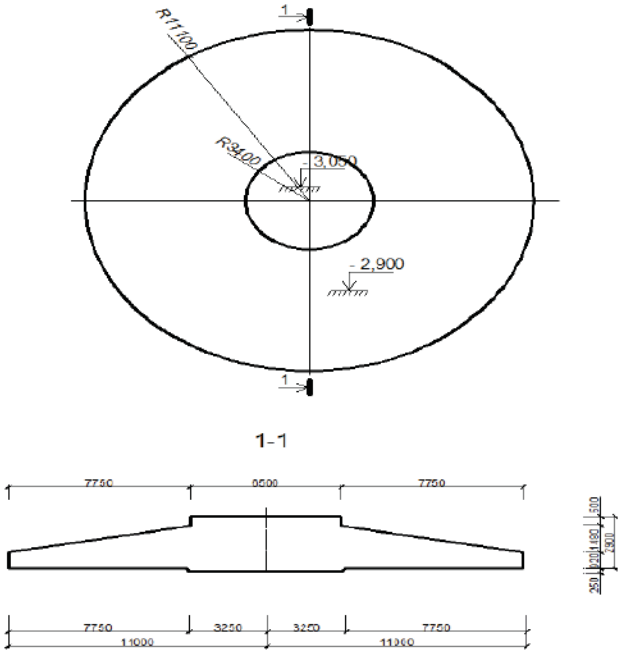

Fig.2: Dimensions and cross-section of typical foundation slab. (Zhussupbekovet al., 2016)

2.1 SWOT Analysis

Table.2: SWOT Analysis

Strengths	Weaknesses
Cabalar *et al.* (2016)– Economic and safe design for the specified conditions. **Cabalar *et al.* (2016)**– Foundation analysis conducted by SAP2000 modelling and analysis software. **Oswell*et al.*(2010)**–Innovation in design due to scarcity of construction resources. **Loubser and Jacobs (2016)**– Optimized foundation design by non-linear approach. **Loubser and Jacobs (2016)** – Modelling of concrete foundation and soil by 3D structural and soil modelling software.	**Cabalar *et al.*(2016)**–Simplifieddesign leads to uneconomic foundation. **Cabalar *et al.*(2016)**– Absence of justification for assumptions made. **Oswell*et al.*(2010)** -Shortage of equipment to carry out geotechnical investigations in permafrost areas. **Oswell*et al.*(2010)** –Unclear elaboration of calculation assumptions and process. **Loubser and Jacobs (2016)**– Inability to apply non-linear analysis results due to operator resistance.
Opportunities	**Threats**
Cabalar *et al.*(2016)–Generalized design for all the foundations built in the area. **Oswell*et al.*(2010)**–Revolution of foundation design under extreme weather conditions. **Loubser and Jacobs (2016)**– Foundation optimization by non-linear approach leading to substantial cost and time reductions.	**Cabalar *et al.*(2016)**– Expensive approach when constructing larger turbines. **Oswell*et al.*(2010)**– Permafrost presence complicates the design and construction procedure. **Loubser and Jacobs (2016)**–Operator refusal to adopt non-linear method results to increase in the overall schedule and budget.

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III. RESULTS AND DISCUSSION

3.1.1 Conclusion

In conclusion, designinga wind turbine foundation can either be simple or sophisticated. The high cost of construction as well as the recurrence of many turbine foundations built on similar ground conditions encourage the use of non-linear analysis and 3D modelling software to minimize time and cost of design. It is therefore the responsibility of construction firms to start utilizing the latest 3D modelling software for soil and concrete structure and assume non-linear behaviour to obtain optimized design results.

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Development of a Fuzzy Controller Applied to the Velocity of a DC Motor

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Abstract*—Control system designs are becoming increasingly complex due to the operational requirements of current processes. An alternative way to this fact is the application of intelligent systems. This work presents a design of a fuzzy controller tuned by genetic algorithm and applied to the velocity control of a DC motor. For comparative performance purposes, it is designed and applied a conventional PI controller. In general, the fuzzy controller presented a better result compared with the conventional implementation. Results from computer simulations are presented.*

***Keywords*—Fuzzy Controller, PI Controller.**

I. INTRODUCTION

Automatic control systems are increasingly present in the industrial environment and have consolidated emphases in academic research. Applications continue to advance as the complexity of control and the need for performance of current processes increases. Control of space vehicle systems and control of innovative manufacturing are examples of areas where automatic control has become essential [1].

Manufacturing systems have been marked with the introduction and modernization of industrial robots that facilitate various activities. For companies specializing in external cleaning of buildings, for example, having drones for cleaning windows, which should be carried out in high places, is something extremely interesting [2].Each day, robots become faster, more flexible, more precise and more economical. This has become possible due to studies in the most varied types of automatic control systems [3].

As explored in [4], the design of a control system is consolidated in function of the identification of an estimated mathematical model that characterizes the process to be controlled. After this step, controller design techniques, such as PID controller tuning are applied. However, the obtaining of the mathematical model can be impracticable, because several unexpected factors dictate this action, for example, the nonlinear dynamics of real processes and the insertion of unexpected perturbations [5].

In the situations where obtaining the estimated mathematical model of the system is impracticable, the intelligent systems are characterized in a valid strategy, mainly when it comesto fuzzy systems, in which the the control strategy is based on linguistic variables and heuristic knowledge of the process to be controlled, which are terms used to define the dynamics of the process to be controlled. An overview of the main concepts of fuzzy control is presented in [6] and [7]. It is important to emphasize that although fuzzy systems do not consider a mathematical formulation with uncertainties associated with each of the parameters they are robust. The errors are compensated by the formulation present in the control system structure itself using the input and output uncertainties of the system [8].

In addition to the mentioned structures, the contributions found in the area of fuzzy controllers also encompass hybrid strategies in which the combination of fuzzy logic and other intelligent systems is contemplated. An example of a hybrid strategy is the situation in which fuzzy controllers have their parameters adjusted from the application of genetic algorithms. These strategies demonstrate satisfactory performances in recent

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investigations, such as: [9] presents a comparison with a conventional PI controller when applied to power control in a given industrial environment; in [10] it is approached an application of such a strategy for the acceleration control of an autonomous vehicle in order to minimize the start situations of the vehicle; in [11] we demonstrate the use of these controllers to control the speed of a DC motor.

In general, several applications of fuzzy control strategies can be evidenced in field research. In [12] the authors expose the application of a Fuzzy-PD controller to perform the control of a pneumatic manipulator of a microscope, in order to control the distance between the test specimen and the equipment.In [13] a drone is controlled through an intelligent fuzzy controller. In the contributions of [14], it is proposed a methodology for the tuning of gains of a Fuzzy-PI controller to perform a temperature control. Similarly, the work presented by the authors [15] presents an online tuning method of Fuzzy-PID controllers. A comparison between the structure of a conventional PID controller and the strategy of a Fuzzy-PID controller is presented in [16].

Based on the information presented, the present article proposes the use of a Fuzzy-Incremental controller, in which its gains are attributed through a genetic algorithm, to accomplish the speed control of a servomechanism, more specifically of a DC motor that composes a didactic tool of the manufacturer DatapoolEletrônicaLtda, model 2208. In order to validate the proposal, the performance of the fuzzy controller is compared with the performance of a conventional PI controller, which is designed from the survey of the process transfer function and applied the appropriate techniques for the respective tuning of the gains.

This paper is organized as follows. Section 2 presents the main aspects of servomechanisms and the didactic tool used. Then, in Section 3, an approach is presented about the main fuzzy control strategies with a focus on the method considered in this work, as well as the method used for the tuning of the conventional PI controller used for the comparison, whereas in the Section 4 are presented the results of computational simulations. Section 5 discusses the main conclusions of this proposal.

II. FUNDAMENTALS ABOUT THE SERVOMECHANISM USED AND GENERAL ASPECTS OF THE TEACHING MODULE

The servomechanism used in this work is part of a teaching module developed by DatapoolEletrônicaLtda, model 2208, in which one can investigate and apply process control techniques to control the speed and angular position of DC motors. It consists of a servo-potentiometer as an angular displacement transducer. To measure rotation, a tachometer is used which provides a voltage signal proportional to velocity in the range of 0 to 5 V. This didactic tool is shown in Fig. 1 [17].

Fig. 1: Datapool module, model 2208.

The voltage range used to generate the angular movement of the servomotor is - 5 to + 5 V where negative values provide a counterclockwise rotation while positive values imply a clockwise rotation. In this way, it was decided to restrict the rotation only in the clockwise direction (0 to 5 V) because abrupt variations between positive and negative voltages (and vice versa) can damage the mechanical system of the module. The output voltage of the module tachometer implies a direct relationship with the angular velocity of the servomotor, that is, 1 V corresponds to 1 rad / sec.

Based on the module definitions presented and from a process control point of view, the manipulated and controlled variables correspond, respectively, the voltage applied to the servomotor and the speed measured by the tachometer. This statement is exemplified by the diagram shown in Fig. 2.

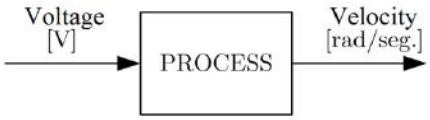

Fig. 2: Block diagram of the process.

For computational simulation purposes, it was necessary toaccomplish the lifting of the transfer functionof the servomotor considered. Techniques for this procedure are defined in the literature as systems identification. It is worth noting that, in practical terms, knowledge of the transfer function is not relevant to the fuzzy controller design of this proposal.

2.1 Identification of the Servomechanism System

Identification of a system is the determination of the estimated mathematical model that represents the main aspects of the dynamics of a system for a particular use: diagnosis, supervision, optimization and control [18].

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The models can be characterized by transfer functions of first or second order. In this work, the estimated process model is represented in(1), where K is the static gain of the process, L is the transport delay and T is the time constant [1].

$$G(s) = \frac{Ke^{-Ls}}{Ts+1} \quad \text{.....(1)}$$

The identification method was Broída [19], which presents the response of the first order system on a higher order curve obtained experimentally, in order to find the parameters K, T and L , where the latter two can be obtained by means of the expressions (2) and (3).

$$T = 5\,(t_2 - t_1) \quad \text{.....(2)}$$

$$L = 2,8t_1 - 1,8t_2 \quad \text{.....(3)}$$

Based on the parameters presented, the identification of the transfer function of the system to be controlled, defined in the literature as G (s), was accomplished from the applicationof a unit step 1 V at the servomotor input. The system response data were collected and then analyzed to obtain the parameters K, T and L. The transfer function G(s) found is presented in (4).

$$G(s) = \frac{1,378}{0,1451s+1} e^{-3,12e-5s} \quad \text{.....(4)}$$

Based on the transfer function obtained, it was possible to implement the control strategies considered. The computational simulations were performed using Matlab software and the Simulink tool.

III. FUZZY CONTROL STRATEGY APPLIED TO SERVOMOTOR CONTROL

The option of using fuzzy logic to establish control strategies is due to the increasing complexity of the processes currentlyfound in industrial demand.

As stated in [20], in some cases PID control may become inadequate, as in the control of higher order processes with oscillatory characteristics or multivariate systems. The factors cited tend to make it difficult to estimate the mathematical model. On these occasions, the implementation of fuzzy control is a valid option.

Fig. 3 shows a fuzzy controller added to a plant. It is observed that the controller admits as input the reference signal and the process output signal, resulting from the feedback of the system. In many cases, this type of control structure uses the reference signal, defined by the process operator, for calculating the error signal, resulting from the difference between the reference and the output signal.

In [21] are evidencedsome possible fuzzy controller structures that are: Fuzzy-P, Fuzzy-PD, Fuzzy-Incremental, and Fuzzy-PD + I. The Fuzzy-Incremental and PD + I structures represent, respectively, analogies to the classical PI and PID controllers.This fact assists in the elaboration of rules of the fuzzy controller because the gains linked to such structures reflect in a control implication similar to the Kp, Ki and Kd gains of the conventional PID controllers.

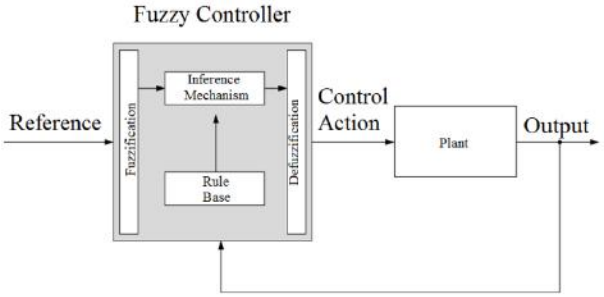

Fig. 3: Block diagram of a generic fuzzy control structure.

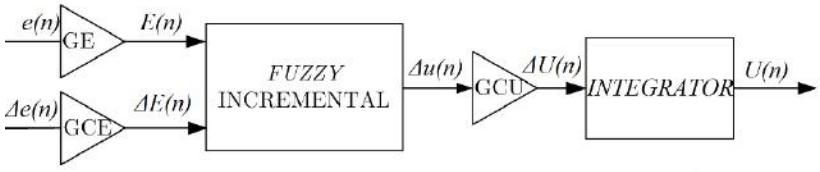

Fig. 4: Fuzzy-Incremental.

In this work it is considered the design of a Fuzzy-Incremental controller in which the gains are adjusted through a genetic algorithm.

3.1 Fuzzy-Incremental

The operational principle of this controller is based on the inputs related to the error and error variation, given by e (n) and Δe (n), and multiplied by the gains GE and GCE, respectively. Its output is represented by an increment given by Δu (n) or ΔU (n), when multiplied by a gain GCU.

The block diagram that represents the Fuzzy-Incremental structure is presented through Fig. 4. It is observed that the incremental output is represented by an integrator term, which can be approximated by a sum of all the previous increments, being called the rectangular approximation [22].

The referred fuzzy control strategypresents a dynamic similar to the conventional PI controllers.The relations of gains (5) and (6) are confirmed for this structure [21].

$$GCE*GCU=Kp \quad \text{.....(5)}$$

$$\frac{GE}{GCE} = \frac{1}{Ti} \quad \text{.....(6)}$$

The implementation of this controller for the velocity control of the servomotor considered in this work can be

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exemplified by means of Fig. 5.It is observed that there are the variables r (n) and y (n) which represent, respectively, the control reference value and the output of the system.Also the possibility of inserting noise was considered, in order to verify the performance of the system against unexpected situations.

For the definition of pertinence functions, the following linguistic variables were considered: PG: large positive; PM: medium positive; PP: small positive; P: positive; Z: zero; N: negative; NP: small negative; NM: medium negative and NG: large negative. The universe of discourse of error and error variation was defined in the range of -5 to +5, which represent positive and negative errors. For the incremental output, the domain was assigned -1 to +1.

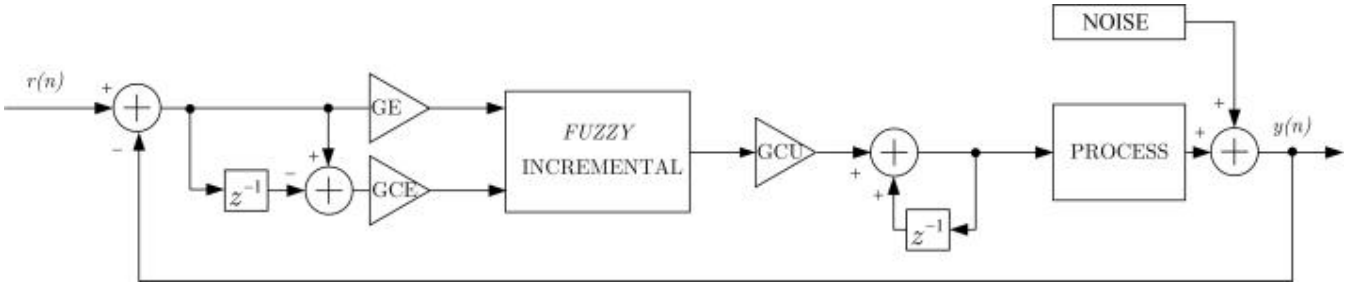

Fig. 5: Fuzzy-Incremental controller implementation diagram.

The pertinence functions are presented by means of Fig. 6, while the rules are shown in Table 1. It is important to emphasize that these definitions were attributed to heuristic knowledge of the process.

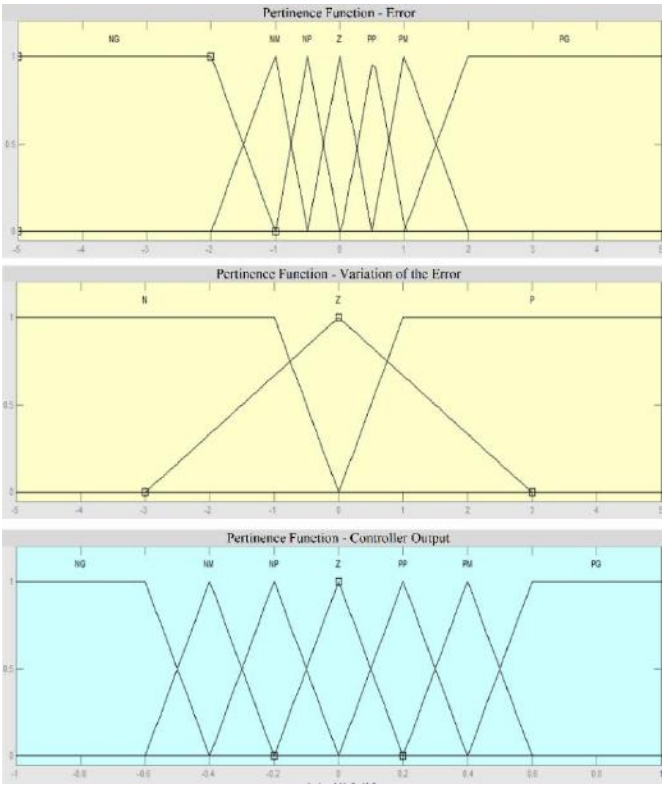

Fig. 6: Pertinence Functions.

Table 1: Fuzzy-Incremental controller rules.

Δe\e	PG	PM	PP	Z	NP	NM	NG
P	Z	Z	Z	NP	NM	NG	NG
Z	PG	PM	PP	Z	NP	NM	NG
N	PG	PG	PM	PP	Z	PM	PG

The GE, GCE and GCU gains were adjusted using the genetic algorithm, which is characterized by a metaheuristic optimization technique [23]. This step was considered from the following procedures:

a) Definition of the initial population: each individual was considered as a set of three parameters. Random values were initially applied to the gains and a unit reference was applied to collect the system response

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data. This procedure was repeated for each individual of the initial population.

b) Definition of the fitness function: in order to evaluate each individual, a fitness function was defined to penalize those that caused a slow response and with high overshoot. To exemplify, consider the expression (7), where the percentage performance of the i-th individual is evaluated. *tr* is the time the response took to reach the reference value for the first time, *tsim*is the considered time of simulation, *tymax* is the time at which there was the maximum output value, *ymax* is the maximum value output and ref is the reference value used.

$$fit\,(i) = \left[1 - \left(\frac{t_r}{tsim} + \frac{t_{y\,max}}{tsim}\right)\right] - \frac{y_{max} - ref}{5} \text{.....(7)}$$

c) Selection of individuals for reproduction: the selection of the roulette type was chosen.

d) Application of the crossover: the crossing of the individuals was performed by the conventional method, in which the offspring receive parcels of each parent chromosome. Subsequently, the mutation procedure was applied, in which the nth gene of the son to be mutable receives the mean among the nth genes of the parent chromosomes.

e) Choice of the best individual: in the end, the individual chosen was the set of gains that implied the highest result of the fitness function.

f) The gains found in this way were: GE = 0, 5, GCE = 1, 62 and GCU =1,4.

For performance comparison purposes, a conventional PI controller was designed based on the transfer function obtained for the simulation. The PI control action combines the characteristics of proportional and integral control in the same controller and can be represented by equation (8) [1], where *Kp* is the proportional gain, and *e(t)* is the error, *Ti* is the integrative time.

$$\frac{U_{(s)}}{E_{(s)}} = K_P\left(1 + \frac{1}{T_{iS}}\right) \text{.....(8)}$$

The method of tuning this controller was approached using the technique known as Cohen-Coon [24], where the gains were: *Kp* = 0,3436 and *Ti* = 8,0244.

IV. RESULTS

The results presented in this section refer to the application of the fuzzy controller tuned via the genetic algorithm and the conventional PI controller.

Three types of experiments were accomplished for the performance analysis. In the first case, it was considered a fixed and unitary reference, in order to evaluate the velocity of response of the controllers, as well as the stabilization of the system.Subsequently, for the second case, the insertion of a disturbance signal into the system was considered after its stabilization and with random amplitude.The disturbance mentioned may represent an unexpected variation in the voltage applied to the actuator. In the third case, the variation in references was considered, including positive and negative steps.

The results are presented in order to make possible the analysis of both the response of the system and the control action employed in the actuator.

Figures 7, 8 and 9 present the results as a function of the three types of experiments described above, respectively. It is possible to notice that for all cases, the Fuzzy-Incremental controller provided a faster stabilization of the response, even spending half the stabilization time of the PI controller in the first case. There was a substantial reduction of the overshoot to the Fuzzy-Incremental controller in the observed cases.In addition, the response of the actuators with the conventional PI controller clearly shows greater variation than the Fuzzy-Incremental controller.

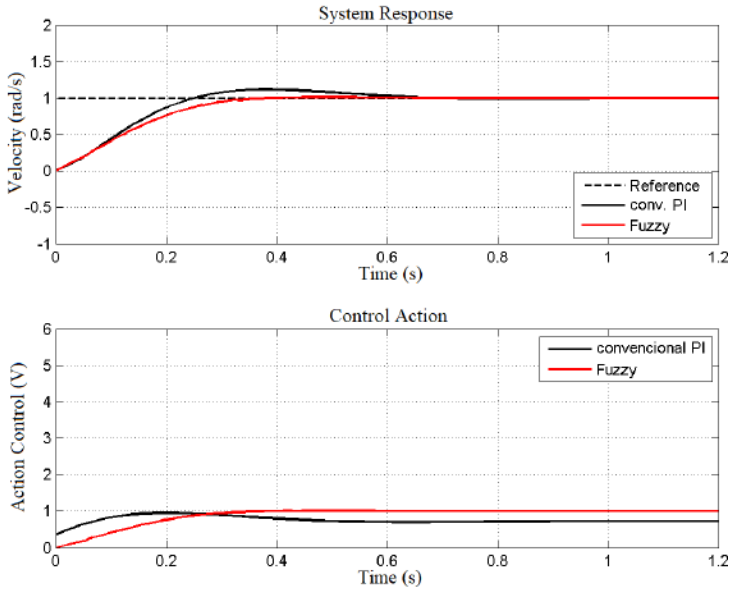

Fig. 7: Experiment 1 – fixed reference.

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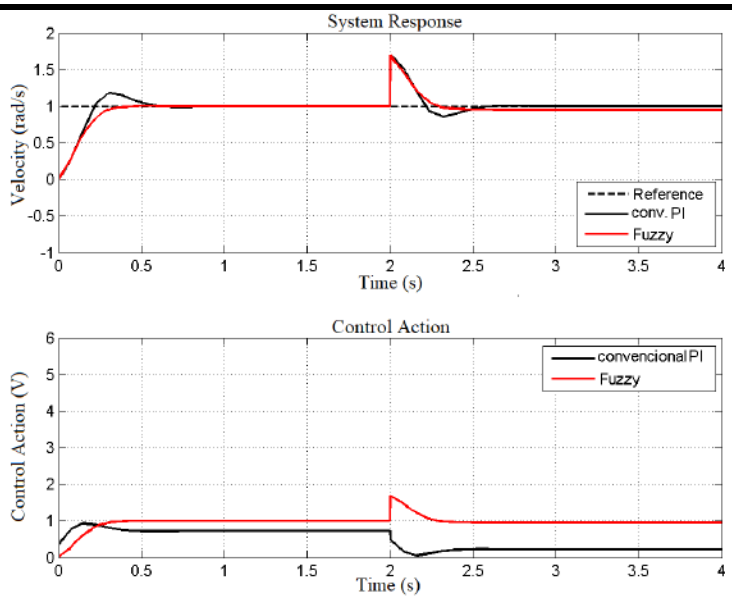

Fig. 8: Experiment 2 –application of disturbance.

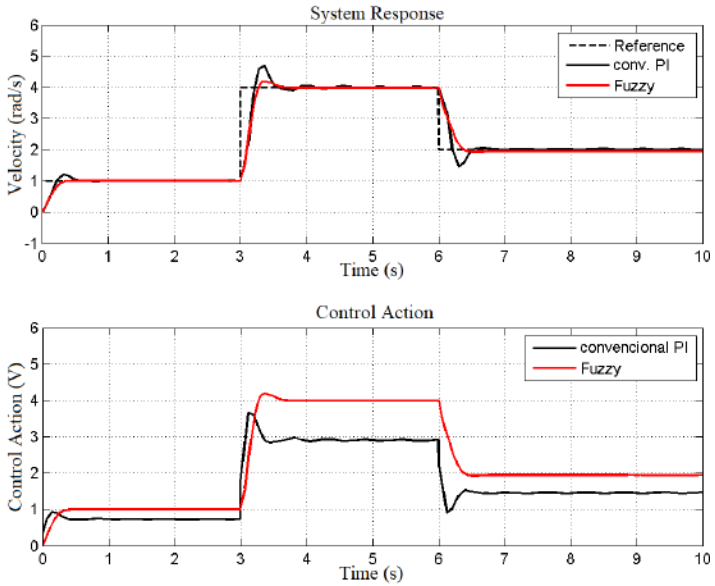

Fig. 9: Experiment 3 – variations in the reference.

V. CONCLUSIONS

In this work a fuzzy control strategy applied to a speed control of a DC motor was presented. It is the Fuzzy-Incremental structure in which its gains were tuned by genetic algorithm.

For comparison purposes, a conventional PI controller was designed for this control purpose, where the gains were attributed according to the Cohen-Coon method.

In general, the fuzzy control presented a better response when compared to the conventional controller. There was a reduction of the overshoot and a faster stabilization of the system.

These results demonstrate that the processes to be controlled that present a dynamic that makes it difficult to obtain the transfer function can be controlled by means of fuzzy strategies and, consequently, modeled from a rule base that composes the heuristic knowledge of the process.

Another factor to be highlighted is the way in which the gains of the fuzzy controller were obtained, since the adjustment of the fuzzy controllers is often done empirically. Such adjustments are intended to fine-tune the inadequacies provided by the rule base initially defined.

As future work, it is suggested to analyze the criterion that quantifies performance properties reconciled the robustness in the two controllers through the analysis of integral of time multiplied by the absolute value of error (ITAE).

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Study of Parking Capacity, Needs, and Effectiveness in Syamsudin Noor Banjarmasin Airport Banjarbaru City Province South Kalimantan

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Abstract**—** *Syamsudin Noor Banjarmasin Airport is a public airport that is used for public purposes managed by PT. AngkasaPura I.The increasing number of aircraft passengers at the Syamsudin Noor Banjarmasin airport makes activities at the airport increasingly high, so that the need for adequate parking facilities is needed. Based on the terms of service it is 14m^2/passenger for domestic and 17m^2/passenger for international. So in this condition, Syamsudin Noor Airport has experienced Overcapacity. Therefore, to meet the requirements for eligibility standards, it is necessary to develop SyamsudinNoor Airport in the near future. The research method used was calculating the performance of the car park at the old terminal.Analysis of research data WAS to present a study analysis of capacity, parking requirements, and effectiveness, by measuring the parking accumulation, parking volume, parking duration, parking index, parking capacity, parking turn over, and parking supply. The next analysis is implementing the effectiveness of parking at the new airport terminal.Parking performance at Syamsudin Noor Airport for two-wheeled and four-wheeled vehicles is not sufficient for parking needs, where the volume of vehicles is greater than the airport's parking capacity. Parking effectiveness based on development at the new Syamsudin Noor Banjarmasin Airport terminal increase based on the parking space for two-wheeled vehicles is 7.300 vehicles,making it effective up to 16 years (in 2034), which are 6.730 units of two-wheeled vehicles.While the parking space for four-wheeled vehicles is as much as 3.800 vehicle unit, so it is effective up to 14 years (in 2032) which is for3.556 four-wheeled vehicle units.*

Keywords**— airport parking parking capacity, parking requirements, parking effectiveness.**

I. INTRODUCTION

Parking conditions and their use at the airport is a very serious problem. This is due to the high level of demand from users of parking at the airport for all vehicle modes,both for two-wheeled vehicles or four wheels. In general, airports in Indonesia have large parking lots, but the capacity decreases by the time, as a result of an increase in the population of a region, easiness to fulfill air transportation needs, improvement of the quality of roads, and the complexity of social and business activities in the society. This has an impact on the availability of parking spaces which are reduced, to be able to accommodate the entire vehicle that will use the parking area. Parking control is becoming increasingly difficult because there are no alternative modes of choice to and from the airport area, while the land used for the development of the parking area is very limited.[1]

The airport development is in response to an increase in the number of airport visitors, who not only need a place to walk, but also need a place to stop. Private vehicles are the most convenient and flexible mode in terms of travel time so that these modes become very dominant at airports throughout the world.[2] Parking per hour parking rates are a common management strategy based on the duration of use of parking facilities (dwell time).[3]

Less orderly and parking density and the difficulty of finding an empty parking lot during rush hour becomes a problem that occurs at Syamsudin Noor Banjarmasin Airport. This is indeed a very disturbing movement around the area. In fact, the existence of an activity should be as minimal as possible causing disruption to the flow of traffic around it the problems that occur, there is a need for further studies to assess the capacity, needs, and effectiveness of parking at

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Syamsudin Noor Banjarmasin Airport. The objectives to be achieved in this study were to find out the needs, parking space capacity and effectiveness of vehicle parking services at Syamsudin Noor Banjarmasin Airport.[4]

The formulation of the problems raised in this study are as follows:

a. What is the analysis of the parking space capacity based on the development at the Syamsudin Noor Banjarmasin Airport?
b. What is the level of parking needs based on the development at Syamsudin Noor Banjarmasin Airport?
c. What is the level of parking effectiveness based on the development at Syamsudin Noor Banjarmasin Airport?

Based on the formulation of the problems raised, the purpose of this study was to:

a. Know and analyze the parking space capacity based on development at Syamsudin Noor Banjarmasin Airport.
b. Know and measure the level of parking needs based on development at Syamsudin Noor Banjarmasin Airport.
c. Know and measure the parking effectiveness based on development at Syamsudin Noor Banjarmasin Airport.

It is expected that this research can provide input on meeting parking needs based on the capacity and efficiency of parking use after the development of Syamsudin Noor Banjarmasin Airport.

In this study the writer proposeda discussion with the following limitations:

a. Parking capacity and needs at the Syamsudin Noor Banjarmasin Airport at the parking location before and after the parking lot was expanded.
b. Parking specifications are for two-wheeled vehicles, airport taxis, and airport transportation (cargo).

II. LITERATURE REVIEW

Parking is an immovable state of a vehicle that is not temporary and the driver leaves the vehicle including the interest in raising and lowering people or goods. Parking facilities are an important part of the land transportation system. The need for parking for vehicles both private vehicles, public passenger transportation, motorbikes and trucks is very important. The parking needs depend on the shape and characteristics of each vehicle with the design and location of the parking lot. Parking problems basically occur when the number of parking needs is greater than the parking capacity, so that it can disrupt traffic around the parking lot.[5]

Separate parking is intended for air bandra workers. This area must be as close as possible to office facilities. Parking requirements for rental cars must be consulted with the rental permit holder. Although it is often expected that rental car parking is as close to the terminal building as possible to minimize passengers to walk far, there is a tendency to locate small rental car parking facilities in terminal buildings to drive from the terminal and rental car parking. Departure passengers can park the rental car away from the rental parking area but still near the airport access road, the rental party will provide transportation to the terminal. This is a general arrangement at a large airport.[6]

Management of airport parking performance consists of several characteristics,is as follows:[7]

a. Parking Accumulation

Parking accumulation is the total number that is parked somewhere at a certain time and divided according to the category of purpose of the trip.

Calculation of accumulated parking can use the equation of:

Accumulation = *Km* – Kk

Where, *Km* is a vehicle that enters a parking location *Kk*is a vehicle that exits the parking location, and x is the number of vehicles that have been parked before observation.

b. Parking Volume

Parking volume is the number of vehicles included in the parking load (which is the number of vehicles per period of time).

The formula used to calculate parking volume is:

Volume = *Nin* + *X* (vehicle)

Where, *Nin* is the number of vehicles that enter, and*X* are*vehicle that existed before the survey time*.

c. Parking Duration

Parking duration is the time used by a vehicle to park at a place where the average value can vary for any given period.The duration of parking is obtained by finding the difference between the time when the vehicle leaves the parking location and the time when the vehicle enters the parking lot.

Duration = Ti –To

Where, *Ti* is the time the vehicle enters (hours), and*To*is the time the vehicle exits (hours).

d. Parking Index

Parking index is another measure to state the use of parking lots expressed as a percentage of space occupied by parking vehicles.

$$IP = \frac{AP}{R} \; X\,100$$

where: *IP*is a parking index, *AP*is accumulated parking, and*R*is available parking space.

e. Parking Capacity

Parking capacity is the maximum ability of a

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parking space in accommodating vehicles, in this case is the volume of vehicles using existing parking facilities.The formula used to calculate parking capacity is:

$$KP = \frac{Service\ time}{D} \ X\ S$$

where, *KP*is parking capacity (vehicle / hour), *S*is the number of parking lots (plot), and*D*is the average duration of parking (hours / vehicle).

f. Parking Turnover

Parking turnover is a number that shows the level of use of parking spaces obtained by dividing the parking volume by the number of parking spaces for each unit of time. The formula used to calculate parking turnover is:

$$TR = \frac{n}{R}$$

where, *TR*is the number of parking changes (vehicle / plot / hour),*n*is the total number of vehicles at the time of the survey, and*R*is available parking space (SRP).

g. Parking Supply

Parking supply or the ability to provide parking is the size limit for the number of vehicles that can be accommodated for a certain period of time (during survey time). The formula used to state the parking supply is as follows:

$$Ps = \frac{S.Ts}{D} \ X\ F$$

where, *Ps* = the capacity of the vehicle that can be parked (vehicle), *S*is the number of parking lots available at the research location (plot), *Ts*is the length of the analysis period/survey time (hours), *D*is the average parking time (hour / vehicle), *F*is a reduction factor due to parking changes, the value is between 0.85 to 0.95.

III. RESEARCH METHODS

3.1 Initial Survey

Aninitial survey was conducted by collecting data on the spatial master plan for the development of Syamsudin Noor Banjarmasin Airport. Based on the initial survey, we can see the parking location, planned parking area, and the design of road infrastructure and parking facilities.

3.2 Data Collection

The research data is an inventory survey of parking survey facilities, questionnaire, parking manager interview, and literature study.

3.3 Research Data Analysis

The results of research data collection used to conduct capacity studies, needs, and parking effectiveness were then analyzed using the following analysis tools.

IV. RESEARCH RESULTS AND DISCUSSION

Based on the estimated development data on the increase in the number of aircraft and the number of passengers that researchers can get from PT AngkasaPura I Banjarmasin, it shows that 2011 was the initial year of investment in the development of the Syamsudin Noor Airport terminal and forecastingin 2019 to 2026 as can be seen in Table 1 below.

Table.1: Data on Number of Aircraft and Number of Passengers Based on Development of Airport Terminal Investment

No.	Information	Year	Number of aircraft (Unit)	Total passenger (person)
1.	Realization operational Terminal Airport	2013	11.242	2.404.121
2.		2014	13.475	3.389.001
3.		2015	14.601	3.708.516
4.		2016	14.745	4.022.904
5.		2017	14.067	4.355.381
6.		2018	14.577	4.732.812
7.		2019	14.885	5.114.811
8.	*Forecasting*Based on Airport Terminal Development	2020	15.631	5.509.761
9.		2021	15.856	5.914.522
10.		2022	16.437	6.754.465
11.		2023	16.574	7.761.867
12.		2024	16.389	8.196.271
13.		2025	18.708	8.634.165
14.		2026	20.022	9.107.980
15.			22.355	9.598.071

Source: PT AngkasaPura I (2018).

4.1 Analysis of Parking Performance of Syamsudin Noor Airport

1. Parking Accumulation

Parking accumulation is calculated based on the number of vehicles entering minus the number of vehicles exiting, and deducted by the number of vehicles that have been in the parking location before the time of the study. [8]The accumulation of parking with the maximum number of two-wheeled vehicles is happening at 07.800 – 08.100 which is 895 units, while the minimum number of two-wheeled vehicles is at 15.00-16.00, which is 351 units. The accumulation of parking with the maximum number

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of four-wheeled vehicles is happening at 12.00 – 13.00 which is 502 units, while the minimum number of four-wheeled vehicles is at o'clock 06.00 – 07.00 which is 183 units.

The calculation results show the results of accumulated parking as follows:

a. Two-wheeled vehicle:
   Vehicle entered = 2.106 units
   Vehicle exited= 952 units
   Vehicles that have been parked before the observation time = 1.829
   Based on these calculations, the total accumulation of parking for two-wheeled vehicles at Syamsudin Noor Airport is as follows :
   Accumulation = 2.106 – 952 – 1.829
   = 2.983 units

b. Four-wheeledvehicle:
   Vehicle entered = 1.695 units
   Vehicle exited= 745 units
   Vehicles that have been parked before the inspection time = 1.171 units
   Based on these calculations, the total accumulation of parking for four-wheeled vehicles at Syamsudin Noor Airport is as follows :
   Accumulation = 1.695 – 745 – 1.171
   = 2.121 units

2. Parking Volume

The results obtained are the parking volume of two-wheeled and four-wheeled vehicles at Syamsudin Noor Airport. Parking volume with the maximum number of two-wheeled vehicles is happening at 07.00 – 08.00 o'clock which is 1.212 units, while the minimum number of two-wheeled vehicles is at 15.00 – 16.00 o'clock which is 457 units. Parking volume with a maximum number of four-wheeled vehicles is happening at 15.00 – 16.00 which is 753 units, while the minimum number of four-wheeled vehicles is at 06.00 – 07.00 o'clock which is 259 units.

Syamsudin Noor's total airport parking volume is calculated based on the Volume formula= *Nin + X* (vehicle), where, *Nin* is the number of vehicles entering,and*X* is *a vehicle that has been there before the survey time*. The calculation results show the results of the parking volume as follows:

a. Two-wheeled vehicle:
   Vehicle entered = 3.859 units
   Vehicles that have been parked before the time of observation = 5.972 units
   Based on these calculations, the total parking volume of two-wheeled vehicles at Syamsudin Noor Airport is as follows.
   Volume = 3.859 + 5.972
   = 9.831 units

b. Four-wheeledvehicles:
   Vehicle entered = 3.759 unit
   Vehicles that have been parked before the time of observation = 2.763 units
   Based on these calculations, the total parking volume of four-wheeled vehicles at Syamsudin Noor Airport is as follows.
   Volume = 3.759 + 2.763
   = 6.522 units

3. Parking duration

Parking duration is the time span used by vehicles to park at a place where the average value can vary for each period of study time.Based on the results of observations that the researchers got in the sample of 50 units of the first two-wheeled vehicle, the parking duration data was generated.

4. Parking Index

The observations show an analysis of parking index calculations at Syamsudin Noor Airport,it can be seen that the available parking spaces experience a lack of parking capacity based on the parking for two-wheeled vehicles at 07.00 - 08.00 o'clock which is equal to 119.33% (lack of 19,33%). Whereas for four-wheeled vehicles there is a lack of capacity based on the parking index at 12.00 - 13.00 o'clock which is equal to 125.50 (deficiency of 25.50%) and at 15.00 – 16.00 which is equal to 126.75% (deficiencyof 26.75%).

5. Parking Capacity

Based on the calculation of parking capacity based on research time for two-wheeled vehicles,in every time of the study one day produces an analysis of fluctuating parking capacity. The maximum parking capacity for two-wheeled vehicles is happening at 11.00 - 12.00 which is equal to 1.212 units. While the minimum parking capacity for two-wheeled vehicles is happening at 15.00-16.00, which is 1.051 units.

Based on Table 4.8 it can be seen parking capacity based on research time for four-wheeled vehicles,where in every time of the study in one day produces an analysis of fluctuating parking capacity. The maximum parking capacity for four-wheeled vehicles is happening at 11.00 - 12.00 which is equal to 664 units. While the minimum parking capacity for four-wheeled vehicles is happening at 13.00 - 14.00 which is equal to 539 units.

6. Parking Turnover

The parking turnover of two-wheeled vehicles at Syamsudin Noor Airport reaches the maximum level at 07.00 - 08.00 which is equal to 1,44or equal to 144%. While the minimum achievement is at 15.00 - 16.00

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which is equal to 0,29or equal to 29%. The turnover of four-wheeled vehicles parking at Syamsudin Noor Airport reaches its maximum level at 15.00 - 16.00 which is equal to 1.78 or equal to 178%. While the minimum achievement is at 07.00 - 08.00 which is equal to 0.85 or equal to 85%.

7. Parking Supply

The results of observing the data for the calculation of the analysis of parking supply based on the parking space capacity at Syamsudin Noor Airport for two-wheeled vehicles reaches the maximum levelat 07.00 – 08.00 o'clock which is equal to 1,086 units. While the minimum achievement is at 15.00 - 16.00 which is equal to 970 units. Parking supply based on the parking space capacity at Syamsudin Noor Airport for four-wheeled vehicles reaches the maximum level at 10:00 - 11.00 which is equal to 592 units. While the minimum achievement is at 07.00 - 08.00 which is equal to 541 units.

4.2 Analysis of Parking Needs of Syamsudin Noor Airport

Parking needs at Syamsudin Noor Airport each year have increased,where this is considered based on an increase in the number of passengers and an increase in the number of flights that occur each year (Table 4.1 page 30).

The average capacity of parking spaces at the Syamsudin Noor Airport can now be said to be lacking in meeting parking needs, even though on average they have capacity that can meet the number of needs, but during the solid hours the capacity does not meet the parking needs, both two wheels and four wheels.Parking performance of two-wheeled vehicles at 07.00 - 08.00 (lack of data capacity of 115 units), 08.00 - 09.00 (lack of data capacity of 70 units). This shows that parking capacity for two-wheeled vehicles is not sufficient for parking, where the volume of two-wheeled vehicles parked is greater than the parking capacity of the airport. While at the other research times, capacity meets the parking needs of two-wheeled vehicles.

Parking performance of four-wheeled vehicles at 13.00 - 14.00 (lack of capacity of 205 units), 15.00 - 16.00 (lack of capacity of 179 units), 16.00 - 17.00 (lack of capacity of 126 units), and 17.00 - 18.00 (lack of capacity of 36 units This shows that parking capacity for four-wheeled vehicles is not sufficient for parking, where the volume of four-wheeled vehicles parked is greater than the parking capacity of the airport.

Parking space on the development of a new terminal in Banjarmasin Syamsudin Noor Airport consists of 2 parts, with the planning of two-wheeled and four-wheeled parking facilities for airport visitors are as follows.

1. Parking area for departure
   The parking area for departure visitors has an area of 22,400 m2 which is divided into 2 parts, which are:
   a. An area of 14.500 m2 is used for four-wheeled vehicles, with a parking capacity of 1800 cars.
   b. An area of 7.900 m2 is used for two-wheeled vehicles, with a parking capacity of 3500 motorcycle units.
2. Parking area for arrivals
   The parking area for arrivals visitors has an area of 22,700 m2 which is divided into 2 parts, which are:
   a. An area of 15.000 m2 is used for four-wheeled vehicles, with a parking capacity of 2000 cars.
   b. An area of 7.700 m2 is used for two-wheeled vehicles, with a parking capacity of 3800 motorcycle units.

The average volume of two-wheeled vehicles is 829 units, while the average volume of four-wheeled vehicles is 569 units. Based on the description of the new terminal parking area of Banjarmasin Syamsudin Noor Airport, the parking capacity of the parking area is 3.800 units of four-wheeled vehicles, and 7.300 units of two-wheeled vehicles. The development of the number of passengers each year has increased by an average of 13.98% (obtained from the growth in the number of passengers each year), so that the parking effectiveness of the new terminal of Banjarmasin Syamsudin Noor Airport with the volume of two-wheeled and four-wheeled vehicles for the next few years can be seen in forecasting an increase in parking service capacity.

Table.2: The Effectiveness of Parking Services at the New Terminal of Syamsudin Noor Airport Every Year (Estimated Increase of 13.98%)

Year	Two wheels (Capacity of 7.300 units)	Four wheels (Capacity of 3.800 units)
2018	829	569
2019	945	649
2020	1.077	740
2021	1.228	843
2022	1.400	961
2023	1.595	1.095
2024	1.819	1.248
2025	2.073	1.423
2026	2.363	1.622
2027	2.693	1.849
2028	3.069	2.107

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2029	3.498	2.402
2030	3.987	2.737
2031	4.545	3.120
2032	5.180	**3.556**
2033	5.904	4.053
2034	**6.730**	4.620
2035	7.671	5.266
2036	8.743	6.002

Source: Data processed (2018)

The results of the parking effectiveness analysis on the development of the new terminal in Banjarmasin Syamsudin Noor Airportcan be seen that the use of parking lots as the development of airport visitor parking services can be seen that the implementation of the airport's new terminal development is dividing the parking area into two parts, which are the parking area for visitors to departures and parking areas for visitors. Based on the parking area provided later, it can be achieved the effectiveness of adequacy, capacity, and feasibility of parking services based on forecasting the development of parking volume carried out by PT. AngkasaPura I every year.

The parking space for two-wheeled vehicles is 7.300 vehicles,so that based on the development of forecasting parking needs every year, then the two-wheeled parking area can be effective up to 16 years (in 2034), which is 6.730 units of two-wheeled vehicles. While the parking space for four-wheeled vehicles is 3,800 vehicles, so that based on the development of forecasting parking needs every year, then the four-wheeled parking area can be effective up to 14 years (in 2032), which is 3,556 units of four-wheeled vehicles.

V. CLOSE

5.1 Conclusions

1. The capacity of the parking space based on development at the Syamsudin Noor Airport in Banjarmasin for two-wheeled vehicles occurs at 07.00 - 08.00, which is 1.143,29 units. Whereas the minimum parking capacity for two-wheeled vehicles occurs at 15.00-16.00 which is equal to 1.021,33 units? The maximum parking capacity for four-wheeled vehicles occurs at 10:00 - 11:00 which is equal to 622,73 units,while the minimum parking capacity for four-wheeled vehicles occurs at 07.00 - 08.00 which is equal to 569.53 units.
2. Parking for two-wheeled and four-wheeled vehicles is not sufficient for parking, where the volume of two-wheeled vehicles parked is greater than the parking capacity of the airport. The average capacity of two-wheeled vehicles is 1.033,2 units while the average parking volume is 787 units. The average capacity of four-wheeled vehicles is 552 units while the average parking volume is 593 units so there is still a lack of availability of four-wheeled vehicle parking at 41 units.
3. The effectiveness of parking based on developments at the Syamsudin Noor Airport in Banjarmasin is increasing based on the parking space for two-wheeled vehicles at 7.300 units and effective up to 17 years (in 2035). While four-wheeled vehicles are 3,800 units of vehicles and are effective up to 14 years (in 2032).

5.2 Suggestions

1. For PT. AngkasaPura I, It is expected that it can improve the performance of airport parking services, making it easier to manage and manage services to airport users. In addition, PT. AngkasaPura I is also expected to be able to implement a digital parking system so that it can be a major aspect to increase parking revenue based on an increase in the number of parking users.
2. For Airport Parking Users, it is expected to be able to utilize the parking area of Syamsudin Noor Airport in accordance with predetermined service needs. Regularity in parking use in addition to providing benefits for parking managers,should also provide benefits and convenience for parking users in the use of airport facilities.
3. For Further Research, it is expected to develop research by presenting aspects that affect the effectiveness of the use of airport parking, among others, by expressing the factors of service quality, the provision of facilities and infrastructure, the level of parking security and others.

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A Review on Access Control Policy and Key Generation in Data Sharing

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Abstract**—** *This review is based on the access control policy and data sharing mechanisms. We know that Cloud computing is the best & proficient manner on handle our information remotely. Data Confidentiality is one of the chief problem now a day's. Security is also matters while data storing & sharing with others. Whenever we are using platform like cloud trust factor also considered. A lot of unauthorized community tries to access & steal the confidential data. In the current time cryptographic technologies are used to secure data. Sharing cloud data in between group of users at a best level is still a complicated issue, especially when dealing with dynamic users group .In this paper we present and discuss propose system which deals with dynamic user group problem like revocation and data privacy & make access control policy.*

Keywords— Data Sharing, Attribute based mechanism, Access Control policy, Data Confidentiality.

I. INTRODUCTION

Cloud computing and information sharing is mainly required and quickly developing trends in this current era. We can get to and share information from various area with the assistance of internet. Additionally it prepared gives client adaptable infrastructure, storage space and hardware similarity to accomplish better execution.

Information privacy and execution are vital factor in cloud storage environment. Cryptographic methods are utilized to secure information from unauthorized access. In cloud computing third parties are likewise assuming primary job in giving us secure channel to exchanging the data from information proprietor to other requested different end clients or customers.

Existing system uses the cipher text policies. In which confidentiality of the data are made by using three factors data, encryption algorithm & the size of key. As well existing concepts third parties are used such as key as well as digital certificate providers & verifiers. Still it is not a piece of cake to keep fully trust over these service providers & third parties. Not everything except rather some of them might have the capacity to attempt to take our information and keys.

Group sharing concept is works like broadcasting particular data among the set of peoples. But while sharing encrypted or sensitive data need to share its key also for decryption purpose. Some time access is given to the set of user and one of them might be leave the group or change the group that time its access should be revoked otherwise it can be able to take unauthorized access from outside also.

In literature review we discussed on the relevant existing topics.

II. LITERATURE SURVEY

There are numerous approaches are characterized in regards to data sharing & data security in cloud computing which are mentioned in our literature.

A. Secure Fine-Grained Access Control and Data Sharing for Dynamic Groups:

Cloud computing additionally brings numerous security issues since cloud service providers (CSPs) are not in the same trusted domain as users. To ensure information protection against untrusted CSPs, existing arrangements apply cryptographic techniques (e.g., encryption mechanisms).challenging issue, particularly when managing dynamic client group. They proposed [1]a secure and efficient fine grained access control and data sharing scheme for dynamic user groups by (1) defining and enforcing access policies based on the attributes of the data; (2) permitting key generation center (KGC) to efficiently update user credentials for dynamic user groups; and (3) allowing some expensive computation tasks to be performed by untrusted CSPs without requiring any delegation key. They first designed an efficient revocable attribute-based encryption (RABE) scheme along with the property of ciphertext delegation

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by exploiting and uniquely combining techniques of identity-based encryption (IBE), Attribute-based Encryption (ABE), subset-cover framework and ciphertext encoding mechanism.

B. Lightweight Policy Preserving EHR Sharing Scheme:

In CP-ABE, access policy is attached to the ciphertext, however, the access policy is not protected, which will also cause some privacy leakage. In this paper, authors proposed [3] a policy preserving EHR system on the basis of CP-ABE. Specifically, authors designed an algorithm which able to hide the entire access policy as well as recover the hidden attributes from the access matrix. The subsequent evaluation of element insert, lookup and recovery shows that their proposed scheme only introduces light-weighted overhead cost. They constructed their scheme by utilizing the Waters CP-ABE as a building block. Apparently, their scheme can easily extend to other CP-ABE schemes with the structure expressed in LSSS form.

C. Efficient Policy-Hiding Attribute-Based Access Control:

With the rapid development of the Internet of Things (IoT) and cloud computing technologies, smart health (shealth)is expected to significantly improve the quality of healthcare. The fine-grained access control, ciphertext-policy attribute-based encryption (CP-ABE) has the potential to ensure data security in s-health. To address these problems, authors introduced [4]PASH, a privacy-aware s-health access control system, in which the key ingredient is a large universe CP-ABE with access policies partially hidden. In PASH, attribute values of access policies are hidden in encrypted SHRs and only attribute names are revealed. In fact, attribute values carry much more sensitive information than generic attribute names. Author's security analysis indicates that PASH is fully secure in the standard model. Performance comparisons and experimental results show that PASH is more efficient and expressive than previous schemes.

D. Key-Policy Attribute-Based Encryption With Equality Test:

In this article, public key encryption with equality test is concatenated with key-policy ABE (KP-ABE) to presented KP-ABE with equality test (KP-ABEwET). This proposed [6] scheme not only offer fine-grained authorization of cipher-texts but also protects the identities of users. In contrast to ABE with keyword search, KP-ABEwET can test whether the cipher-texts encrypted by different public keys contain the same information. Moreover, the authorization process of the presented scheme is more flexible than that of Ma et al.'s scheme. Furthermore, the proposed scheme achieves one-way against chosen-ciphertext attack based on the bilinear Diffe-Hellman (BDH) assumption. In addition, a new computational problem called the twin-decision BDH problem (tDBDH) is proposed in this paper. tDBDH is proved to be as hard as the decisional BDH problem. Finally, for the first time, the security model of authorization is provided, and the security of authorization based on the tDBDH assumption is proven in the random oracle model.

E. Attribute-Based Data Sharing Scheme Revisited:

Ciphertext-policy attribute-based encryption (CPABE) is a very capable encryption technique for secure data sharing. CP-ABE is limited to a potential security risk that is known as key escrow problem whereby the secret keys of users have to be issued by a trusted key authority. Besides, most of the existing CP-ABE schemes cannot support attribute with arbitrary state. They proposed [9] an improved two-party key issuing protocol that can guarantee that neither key authority nor cloud service provider can compromise the whole secret key of a user individually. Authors proposed an attribute-based data sharing scheme for cloud computing applications, which is denoted as ciphertext-policy weighted ABE scheme with removing escrow (CP-WABE-RE). It successfully resolves two types of problems: key escrow and arbitrary-sate attribute expression. This proposed system enhanced data confidentiality and privacy in cloud system against the managers of KA and CSP as well as malicious system outsiders, where KA and CSP are semi-trusted.

F. Secure and Verifiable Access Control Scheme for Big Data Storage:

Traditional approaches are either completely ignore the issue of access policy update or delegate the update to a third party authority; but in practice, access policy update is important for enhancing security and dealing with the dynamism caused by user join and leave activities. In this paper, authors proposed [14] a secure and verifiable access control scheme based on the NTRU cryptosystem for big data storage in clouds. NTRU cryptosystem is a type of lattice-based cryptography. The proposed a new NTRU decryption algorithm to overcome the decryption failures of the original NTRU. It allows the cloud server to efficiently update the ciphertext when a new access policy is specified by the data owner, who is also able to validate the update to counter against cheating behaviours of the cloud. It also enables (i) the data owner and eligible users to effectively verify the legitimacy of a user for accessing the data, and (ii) a user to validate the information provided by other users for correct plaintext recovery.

G. An Efficient File Hierarchy Attribute-Based Encryption Scheme:

In this article, an efficient file hierarchy attribute-based encryption scheme is proposed [15]. The layered access

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structures are integrated into a single access structure, and then the hierarchical files are encrypted with the integrated access structure. Hence, both ciphertext storage and time cost of encryption are saved. Additionally, the proposed scheme is proved to be secure under the standard assumption. Experimental model shows that the proposed scheme is highly efficient in terms of encryption and decryption. With the number of the files increasing, the advantages of this proposed scheme become more and more conspicuous. In this study, an efficient encryption scheme based on layered model of the access structure is proposed in cloud computing, which is named file hierarchy CP-ABE scheme (or FH-CP-ABE, for short). FH-CP-ABE extends typical CPABE with a hierarchical structure of access policy, so as to achieve simple, flexible and fine-grained access control Moreover, the proposed scheme is proved to be secure under DBDH assumption.

- ***Comparison Of ABE Schemes***

Sr. NO	Parameters	KP-ABE	CPABE	HABE	MABE
1	Drawback	It cannot decide who can encrypt data.	Decrypt key only support user attribute that are organized logically.	Unsuitable to implement	Each authority attribute set should be disjoint
2	Efficiency	Average	Average	Better	Scalable
3	Secured Access Control	Low	Average	High	Average
4	Computational Overhead	High	Average	More	More
5	Data Confidentiality	no	yes	yes	yes
6	Scalability	no	yes	no	yes
7	User Revocation	no	no	yes	yes
8	collusion resistant	yes	yes	yes	yes

III. PROPOSE WORK

We go for implementation of cloud based system which deals with complexity of access control policy & dynamic group data sharing problem. Access control is the better one security mechanism in cloud computing. In this propose Attribute based access control scheme we provides a lightweight approach that allows data owners to easily define and undefined the access policies for the respective data share over the groups. Propose system will also include the re key generation concept for making decryption key unique for each end user. Also in propose system we will build up the system to deal with the major problem of dynamic group sharing i.e User revocation. Revocation is becomes mandatory when the particulars want leave the assigned or joined group that time its access policies should be revoked with its dynamic behavior.

IV. CONCLUSION

Cloud computing is most favorable and preferable fashion for the users which provides several useful services. Yet, some place, there is some security or assurance is required against the information put away or action done over the cloud. This paper provides a review of attribute based encryption mechanisms for cloud computing in which a number of security features are provided. Also we review the different attribute based access control mechanisms used in existing systems. It consist four different attribute based encryption schemes such as KP-ABE (Key-policy attribute-based encryption), CP-ABE (ciphertext-policy attribute-based encryption), HABE (Hierarchical Attribute Based Encryption), MA-ABE (Multi-Authority Attribute Based Encryption). Access Controls are associated with attributes and data . These data & attribute are associated with keys and just those keys that the related to attributes which satisfy the policy associated with the data. Also we discussed about problems within the group sharing concept. Revocation and reassignment both the things are more important while data is sharing inside the group of peoples.

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Towards a New Concept of Closed System: from the Oscillating Universe to the EM-Drive

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Abstract**—***The EM-Drive, as long as it is considered a closed system, explicitly violates the conservation of momentum and Newton's well-known third law: however, it would appear, according to several tests to date, that the device may concretely deliver a certain thrust without a detectable exhaust. The question is: can the EM-Drive be actually regarded as a closed system? We have elsewhere tried to provide a qualitative answer by resorting to a theory based, amongst other hypotheses, upon the existence of a further spatial (hidden) dimension. In this paper, the whole revised theory is step-by-step expounded, avoiding, for the sake of brevity, some aspects that, notwithstanding their undeniable relevance, do not concretely contribute to the achievement of our main goal. We consider a Universe belonging to the so-called oscillatory class. Firstly, we formally show that, as it is well known, a simple-harmonically oscillating Universe is fully compatible with General Relativity. Then, we carry out an alternative deduction of the mass-energy equivalence formula as well as of the Friedmann–Lemaître equations. Finally, by resorting to an opportune writing of the conservation of energy (carried out by taking into account the alleged extra spatial dimension), we implicitly obtain a new definition of closed system, so providing an answer to the question previously posed.*

Keywords**—Closed System, Oscillating Universe, Extra Dimension, Friedmann–Lemaître Equations, EM-Drive, Mass-Energy Equivalence, Relativistic Energy, Resonant Cavity Thruster, Reflectors Temperature.**

I. THE OSCILLATING UNIVERSE

1. Uniform Cosmological Models: Oscillatory Class

For a uniform Universe, with the usual hypotheses of homogeneity and isotropy, we can write the first Friedmann – Lemaître Equation [1] as follows:

$$\left(\frac{dR}{dt}\right)^2 = \frac{1}{3}(8\pi G\rho + \lambda c^2)R^2 - kc^2 \tag{1}$$

R represents the scale factor, G the gravitational constant, ρ the density, λ the so-called cosmological constant, k the curvature parameter, whose value depends on the hypothesized geometry, and c the speed of light.

As well known, if we denote with E energy, with T the thermodynamic temperature, with S the entropy, with p the pressure, and with V the volume, we can write:

$$dE = TdS - pdV \tag{2}$$

If we identify the evolution of the Universe with an isentropic process, from the previous relation we obtain:

$$dE + pdV = 0 \tag{3}$$

According to *Mass-Energy Equivalence* [2], we have:

$$E = Mc^2 \tag{4}$$

Obviously, we can write:

$$\frac{dM}{dt} = \frac{d}{dt}(\rho V) = V\frac{d\rho}{dt} + \rho\frac{dV}{dt} \tag{5}$$

Taking into account *(4)* and *(5)*, from *(3)* we obtain:

$$c^2V\frac{d\rho}{dt} + c^2\rho\frac{dV}{dt} + p\frac{dV}{dt} = 0 \tag{6}$$

$$V\frac{d\rho}{dt} + \left(\rho + \frac{p}{c^2}\right)\frac{dV}{dt} = 0 \tag{7}$$

Since V is regarded as directly proportional to R^3, we have:

$$\frac{d\rho}{dt} = -\frac{1}{V}\frac{dV}{dt}\left(\rho + \frac{p}{c^2}\right) = -\frac{3}{R}\frac{dR}{dt}\left(\rho + \frac{p}{c^2}\right) \tag{8}$$

$$\dot{\rho} = -3\frac{\dot{R}}{R}\left(\rho + \frac{p}{c^2}\right) \tag{9}$$

The foregoing represents the so-called *Fluid Equation*.

According to Zeldovich [3], the relation between pressure and density can be expressed as follows:

$$p = (\nu - 1)\rho c^2 \tag{10}$$

The value of ν, hypothesized as being constant, depends on the ideal fluid with which we identify the Universe.
From *(8)*, taking into account *(10)*, we obtain:

$$\frac{d\rho}{\rho} = -3\nu\frac{dR}{R} \tag{11}$$

As a consequence, if we denote with C the constant of integration, we can easily deduce the following:

$$\rho R^{3\nu} = C \tag{12}$$

Equation *(1)* can be evidently rewritten as follows:

$$\left(\frac{dR}{dt}\right)^2 = \frac{8\pi G\rho R^{3\nu}}{3}R^{2-3\nu} + \frac{1}{3}\lambda c^2R^2 - kc^2 \tag{13}$$

We can now define the underlying new constant:

$$C_\nu = \frac{8\pi G\rho R^{3\nu}}{3} = \frac{8\pi GC}{3} \tag{14}$$

By substituting the previous identity into *(13)*, we obtain:

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$$\dot{R}^2 = C_\nu R^{2-3\nu} + \frac{1}{3}\lambda c^2 R^2 - kc^2 \quad (15)$$

If we denote with ω the pulsation of the Universe we want to describe, we can carry out the following position involving the cosmological constant:

$$\lambda = -3\left(\frac{\omega}{c}\right)^2 \quad (16)$$

If we set the curvature parameter equal to zero, by substituting *(16)* in *(15)* we finally obtain:

$$\dot{R}^2 = C_\nu R^{2-3\nu} - \omega^2 R^2 \quad (17)$$

From the previous equation, we can deduce as follows:

$$\frac{dR}{dt} = \sqrt{C_\nu} R^{1-\frac{3}{2}\nu}\sqrt{1-\left(\frac{\omega R^{\frac{3}{2}\nu}}{\sqrt{C_\nu}}\right)^2} \quad (18)$$

$$\frac{1}{\sqrt{C_\nu} R^{1-\frac{3}{2}\nu}} \frac{dR}{\sqrt{1-\left(\frac{\omega R^{\frac{3}{2}\nu}}{\sqrt{C_\nu}}\right)^2}} = dt \quad (19)$$

$$\frac{2}{3\nu\omega} \frac{d\left(\frac{\omega R^{\frac{3}{2}\nu}}{\sqrt{C_\nu}}\right)}{\sqrt{1-\left(\frac{\omega R^{\frac{3}{2}\nu}}{\sqrt{C_\nu}}\right)^2}} = dt \quad (20)$$

If we impose that the radius of curvature assumes a null value when *t=0*, from the prior equation we can deduce:

$$\sin^{-1}\left(\frac{\omega R^{\frac{3}{2}\nu}}{\sqrt{C_\nu}}\right) = \frac{3}{2}\nu\omega t \quad (21)$$

$$R^{3\nu} = \frac{C_\nu}{\omega^2}\sin^2\left(\frac{3}{2}\nu\omega t\right) = \frac{C_\nu}{2\omega^2}[1-\cos(3\nu\omega t)] \quad (22)$$

$$R = \left(\frac{C_\nu}{2\omega^2}\right)^{\frac{1}{3\nu}}[1-\cos(3\nu\omega t)]^{\frac{1}{3\nu}} \quad (23)$$

According to *(23)*, we have formally achieved a model of Universe belonging to the oscillatory class ("O Type" in Harrison's Classification) [4].

From *(14)* and *(22)*, we immediately obtain:

$$\rho = \frac{3}{8\pi G}\frac{C_\nu}{R^{3\nu}} = \frac{3\omega^2}{4\pi G}\frac{1}{1-\cos(3\nu\omega t)} \quad (24)$$

Finally, by taking into account *(16)*, we can write the foregoing equation as follows:

$$\rho = -\frac{\lambda c^2}{4\pi G}\frac{1}{1-\cos(3\nu\omega t)} \quad (25)$$

2. A Simple-Harmonically Oscillating Universe

If we set ν equal to *1/3*, from *(23)* we obtain:

$$R = \frac{C_{1/3}}{2\omega^2}[1-\cos(\omega t)] \quad (26)$$

In other terms, we have found a simple-harmonically oscillating universe characterized by a variable density whose value, taking into account *(25)*, is provided by the following relation:

$$\rho = -\frac{\lambda c^2}{4\pi G}\frac{1}{1-\cos(\omega t)} \quad (27)$$

If we denote with *A* the amplitude of the motion, taking into account *(26)*, we can immediately write:

$$A = \frac{C_{1/3}}{2\omega^2} \quad (28)$$

Finally, denoting with R_m the mean radius, we have:

$$\omega t = \frac{\pi}{2} \rightarrow R = A = R_m \quad (29)$$

$$R = R_m[1-\cos(\omega t)] \quad (30)$$

$$\omega t = \frac{\pi}{2} \rightarrow \rho_m = \rho(R_m) = -\frac{\lambda c^2}{4\pi G} \quad (31)$$

From *(12)*, since ν has been set equal to *1/3*, we have:

$$\rho R = \rho_m R_m \quad (32)$$

From *(14)*, *(28)*, *(30)* and *(32)*, we have:

$$\omega^2 = \frac{C_{1/3}}{2R_m} = \frac{4\pi G}{3}\rho\frac{R}{R_m} = \frac{4\pi G\rho_m}{3} \quad (33)$$

$$(\omega R_m)^2 = \frac{2\left(\frac{2}{3}\pi R_m^3\rho_m\right)G}{R_m} \quad (34)$$

We can now carry out the following noteworthy positions:

$$M_m = \frac{2}{3}\pi R_m^3\rho_m \quad (35)$$

$$\omega R_m = c \quad (36)$$

The position in *(35)*, at a first glance undoubtedly puzzling, will be at a later time easily understood when dealing with the concept of "global symmetry".

From *(34)*, taking into account *(35)* and *(36)*, denoting with R_s the so-called Schwarzschild radius [5] [6], we obtain:

$$R_m = \frac{2M_m G}{c^2} = R_s(M_m) \quad (37)$$

In the light of the outcomes so far achieved, we can write the following relations:

$$\omega t = \frac{ct}{R_m} = \alpha \quad (38)$$

$$R = R_m(1-\cos\alpha) \quad (39)$$

$$\cos\alpha = 1 - \frac{R}{R_m} \quad (40)$$

$$\dot{R} = \frac{dR}{dt} = c\sin\alpha \quad (41)$$

$$\ddot{R} = \frac{d\dot{R}}{dt} = c\omega\cos\alpha = \frac{c^2}{R_m}\left(1-\frac{R}{R_m}\right) \quad (42)$$

The beginning of a new cycle *(t=0)* occurs when the radius of curvature assumes a null value. The problem related to the singularity at *R=0*, herein not addressed, may be solved by postulating a quantized space: in other terms, we should impose some sort of quantum "bounce" (actually, the concept is anything but a novelty) [7] [8] [9] so as to prevent the radius from concretely assuming a null value.

The evolution of the hypothesized Universe is evidently characterized by four consecutive phases: an accelerated

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expansion, a decelerated expansion, a decelerated contraction, an accelerated contraction. All the above-mentioned phases have the same duration.

By taking into account *(39)* and *(41)*, we can immediately write the Hubble parameter [10], commonly denoted by *H*, as follows:

$$H = \frac{\dot{R}}{R} = \frac{c}{R_m}\frac{2\sin\left(\frac{\alpha}{2}\right)\cos\left(\frac{\alpha}{2}\right)}{2\sin^2\left(\frac{\alpha}{2}\right)} = \frac{c}{R_m}\frac{1}{\tan\left(\frac{ct}{2R_m}\right)} \quad (43)$$

As a consequence, it is quite evident how the Hubble parameter may have assumed in the past, and could possibly assume in the future, negative values.

II. A DIFFERENT POINT OF VIEW

1. Mass - Energy Equivalence: Alternative Deduction

Let's consider a material point whose motion is defined by equation *(39)* (in other terms, a simple harmonic oscillator consisting of a mass and an ideal spring). If we denote with *m* the mass of the above-mentioned point, the elastic constant, denoted by *K*, can be written as follows:

$$K = m\omega^2 = m\left(\frac{c}{R_m}\right)^2 \quad (44)$$

Consequently, the total (mechanical) energy, with obvious meaning of the notation, acquires the following form:

$$E_{R_m-point} = \frac{1}{2}KR_m^2 = \frac{1}{2}mc^2 \quad (45)$$

Now, by solely modifying the amplitude of the motion, denoted by z_m, and by keeping the values of mass and pulsation constant, we obtain:

$$z = z_m(1-\cos\alpha) \qquad z_m \in [0, R_m] \quad (46)$$

Once fixed the value of z_m, from *(39)* and *(46)* we have:

$$\frac{z_m}{R_m} = \frac{z}{R} \quad (47)$$

At any given time, the value of *R* is obviously univocally determined by means of *(39)*, being R_m a constant. On the contrary, the value of *z*, provided by *(46)*, depends on the amplitude of the motion, denoted by z_m, that can vary between zero and R_m.

The total (mechanical) energy of a material point, whose motion is defined by *(46)*, acquires the following form:

$$E_{z_m-point} = \frac{1}{2}Kz_m^2 = \frac{1}{2}\left(\frac{z_m}{R_m}\right)^2 mc^2 = \frac{1}{2}\left(\frac{z}{R}\right)^2 mc^2 \quad (48)$$

The material point can be replaced by a material segment (in other terms, it is as if we consider a spring, no longer ideal, whose length at rest is equal to R_m). The length (*R*) of the segment evolves in accordance to *(39)*.

If we denote with *M* the (constant) mass of the segment, the linear density can be defined as follows:

$$\bar{M} = \frac{M}{R} \quad (49)$$

Consequently, denoting with M_z the mass of a portion of segment characterized, at any given time, by a length equal to *z*, we can write the following:

$$M_z = z\bar{M} = \frac{z}{R}M \quad (50)$$

$$\bar{M} = \frac{M}{R} = \frac{M_z}{z} \quad (51)$$

Taking into account *(48)* and *(50)*, the energy related to an infinitesimal material segment can be written as follows:

$$dE_z = \frac{1}{2}\left(\frac{z}{R}\right)^2 c^2 dM_z = \frac{1}{2}\left(\frac{z}{R}\right)^2 c^2\bar{M}dz = \frac{Mc^2}{2R^3}z^2dz \quad (52)$$

Taking now into account *(50)* and *(52)*, the final expression for the energy of a material segment, whose length, at any given time, is equal to *z*, acquires the underlying form:

$$E_z = \int_0^z dE_z = \frac{1}{6}\left(\frac{z}{R}\right)^3 Mc^2 = \frac{1}{6}\left(\frac{z}{R}\right)^2 M_z c^2 \quad (53)$$

At this stage, in order to follow our line of reasoning, it is necessary to introduce a further spatial dimension.

The Universe we hypothesize is identifiable with a *4-ball* whose radius, denoted by *R*, evolves in accordance to *(39)*. The corresponding boundary, that represents the space we are allowed to perceive [11], is a three-dimensional surface (a *hyper sphere*) described by the following identity:

$$x_1^2 + x_2^2 + x_3^2 + x_4^2 = R^2 \quad (54)$$

The *4-ball* is banally described by the following inequality:

$$x_1^2 + x_2^2 + x_3^2 + x_4^2 \le R^2 \quad (55)$$

Let's consider the point P^+ defined as follows:

$$P^+ = (0,0,0,R) \quad (56)$$

If we denote with the P^- the antipode of P^+ (the point diametrically opposite), we have:

$$P^- = (0,0,0,-R) \quad (57)$$

We must now consider the straight line segment bordered by the points P^+ and P^- just defined.

Figures 1, *2* and *3* provide the representations of the above-mentioned segment, by looking into the scenarios that arise from *(55)* if we set equal to zero, one at a time, all the four coordinates.

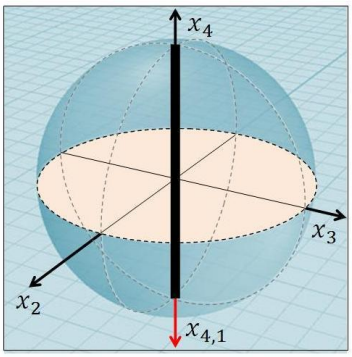

Figure 1. First Scenario (x_1=0)

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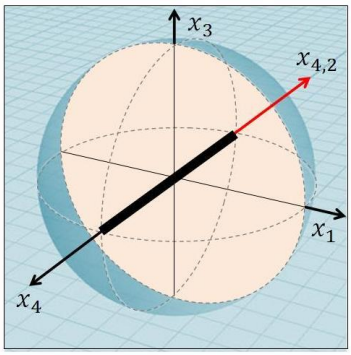

Figure 2. Second Scenario (x_2=0)

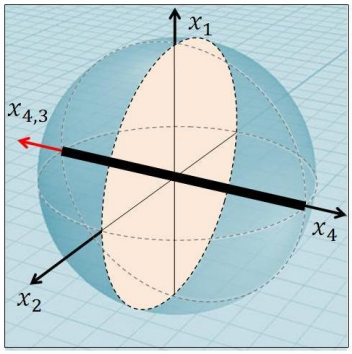

Figure 3. Third Scenario (x_3=0)

If we set x_4=0, we evidently obtain nothing but a single point (as shown in *Figure 4*).

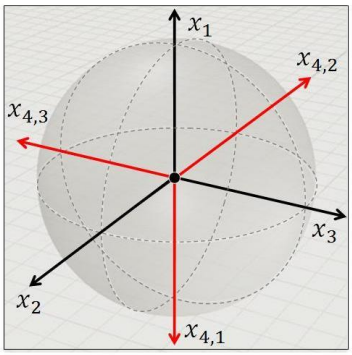

Figure 4. Fourth Scenario (x_4=0)

Therefore, we have to examine the three-dimensional scenarios that arise from the underlying identity:

$$x_i = 0 \qquad i = 1,2,3 \tag{58}$$

For example, we can set x_1=0 (obviously, the same line of reasoning can be followed by setting x_2=0 and x_3=0). As a consequence, from *(54)*, *(55)* and *(56)*, we immediately obtain the following:

$$x_2^2 + x_3^2 + x_4^2 \leq R^2 \tag{59}$$

$$P_1^+ = (0,0,R) \tag{60}$$

$$P_1^- = (0,0,-R) \tag{61}$$

Let's now consider the straight line segment bordered by the centre of the ball and the point defined by *(60)*.

If the segment in question, whose length evolves in accordance with *(39)*, is provided with a mass equal to *M*, its energy can be immediately deduced from *(53)* by setting *z*=*R*. Consequently, underlining how the same procedure can be obviously adopted for the point defined by *(61)*, we can write, with obvious meaning of the notation, as follows:

$$E_{R,1}^+ = E_{R,1}^- = \frac{1}{6}Mc^2 \tag{62}$$

Generalizing the outcome just obtained, we can write:

$$E_{R,i}^+ = E_{R,i}^- = \frac{1}{6}Mc^2 \qquad i = 1,2,3 \tag{63}$$

Consequently, continuing with the generalization, for the material segment characterized by a length equal to *2R* and a mass equal to *2M*, we have:

$$E_i = E_{R,i} = E_{R,i}^+ + E_{R,i}^- = \frac{1}{3}Mc^2 \qquad i = 1,2,3 \tag{64}$$

Finally, by superposition, we can easily write the total amount of energy related to the material segment bordered by the points defined by *(56)* and *(57)* as follows:

$$E = \sum_{i=1}^{3} E_i = Mc^2 \tag{65}$$

The points defined by *(56)* and *(57)* are nothing but the interceptions between the material segment, whose energy is provided by *(65)*, and the hyper surface described by *(54)*, that represents the Universe we are allowed to perceive when we are at rest [11] [12]. As far as our perception of reality is concerned, each point and its antipode are to be actually considered as being the same thing, since they both belong to the same straight line segment [11] [12]. In other terms, we could state that, according to our model of Universe, everything is doubled. On this subject, it is fundamental to underline how we could carry out a banal translation of the frame of reference, by setting the origin in correspondence of one of the endpoints of the material segment.

In the light of what just declared, taking into account the symmetry, the scenarios that arise from *(58)* may be alternatively represented as shown in *Figures 5*, *6* and *7*.

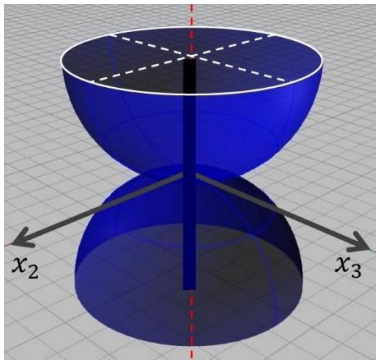

Figure 5. Alternative First Scenario (x_1=0)

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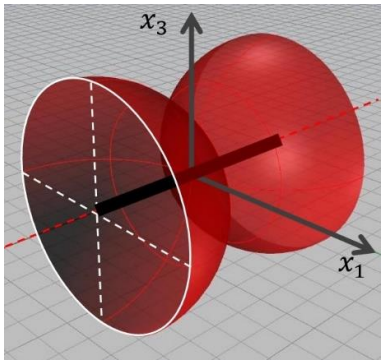

Figure 6. Alternative Second Scenario (x_2=0)

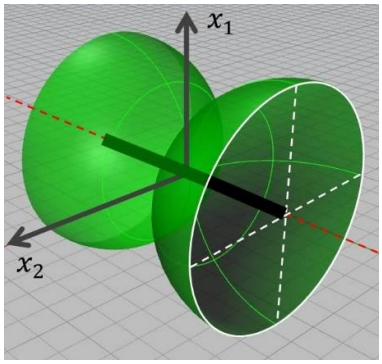

Figure 7. Alternative Third Scenario (x_3=0)

Although the topic, for the sake of brevity, is not herein addressed, it is worth highlighting how the energy in *(65)* consists of a kinetic component and a potential (elastic) component: the latter, in a certain sense, may be related to the so-called "dark energy".

2. The Conservation of Energy

Let's suppose that a material segment, characterized by an initial length equal to *2R*, starts rotating around its centre (that, by virtue of the alleged symmetry, coincides with the one of the *4-ball* with which we identify the Universe). If the total energy has to be preserved, both the length of the segment and its mass must undergo a reduction: otherwise, the kinetic energy due to the hypothesized motion should be necessarily added to the energy at rest, defined by *(65)*. Denoting with *v* the tangential speed of the endpoints, with *2z* the reduced length of the segment (in motion), with $2M_z$ the corresponding (reduced) mass, and with *I* the moment of inertia, we can write the kinetic energy as follows:

$$E_{kinetic\ z,i} = \frac{1}{2} I \left(\frac{v}{z}\right)^2 \tag{66}$$

The moment of inertia of the segment is banally provided by the following relation:

$$I = \frac{1}{12}(2M_z)(2z)^2 = \frac{2}{3} M_z z^2 \tag{67}$$

From *(66)* and *(67)* we immediately obtain:

$$E_{kinetic\ z,i} = \frac{1}{3} M_z v^2 \tag{68}$$

The value of M_z is provided by *(50)*: in other terms, according to *(51)*, the linear density is considered as being constant (it does not vary along the radial direction).

From *(53)*, taking into account the symmetry, we can state that the above-mentioned segment, since it is involved in the cyclic evolution described by *(46)*, is also provided with an energy that, for each of the scenarios that arise from Equation *(58)*, can be written as follows:

$$E_{z,i} = E^+_{z,i} = E^-_{z,i} = \frac{1}{3}\left(\frac{z}{R}\right)^2 M_z c^2 \tag{69}$$

According to our theory [11], taking into account *(64)*, *(68)* and *(69)*, we may express the *Conservation of Energy*, for the considered scenario, as follows:

$$E_i = \frac{1}{3} M c^2 = \frac{1}{3} M_z v^2 + \frac{1}{3}\left(\frac{z}{R}\right)^2 M_z c^2 + \frac{1}{3}(M - M_z)c^2 \tag{70}$$

By multiplying by three all the members of *(70)*, taking into account *(65)*, we easily obtain the underlying relation:

$$E = M c^2 = M_z v^2 + \left(\frac{z}{R}\right)^2 M_z c^2 + (M - M_z)c^2 \tag{71}$$

As far as the last member of *(71)* is concerned, we may state that the first term represents the (real) kinetic energy, the second term the potential energy (related to the cyclic evolution of the Universe), while the third term (the "non-material" component, that may be related to the so-called "quantum potential") [13] [14], represents the energy needed to obtain the motion (to obtain the mass reduction).

From the previous equation we immediately deduce the underlying noteworthy identity:

$$M_z c^2 = M_z v^2 + \left(\frac{z}{R}\right)^2 M_z c^2 \tag{72}$$

According to the definition of Lorentz factor [15], we have:

$$\gamma = \frac{1}{\sqrt{1 - \left(\frac{v}{c}\right)^2}} \tag{73}$$

$$\left(\frac{v}{c}\right)^2 = \beta^2 = 1 - \frac{1}{\gamma^2} \tag{74}$$

From *(72)*, exploiting *(73)* and *(74)*, we evidently obtain:

$$z = R\sqrt{1 - \left(\frac{v}{c}\right)^2} = R\sqrt{1 - \beta^2} = \frac{R}{\gamma} \tag{75}$$

By virtue of *(50)*, we can evidently write:

$$\frac{M}{z} = \frac{R}{z}\bar{M} \tag{76}$$

Consequently, taking into account *(50)*, *(51)* and *(76)*, the specific energies (the energies per unit of length) defined in *(71)* can now be written, with obvious meaning of the notation, as follows:

$$\bar{E} = \frac{M c^2}{z} = \frac{\bar{M}}{\frac{z}{R}} c^2 = \frac{\bar{M} c^2}{\sqrt{1 - \left(\frac{v}{c}\right)^2}} = \gamma \bar{M} c^2 \tag{77}$$

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$$\bar{E}' = \frac{M_z}{z}v^2 = \bar{M}\beta^2 c^2 = \left(1 - \frac{1}{\gamma^2}\right)\bar{M}c^2 \quad (78)$$

$$\bar{E}'' = \left(\frac{z}{R}\right)^2 \frac{M_z}{z}c^2 = \frac{\bar{M}c^2}{\gamma^2} \quad (79)$$

$$\bar{E}''' = \left(\frac{M}{M_z} - 1\right)\frac{M_z}{z}c^2 = \left(\frac{R}{z} - 1\right)\frac{M_z}{z}c^2 = (\gamma - 1)\bar{M}c^2 \quad (80)$$

Very evidently, by virtue of the last four equations, we can concisely write *(71)* as follows:

$$E = Mc^2 = E' + E'' + E''' \quad (81)$$

Alternatively, taking into account *(77)*, *(78)*, *(79)* and *(80)*, we can resort to the underlying extend writing:

$$\gamma\bar{M}c^2 = \left(1 - \frac{1}{\gamma^2}\right)\bar{M}c^2 + \frac{\bar{M}c^2}{\gamma^2} + (\gamma - 1)\bar{M}c^2 \quad (82)$$

Denoting with E_0 the energy at rest, we can write:

$$\bar{E}_0 = \frac{Mc^2}{R} = \bar{M}c^2 \quad (83)$$

$$\bar{E} = \gamma\bar{M}c^2 = \bar{E}_0 + (\gamma - 1)\bar{M}c^2 = \bar{E}_0 + \bar{E}''' \quad (84)$$

By dividing both members of *(72)* by *z*, taking into account *(51)* and resorting to the Lorentz factor, we obtain:

$$\bar{M}c^2 = \bar{M}v^2 + \frac{\bar{M}c^2}{\gamma^2} \quad (85)$$

By multiplying both members of the foregoing equation by the Lorentz factor, we have:

$$\gamma\bar{M}c^2 = \gamma\bar{M}v^2 + \frac{\bar{M}c^2}{\gamma} \quad (86)$$

$$\bar{E} = \frac{\bar{M}c^2}{\sqrt{1 - \left(\frac{v}{c}\right)^2}} = \frac{\bar{M}v^2}{\sqrt{1 - \left(\frac{v}{c}\right)^2}} + \sqrt{1 - \left(\frac{v}{c}\right)^2}\,\bar{M}c^2 \quad (87)$$

3. The "Relativistic" Energy

In order to obtain the formal definition of the so-called *Relativistic Energy*, we have to recall the concept of "dimensional thickness", elsewhere introduced [11].

Very briefly, according to our theory, the three-dimensional curved space we are allowed to perceive may be characterized by a thickness, denoted by Δz_{min}, that may represent nothing but the (radial) "quantum of space".

Consequently, the mass we perceive, denoted by *m*, may be provided by the underlying banal relation:

$$m = \bar{M}\Delta z_{min} \quad (88)$$

As for the energy we perceive, with obvious meaning of the notation, we can write:

$$E_m = \bar{E}\Delta z_{min} = (\bar{E}' + \bar{E}'' + \bar{E}''')\Delta z_{min} \quad (89)$$

$$E_m = E'_m + E''_m + E'''_m \quad (90)$$

By multiplying both members of *(82)* by Δz_{min}, we have:

$$E_m = \gamma mc^2 = \left(1 - \frac{1}{\gamma^2}\right)mc^2 + \frac{mc^2}{\gamma^2} + (\gamma - 1)mc^2 \quad (91)$$

Finally, by multiplying all the members of *(87)* by Δz_{min}, we obtain the well-known underlying equation:

$$E_m = \frac{mc^2}{\sqrt{1 - \left(\frac{v}{c}\right)^2}} = \frac{mv^2}{\sqrt{1 - \left(\frac{v}{c}\right)^2}} + \sqrt{1 - \left(\frac{v}{c}\right)^2}\,mc^2 \quad (92)$$

Denoting with *p* the momentum, with *L* the (relativistic) Lagrangian, and with *H* the Hamiltonian, we have:

$$p = \frac{mv}{\sqrt{1 - \left(\frac{v}{c}\right)^2}} \quad (93)$$

$$L = -\sqrt{1 - \left(\frac{v}{c}\right)^2}\,mc^2 \quad (94)$$

$$E_m = H = pv - L \quad (95)$$

Let's now define the angular speed as follows:

$$\dot{\chi} = \frac{d\chi}{dt} = \frac{v}{z} \quad (96)$$

According to *(71)*, As a consequence, from the point of view of an observer at rest, the value of the (tangential) speed of the endpoints of the rotating segment is greater than *v*. Therefore, taking into account *(75)* and *(96)*, we can define the perceived (virtual) speed [12], denoted by *v**, as follows:

$$v^* = \dot{\chi}R = \frac{v}{\sqrt{1 - \left(\frac{v}{c}\right)^2}} \quad (97)$$

It is worth underlining how, according to *(71)*, the rotating segment (perceived as a translating point) may also exhibit a wave-like behavior. In particular, there is no mass in the range *]z, R]*. Consequently, taking into account *(75)* and *(97)*, denoting with *h* the Planck constant, we can immediately write the corresponding de Broglie (relativistic) length [16] as follows:

$$\lambda_R = \frac{h}{mv^*} = \frac{h}{mv}\sqrt{1 - \left(\frac{v}{c}\right)^2} \quad (98)$$

4. Friedmann – Lemaître Equations: alternative deduction

Our analysis will be carried out by considering one amongst the scenarios that arise from *(54)* and *(55)*, once having set equal to zero one of the coordinates. In other terms, the Universe in its entirety is identified with a ball, and the curved space we are allowed to perceive is assimilated to a spherical surface.

Taking into account the "global symmetry" so far hypothesized, denoting with *M* half the mass of the Universe, we can define the density as follows:

$$\rho = \frac{M}{\frac{2}{3}\pi R^3} \quad (99)$$

If M_m represents the mass when $R=R_m$, from the prior equation, coherently with *(35)*, we obtain:

$$\rho_m = \rho(R_m) = \frac{M_m}{\frac{2}{3}\pi R_m^3} = \frac{3\frac{c^2}{R_m^2}}{4\pi\frac{c^2 R_m}{2M_m}} \quad (100)$$

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We can now carry out, coherently with *(37)*, the following noteworthy position [17]:

$$G = \frac{R_m c^2}{2M_m} \tag{101}$$

From the previous identity, by virtue of which we may identify R_m with the Schwarzschild radius of the Universe [5] [6] [17], taking into account *(100)*, we obtain:

$$\rho_m = \frac{3\frac{c^2}{R_m^2}}{4\pi G} \tag{102}$$

We can now define the cosmological constant as follows:

$$\lambda = -\frac{3}{R_m^2} \tag{103}$$

In accordance with the foregoing position, from *(102)* we immediately obtain what already deduced in *(31)*.

If we identify the evolution of the Universe with an isentropic process, taking into account the relation between pressure and density, denoting with V_m the mean volume, we can write:

$$\frac{d}{dt}(pV^\nu) = 0 \tag{104}$$

$$\frac{d}{dt}(\rho V^\nu) = 0 \tag{105}$$

$$\rho V^\nu = \rho_m V_m^\nu \tag{106}$$

$$\rho R^{3\nu} = \rho_m R_m^{3\nu} \tag{107}$$

The Newtonian gravitational field produced by a generic mass *m* can be written as follows:

$$g = \frac{Gm}{d^2} \tag{108}$$

We can approximatively identify *d* with the measured distance between the gravitational source and the point in correspondence of which we want to evaluate the field. Alternatively, taking into account a possible pseudo-Newtonian gravity, whose expression should obviously resemble *(108)*, we could simply impose a linear dependence between *d*, that would no longer be identifiable with the measured distance, and the radius of the Universe. Hence, for a generic source *m*, once fixed the angular distance (as perceived by an observer placed at the center of the ball with which we identify the Universe), we may write, with obvious meaning of the notation, the following:

$$d = d(R, \chi) \propto R \tag{109}$$

$$g \propto \frac{m}{R^2} \tag{110}$$

To maintain the field constant, generalizing *(110)*, we must necessarily write [17]:

$$\frac{d}{dt}\left(\frac{M}{R^2}\right) = 0 \tag{111}$$

$$\frac{M}{R^2} = \frac{M_m}{R_m^2} \tag{112}$$

From the previous, we obtain what already deduced in *(32)*. By comparing *(32)* to *(107)*, we have:

$$\nu = \frac{1}{3} \tag{113}$$

The previous is the value of ν we have resorted to in order to achieve a Simple-Harmonically Oscillating Universe starting from the Friedmann – Lemaître Equations.

Evidently, we consider the variations of cosmological distances as being exclusively "metric": in other words, we are postulating that the amount of space between whatever couple of points remains the same with the passing of time (on this subject, it could be worth bearing in mind how Hubble himself started bringing into question the relation between the redshift and the recessional velocity of astronomical objects) [18]. As a consequence, if we assign a variable value to cosmological distances, coherently with the apparent evolution of the Universe, we also have to assign, to maintain the gravitational field constant, a variable value to the mass that produces the field itself. On this subject, although the topic, for the sake of brevity, is not herein addressed, we hypothesize that the so-called cosmological redshift may be a phenomenon banally related to the conservation of energy. As well known, the energy of a quantum of light can be expressed as the product between the value of its frequency and the Plank constant. On the one hand, as an alternative to the conventional interpretation of the cosmological redshift, we could accept that, in travelling through the interstellar vacuum, light may somehow "get tired", so as losing part of its energy [19] [20] [21]. On the other hand, we may simply imagine that the Plank constant could vary over time [22] [23]: consequently, in order to preserve its energy, a photon could be forced into modifying its frequency (and its length).

Now, by taking into account *(10)*, we can write:

$$p = -\frac{2}{3}\rho c^2 \tag{114}$$

From *(32)* and *(102)* we immediately deduce the following:

$$\rho = \frac{R_m}{R}\rho_m = \frac{3}{4\pi G}\frac{c^2}{RR_m} \tag{115}$$

$$\frac{c^2}{RR_m} = \frac{4\pi G}{3}\rho \tag{116}$$

From *(40)* and *(41)* we easily obtain:

$$\dot{R}^2 = c^2(1 - \cos^2\alpha) = 2c^2\frac{R}{R_m} - c^2\frac{R^2}{R_m^2} \tag{117}$$

$$\dot{R}^2 + c^2\frac{R^2}{R_m^2} = 2c^2\frac{R}{R_m} \tag{118}$$

If the radius is different from zero, considering the previous relation, by virtue of *(116)*, we have:

$$\left(\frac{\dot{R}}{R}\right)^2 + \frac{c^2}{R_m^2} = 2\frac{c^2}{RR_m} = \frac{8\pi G}{3}\rho \tag{119}$$

Taking into account *(102)*, from the foregoing we obtain:

$$\left(\frac{\dot{R}}{R}\right)^2 - \frac{\lambda c^2}{3} = \frac{8\pi G}{3}\rho \tag{120}$$

$$\left(\frac{dR}{dt}\right)^2 = \frac{1}{3}(8\pi G\rho + \lambda c^2)R^2 \tag{121}$$

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Obviously, the previous equation is nothing but *(1)* with the curvature parameter equal to zero.

Now, we may easily rearrange *(117)* as follows:

$$\dot{R}^2 = 2R\frac{c^2}{R_m}\left(1-\frac{R}{R_m}\right)+c^2\frac{R^2}{R_m^2} \tag{122}$$

From the foregoing equation, by virtue of *(42)* and *(103)*, we can deduce:

$$\dot{R}^2 = 2R\ddot{R}+c^2\frac{R^2}{R_m^2} = 2R\ddot{R}-\frac{\lambda c^2}{3}R^2 \tag{123}$$

$$\left(\frac{\dot{R}}{R}\right)^2 = 2\frac{\ddot{R}}{R}-\frac{\lambda c^2}{3} \tag{124}$$

From *(120)*, taking into account *(114)*, we can easily deduce the following:

$$\left(\frac{\dot{R}}{R}\right)^2-\frac{\lambda c^2}{3} = -\frac{4\pi G}{c^2}p \tag{125}$$

If we multiply by two the first and second member of the previous equation, we immediately obtain:

$$2\left(\frac{\dot{R}}{R}\right)^2-\frac{2}{3}\lambda c^2 = \left(\frac{\dot{R}}{R}\right)^2+\left(\frac{\dot{R}}{R}\right)^2-\frac{2}{3}\lambda c^2 = -\frac{8\pi G}{c^2}p \tag{126}$$

From the previous, by taking into account *(124)*, we finally obtain the second Friedmann- Lemaître equation:

$$2\frac{\ddot{R}}{R}+\left(\frac{\dot{R}}{R}\right)^2-\lambda c^2 = -\frac{8\pi G}{c^2}p \tag{127}$$

III. TOWARDS A NEW CONCEPT OF CLOSED (AND OPEN) SYSTEM: THE EM - DRIVE

1. EM-Drive: Brief Introduction

Very qualitatively, the *EM-Drive* is nothing but a resonant cavity fuelled by microwaves, basically consisting of a hollow conical frustum and a magnetron. According to Shawyer [24], the principle of operation of his revolutionary contraption is essentially based on the radiation pressure: in a few words, the alleged thrust would arise from the difference between the forces exerted upon the reflectors (the bases of the frustum). In spite of the fact that such a device, as long as it is considered as being a closed system, explicitly violates the conservation of momentum and Newton's well-known third law, it would appear, according to several tests to date, that the *EM-Drive* can concretely deliver a certain thrust without a detectable exhaust [25]. As implicitly suggested in the foregoing sentence, the easiest way to solve the paradox may consist in demonstrating, first and foremost, that the device in question cannot be properly regarded as a closed system.

For the sake of clarity, we reveal in advance that the detectability of the exhaust [26], a term that actually will turn out to be not entirely suitable for the hypothesized scenario, is not herein addressed.

2. EM-Drive: Reflectors Temperature

If something can be heated, it is surely characterized by a microstructure. Obviously, this intuitive concept also applies to the *EM-Drive* reflectors. Very approximately, when a solid is heated, its atoms start vibrating faster (around points that can be considered as being fixed). In other terms, as the temperature increases, the average kinetic energy increases (and vice versa). Several thermal analyses of the *EM-Drive* have shown how the bases of the above-mentioned device (when in operation) reach different temperatures [27]. For the sake of simplicity, we ignore how the temperature is distributed (in other terms, two generic points belonging to the same base are regarded as characterized by the same temperature). Consequently, let's denote with T_1 and T_2 the average temperatures reached by the bases (with T_2 greater than T_1).

The scenario is qualitatively depicted in *Figure 8*.

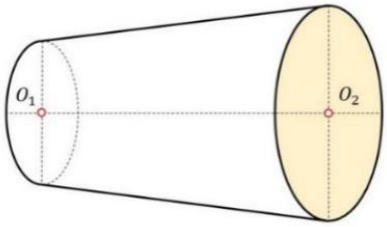

Figure 8. Hollow Conical Frustum

According to the model herein briefly expounded, O_1 and O_2, the centres of the bases, are not the endpoints of a horizontal straight line segment (ideal, since the cavity is empty). When the device is completely at rest, O_1 and O_2 can be approximately considered as being the endpoints of an (ideal) arc of circumference whose radius is equal to R. Moreover, bearing in mind the model herein exploited, the above-mentioned points are actually straight line segments whose radial extension at rest, net of the symmetry, equates the radius (of curvature) of the Universe.

3. Is the EM – Drive a Closed System?

At the beginning, when the device is not in operation, the bases are characterized by the same temperature, and the *EM-Drive* can be obviously regarded as a closed system. When the device is in operation, the bases, after a certain time, reach the temperatures T_1 and T_2. Consequently, we can (statistically) state that the average kinetic energy (and, consequently, the average vibrational speed) of the points belonging to *Surface 1* is less than the average kinetic energy of the points belonging to *Surface 2*. According to the theory we have being resorting to, this means that, net of the symmetry, the radial extension of the material segment that corresponds to O_1, denoted by z_1, is greater than the one that corresponds to O_2, denoted by z_2.

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The scenario is qualitatively depicted in *Figure 9*.

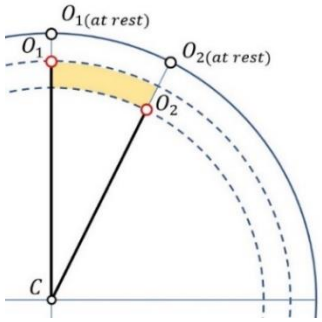

Figure 9. The "Hidden" Exhaust

In other terms, we have:

$$\overline{CO_2} = z_2 < z_1 = \overline{CO_1} \quad (128)$$

Since the electromagnetic radiation can propagate at any level [12] (for any value of z less than or equal to R), photons are allowed to leave the cavity if z is greater than z_2 (and the thrust is so legitimized). On balance, notwithstanding our perception of reality, the *EM-Drive* can be considered as being a closed system only for z less than z_2.

IV. FINAL REMARKS AND CONCLUSIONS

Firstly, it is worth highlighting how the dissertation concerning the EM – Drive has been carried out by introducing several heavy approximations and intentionally ignoring a great deal of subjects, among which stand out the detectability of the alleged exhaust and a more accurate description of the device. In particular, as far as the principle of operation of the *EM-Drive* is concerned, we have evidently avoided discussing Shawyer's explanation [24] (who, among other things, explicitly resorts to Special Relativity) [13], limiting ourselves to referring to the contents of the official *EM-Drive* page. However, the aim of this paper fundamentally lies in qualitatively providing an alternative explanation to the alleged functioning of the device, by implicitly achieving a new definition of closed system.

According to our theory, if a material point (actually a material segment) is provided with a certain kinetic energy, its radial coordinate (the radial extension of the material segment, net of the symmetry) is different from R: on this subject, we underline that if z^* is the value taken by the radial (de facto hidden) coordinate, there is no mass for z greater than z^*. Consequently, radiation (but not mass) can, as it were, pass through the point (the segment). The third addend in the second member of *(71)*, that represents the energy needed to produce the motion (in this specific case vibrational), is clearly related to the non-material component of the particle. To this extent, although the wave-particle duality is not herein addressed, we would like to underline, once again, how the above-mentioned energetic component is somehow connected to the well-known concept of quantum potential. Ultimately, we may state that the *EM-Drive* may be simultaneously regarded as being both a closed and an open system. More precisely, the device is completely closed when it is concretely at rest (actually, this is an ideal condition), and partially closed when it is in operation. Moreover, the opening of the (hidden) exhaust basically depends on the difference between the reflectors temperatures.

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The Use of Lectin Gel in the Treatment of Thermal Burns in Rats Immunocompromised

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Abstract*— *Thisstudy aimed at evaluating the use of lectin gel in the treatment ofsecond-degree burns in rats immunocompromised. Thirty-two male rats were randomly divided into two groups (G1 = treatment with hydrogel containing 100 µg / ml Cramoll 1,4 and G2 = Control, hydrogel without lectin). Thermal lesions were produced in the animals of both groups, positioning a massive aluminum bar 10 mm in diameter (51 g), preheated to 99° C ± 2° C/10 min in the dorsal proximal region for 15 sec. After 7, 14, 21 and 28 days, animals were euthanized. The percentage of tissue shrinkage in the group treated with lectin at 28 days was 81.0 ± 2.2 %. There was no sign of infection, bleeding or secretion. There were nosignificant differences inbiochemical and hematological parametersanalyzed.Histological evaluation of G1revealed: on the 7th day moderate inflammatory infiltrate and mild fibrosis, on the 14th day intense autolysis, neovascularization, mild fibroblast proliferation and intensefibrosis, on the 21st day re-epithelialization, non-modeled and densecollagen, moderate fibrosis and on the 28th day complete tissue epithelialization. These results extend the potential of therapeutic applications for Cramoll 1,4 in the treatment of thermal burns in immunocompromised animals.

***Keywords*— *lectin, burn, immunocompromised*.**

I. INTRODUCTION

Lectins are proteins or glycoproteins of plant, animal or bacterial origin that bind to cell surfaces through specific carbohydrate containing receptor sites [1]. These proteins vary remarkably in their specificity, not only in terms of the recognition of monosaccharides, but also in terms of differential binding to complex carbohydrates [2]. Legume lectins are central to the study of the molecular basis and specificity of protein–carbohydrate interactions [3] and they also have medical implications for the understanding of cell–cell recognition, adhesion, tumor spread, bacterial and viral infection, and inflammation [4].

Similarly, Cramoll a specific glucose / mannose lectin, which has multiple forms designated: Cramoll 1, Cramoll 2, Cramoll 3, Cramoll 4 [5], extracted from seeds of *Cratyliamollis* Mart., a plant native to Northeast Brazil, has shown high clinical potential due to its immunomodulatory profile in the production of IFN-γ and nitric oxide [6], mitogenic activity in human lymphocytes [7] and antitumor activity [8].In a study conducted by Oliveira et al.[9], the Cramoll 1, 4 is able to induce IL-6, IL-17A, IL-22 and IL-23 cytokines in vitro was demonstrated to be better than Concavalin A, besides immunologic memory generation, being a potential biotechnological tool in Th17 pathway studies.

History reveals that concern for wound healing has always existed since, for some patients a small wound is enough to give rise to a chronic lesion at risk of presenting serious complications. Burns are traumatic wounds caused in most cases, by thermal agents, chemical, electrical and radioactive. The extent and

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severity vary with the type of agent, time of exposure, depth and location body [10,11]. It is estimated around two million burn accidents per year in Brazil [12]. Burns are considered injuries that cause severe trauma, since they can lead patients to death or cause emotional and social disorders. According to information from the Brazilian Ministry of Health, in the period between 2013 and 2014, more than 15,000 cases of burn hospitalization were reported in children aged 0 to 10 years [13].

In addition to second-degree burns cause the destruction of the skin's mechanical components, which are natural defense barrier, the impairment of humoral and cellular immune defense becomes an aggravating factor, directly related to patients' clinical conditions that favor the acquisition of infections [14]. In turn, the immune response to burns is a complexevent influenced by a number of factors such as the extent and burn severity, depth, age, presence or absence of infection, type of treatment, etc. [10]. Several local and systemic factors can delay or prevent healing, such as: inadequate nutritional support, oxygenation deficit in tissue necrosis, dry environment, immunosuppression, etc. [15]. Any change in the repair process leads to pathological scarring, which can be broadly grouped into: deficientformation of scar tissue, excessive formation (keloid and hypertrophic scar) and formation of contractures [16].

Despite being observed the benefits of promoting a moist environment in the healing of woundsin the clinical practice, until the early 60's there were few studies directed to this study line. However, the publication of Winterin 1962, which demonstrated the increased rate of epithelialization of wounds in a wet environment with consequent minimization of crust formation, encouraged the research, production and marketing of wet dressings. In 1982 the hydrocolloids-based coverage are released in the United States and Europe, becoming widely used in partial thickness wounds. These covers were not available in the market from the 90's, and their high cost was an initial barrier to diffusion [17].

On the other hand, the healing mechanism involves an extremely complex series of events that has aroused the interest of many researchers engaged in the search for new therapeutic technologies that can solve or minimize the flaws in the process of tissue repair, in particular the tissues damaged by thermal burns.On the other hand, according to Thomas and colleagues [18], the use of hydrocolloids in burns is related to better wound healing rates, greater comfort for the patient due to the mobility of the dressing, pain relief, less frequency in the dressing change and should be considered as a treatment for partial thickness burns. In this context, this study aimed at evaluating the effect of topical gel use containing 1 and 4 isoforms of the lectin from *C. mollis* in the healing of second-degree thermal injuries deep in experimentally immunosuppressed rats.

II. EXPERIMENTAL PROCEDURES

2.1. Animals

Male wistar rats, *Rattusnorvegicus*, albinus, (n = 16 / group), 8 - 10 weeks old and 250 ± 300 g were raised at the animal facilities of Laboratório de Experimentação Animal – UFPE. Each animal was maintained in individual cage, under controlled environmental conditions (12 h light / dark cycle, temperature 23 ± 2 ◦C and humidity 55 ± 10 %) with water and commercial food ad libitum (Labina®). All rats were treated and sacrificed in accordance with the Ethical Committee of Universidade Federal de Pernambuco for Experiments with Laboratory Animals (23076.015015/2009-31).

2.2. Lectin extraction and purification

C. mollis seed extract (10% w/v prepared in 0.15M NaCl) was fractionated using ammonium sulphate (40–60% w/v) and the fraction obtained was submitted to affinity chromatography in Sephadex G-75. Cramoll 1,4 preparation was bioselectively eluted with 0.3 M d-glucose in 0.15M NaCl, dialyzed against 0.15M NaCl during 24 h and lyophilized [5].

2.2.1.Lectin hydrogel (Cramoll 1,4)

Carbopol®was used as vehicle suspended in boric acid buffer (pH 6.0) at 25 °C. After extraction and purification, Cramoll1,4 solutions were added in sufficient quantity to achieve the final concentration of 100 µg Cramoll1,4 per ml of hydrogel. Irradiation was performed at room temperature using Co^{60} at 15 kGy h^{-1}[19].

2.3. Immunosuppression induction

Methotrexate (MTX) was administered to each animal using a low-dose (0.8 mg / kg / week). MTX was administered, according to [20], intramuscularly in 0.15 M NaCl weekly at 7 days before surgery, on surgery day and 7 days after surgery.

2.4. Experimental protocol and groups

Animals were divided into two groups (n = 30 / group) and were anesthetized for the surgical procedure using 2 % xilazinechloridrate (10 mg / kg) and 10 % ketamine chloridrate (115 mg / kg) in subcutaneous injections [20]. Each animal was placed in a prone position and prepared for aseptic surgery using 1 % polyvinylpyrrolidone-iodine. A standard Burns were symmetrically caused on depilated areas through contact with an aluminum bar (diameter = 10 mm), preheated for

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100 °C for 15 s (Figure 1). After burn injury and animal a wakening, once the procedure completion, analgesia was processed by means of intramuscular dypirone application (0.01 mg kg-1) to prevent pain. Injuries were observed during 35 consecutive days followed by the application of 100 µl hydrogel on the burn as follows: Group-1 immunocompromised animals topically treated with hydrogel containing 100 µg / ml Cramoll 1,4; Group-2 (control) immunocompromised animals topically treated with hydrogel without isolectin.

Fig.1: Appearance of the deep second-degree thermal lesion induced in experimentally immunosuppressed male Wistar rats. 10-mm burn in diameter made aiming at evaluating the healing effect of the lectin hydrogel (Cramoll 1.4).

2.5. Clinical Evaluation

Clinical characteristics of the experimental lesions were observed every day, considering the following aspects:edema, hyperemia, exudation and the firmness of wound surface, presence or absence of granulation tissue, presence or absence of scar tissue and crust. Wounds were considered closed if moist granulation tissue was no longer apparent and wounds seemed covered with new epithelium.

All the rats were examined weekly under anesthesia for observation of wound contracture. The wound retraction was evaluated in 7, 14, 21 and 28 days after burn induction. Wound contraction was expressed as reduction in percentage of original wound size. % wound contraction on day-X = [(area on day 0 - open area on day X) / area on day 0] x 100 [21].

2.6. Biochemical and hematological evaluations

Blood from three animals per group were collected on days 7, 14, 21 and 28 after burn induction for biochemical determination. Levels of creatinine, urea, glutamic pyruvic transaminase, glutamic oxalacetic transaminase, gamma glutamyl transferase, amylase, alkaline phosphatase, calcium, prothrombin and fibrinogen were determined. Hematological parameters (erythrocytes, leukocytes and platelets) were determined immediately after blood collection. Evaluations performed in triplicate.Animals in both G1 and G2 were sacrificed by injecting 30 mg kg^{-1} thiopental sodium.

2.7. Microbiological evaluation

Microbiological evaluation was carried out using “swabs” in the injury area at the moment of surgery and respective days of biopsies. This sample was transferred to a Petri dish of 20 x 150 mm containing nutrient agar medium in a laminar flow chamber. After 24h incubation, plates inoculated in triplicate for each sample were evaluated. This routine evaluation was performed to evaluate the degree of contamination of injuries.

2.8. Histopathologic Evaluation

After collection, tissue samples were fixed in 4 % formaldehyde (v/v) prepared in PBS (0.01 M, pH 7.2) followed by histological processing through paraffin embedding, microtome with 4 µm cuts and Masson's trichrome and hematoxylin-eosin staining. Histological analysis was performed by comparative descriptive analysis of experimental groups in binocular optical microscope (Zeiss – Axiostar model) where cellular and tissue characteristics of skin were evaluated after thermal injury and subsequent healing pattern.

The histological analysis was performed by an independent pathologist who was experienced in the examination of burn wound specimens, in the following way: 1) Inflammatory response: characterized by the presence of polymorphonuclear cells (SMC), 2) granular tissue: characterized by the presence of fibroblasts, myofibroblasts and neovascularization; 3) fibrosis: characterized by densities of collagen fibers identified by blue staining intensity observed under optical microscopy, resulting from staining by Masson's trichrome. The score made for parameters was: - = absent, + = mild presence; + + = moderate presence; + + + = strong presence.

2.9. Statistical analysis

To detect differences between groups, the Kruskal-Wallis was used. The results from at least eight independent experimentsperformed in triplicate are displayed as mean values ±standard deviation. For comparative analysis of the quantitative variable the

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Student'st-test was applied considering the value of $p < 0.05$ as statistically significant.

III. RESULTS AND DISCUSSION

3.1. Lectin Hydrogel

The hydrogel of Cramoll 1,4 showed uniform, transparent sheets of three-dimensional networks and good transparency, which allowed the monitoring of healing progression of thermal injuries. The formulation pH equal to 6 was chosen by being similar to that observed in the skin and by not altering the hemagglutinating activity of isolectinCramoll 1.4. In turn, the gamma irradiation was effective in the microbiological control of the gel formulation without causing changes on the hemagglutinating activity of lectin. In addition to these results, various aspects described in the literature make the gel formulation optimal display for treatment of injuries, such as biocompatibility, lack of toxicity, biodegradability, adhesion and absorption [22,23].

3.2. Clinical Evaluation

Results of this study revealed thermal burns white in color, painful, with no blistering, mild edema until 2 days after injury induction in both groups. The hyperemia degree varied from mild to absent in the first two days for group 1, being present in group 2 until the 3rd day of experimentation. The formation of a dense and dry crust was observed in 90% of the animals in the G1 (Figure 2A) and 85% in G2 (Figure 3A) from the third day after burn induction. At 14 days after injury was observed in 33.4% of the animals of G1 (Figure 2B) and 41.6% of the animals of group 2 (Figure 3B), the presence of a second dry and thin crust, smaller than the first crust located in the burn center.

The granulation tissue was observed in the lesions of group 1 at day 12 after injury being visible until day 21 (Figure 2C). In the control group was verified the presence of red color granulation tissue, located at the skin height, similar to that observed in G1 between day 12 and day 23 after injury (Figure 3C). Signs of the scar tissue formation at the lesion edge were observed from day 14. At 28 days the scar tissue was still present but to a lesser degree in group 1 (Figure 2D) compared to its respective control (Figure 3D).

The shrinkage percentage of the inducedthermal lesion in immunosuppressed rats was observed by measuring the total burn area with the aid of a caliper on days 7, 14, 21 and 28 after injury induction. Lesion areas gradually decreased in both groups overtime. However, when groups were comparedamong each other, averages of the contractionpercentages were similar (Figure 4). The contraction of skin lesions is centripetally from the lesion edges. According to Mandelbaum et al [17], the tissue contraction in a healing process by second intention, such as thosein burns, can induce a reduction rate of up to 62% of the total surface area of the initial injury. However, the contraction is only possible due to the myofibroblastsmovement that generates a tensile strength to the smooth muscle cells [24, 25]. In turn, the myofibroblasts can promote50-70% lesion retraction from the initial size [26].

3.3. Hematological and biochemical evaluation

Rats, like other mammals, have to maintain strict control of the internal environment thus ensuring homeostasis. It is known that rats can produce changes in these parameters as a result of pathological processes or external factors such as sex, ancestry, age, diet, handling and environment [27,28]. When analyzing the hematological data in group 1, treated with hydrogel containing Cramoll 1.4,there is a change on the increase in the number of leukocytes (mononuclear and polymorphonuclear) in the 7th, 14th and 21th days of treatment, which was higher than the control group (Table 1). The prevalence of polymorphonuclear cells induced by Cramoll 1.4 is important to remove cellular debris and microorganisms in the wound, favoring healing [29]. Moreover, the number of monocytes showed high in both groups.

The biochemical evaluation revealed increased ALT levels in response to injury by burning and alkaline phosphatase-related to inflammatory period of the healing process animals (Table 2). On the other hand, metabolic changes are considered high risk in third-degree burns with hyperglycemia [30] and high protein catabolism [31] as the main aggravating factors to the injury.The other biochemical parameters were similar to those reported in the literature for healthy animals.

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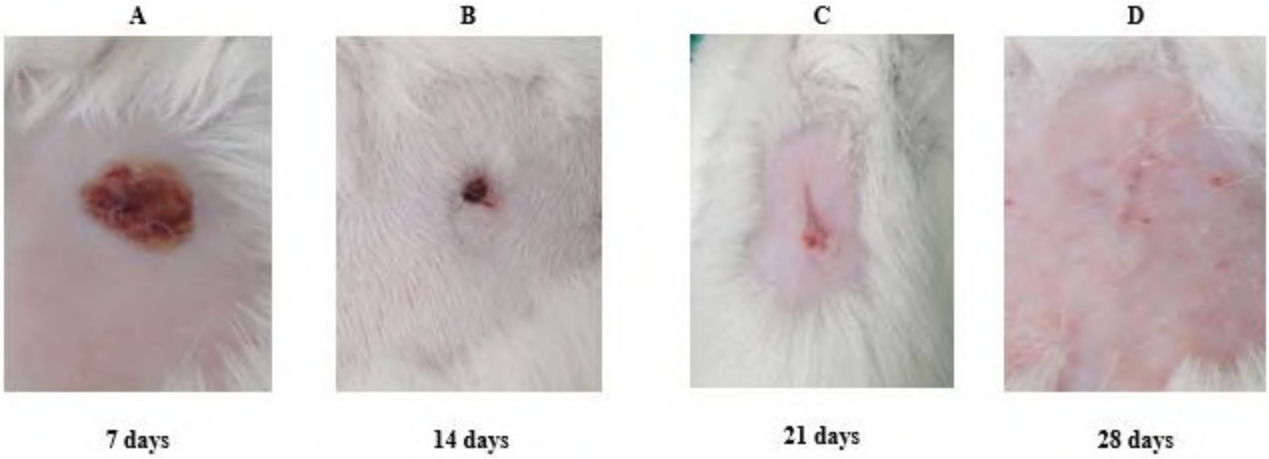

Fig.2: Healing clinical evolution of second-degree thermal burns in immunosuppressed rats experimentally treated by daily topical application of hydrogel containing 100 µl of lectin Cramoll 1.4 at 100 µg / ml. A - Presence of thin and dry crust with slight edges detachment. B - Presence of a small crust in the lesion center. C - Presence of granulation tissue, red color, skin height, located in the lesion center. D - Mild presence of scar tissue at the burn induction site.

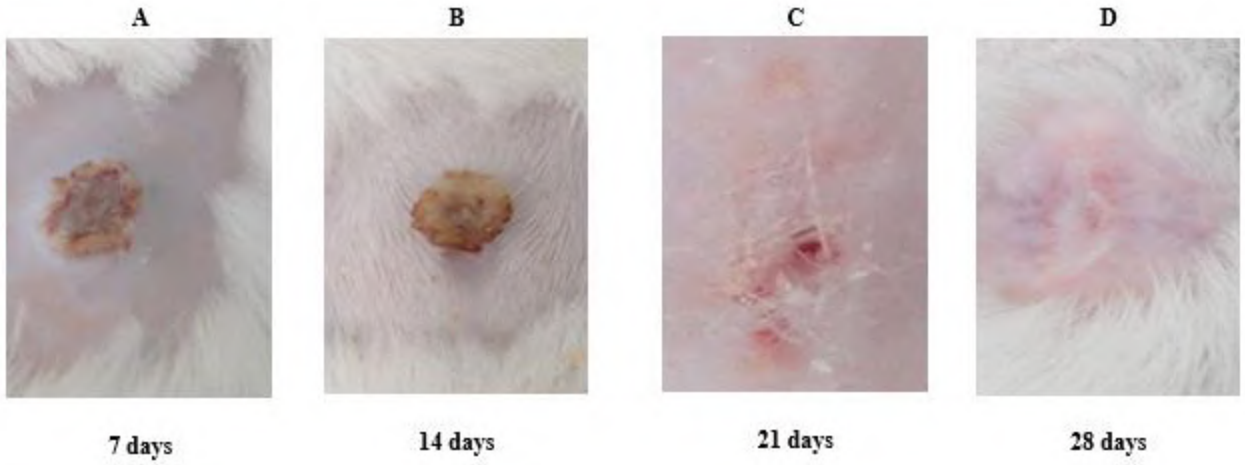

Fig.3: Healing clinical evolution of second-degree thermal burns in immunosuppressed rats experimentally treated by daily topical application of 100 µl hydrogel without lectin (control group)A - Presence of thin and dry crust with slight edges detachment. B - Presence of crust with strong edges detachment; C - Presence of granulation tissue, red color, skin height, located in the lesion center. D - Mild presence of scar tissue at the burn induction site.

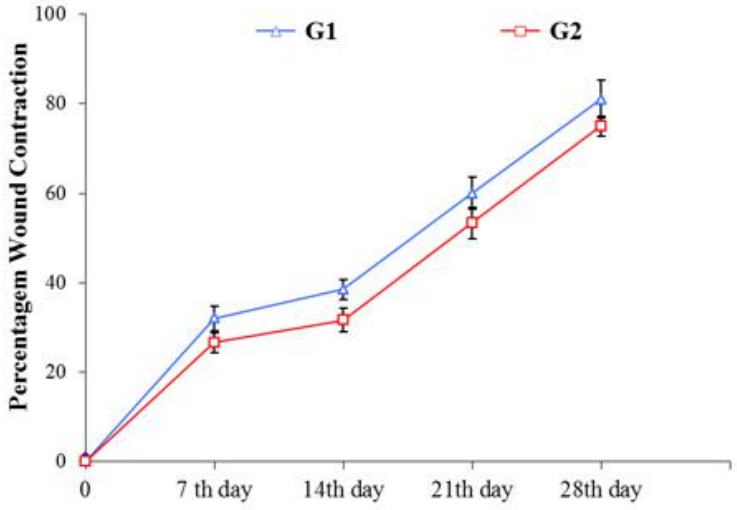

*Fig.4: Contraction area percentage of deep second-degree thermal burn in the experimental model, in male Wistar rats. n = 3. Valuesare mean ± SEM. * p <0.05.*

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3.4. Microbiological Evaluation

The lesions of both groups were not contaminated at any time during the experimental evaluation. For this reason, itwas not observed the presence of secretion and exudates in the lesion area during the daily clinical evaluation. Infected wounds heal more slowly, re-epithelialization is longer and there is also the risk of systemic infection [32].Severe burn trauma is generally associated with bacterial infections, which causes a more persistent inflammatory response with an ongoing hypermetabolic and catabolic state. This complex biological response, mediated by chemokines and cytokines, can be more severe when excessive interactions between the mediators take place [33].

3.5. Histological analysis

The assessment of histological sections of animals treated with 100 µl lectin hydrogel (Cramoll 1.4) revealed the presence of points with necrosis, hemorrhage, fibrin, and extensive inflammatory exudate characterizingan acute inflammatory reaction assessed by the presence of polymorphonuclear cells (Figure 5A) at 7 days of treatment. In the control group (G2) are visualized signs of bleeding in the dermis, similar to the G1, presence of fibrin anddiscrete inflammatory infiltrate (albumin/leukocyte/macrophage) (Figure 6A). Fibrosis was classified as mild to the 7th day of treatment in both groups (Table 3).

The collagen deposition in fibroplasia phase, necessary for the efficient arrival of fibroblasts at the lesion site was classified as mild in the control groupand intense in the group treated with hydrogel containing 1.4 Cramoll. Methotrexate has been shown to have an effect on both circulating and cutaneous lymphocytes[34]. *In vitro*, keratinocytes were a thousand times more resistant to their cytotoxic effects than lymphoid cells, [35] confirming their immunosuppressive properties. For this reason, the use of methotrexate to induce immunosuppression in male Wistar rats causes negative effects on the healing process.

Peters et al. [36] observed that CD18 present in the neutrophil surface during migration emits a chemical signal that induces infiltrations of macrophages to secrete TGF-β 1. Therefore the lack of CD18 in one or another cell leads to an extremely reduced release of TGF-β 1 due to defective adhesion and to subsequent extravasation of the phagocyte in the injury area. Ronty et al. [37] additionally affirmed that this deficient release of TGF-β 1 promotes a delay in the arrival in fibroblasts to the injury sitewith consequential deficit collagen staple fiber deposition.

By day 14 the inflammatory response was classified as mild in G2 (Figure 6B), progressing to moderate to 21 days after the induction of thermal injury (Figure 6C). On the other hand, the intensity of the inflammatory response evolved from acute to chronic in the group 1 assessed by fibroblastic proliferation, 14 days after injury induction (Figure 5B). After 21 days of experimentation the group showed moderate inflammatory infiltrate (Figure 5C). The inflammatory reaction may impair the healing process by promoting swelling, excessive amount of exudate, which favors dehiscence, bacterial growth and consequently inhibition of fibroblast proliferation and collagen deposition [38].

Due to the large molecular diversity of lectins, they have distinct roles in modulating the physiological response participating in the activation of immune cells [39], enlisting neutrophils through indirect mechanisms [40], promoting pro-inflammatory effects in PMN and inducing the release of cytokines [41] as well as triggering the proliferation of fibroblasts [42]. Recent assays also demonstrated higher proliferative induction promoted by this lectin, in addition to IL-2, IL-6, nitric oxide and NK cell activation, in preimmunized mice with Cramoll 1,4 [43]. The IL-6 is a mediator in various stages of inflammation [44]. Among the several pro-inflammatory effects attributed to it, those closely related to the repair process are: mitotic induction of keratinocytes in a later stepand their effects on neutrophil chemoattractantsat the earliest stage [45].

At 28 days thermal injuries treated with hydrogel containing Cramoll 1.4demonstrated excellent repair in relation to collagen deposition and early development of skin appendages compared with their respective control (Figure 5D). The control group also showed collagen deposition and re-epithelialization (Figure 6D). The decrease in collagen deposition in the phase of tissue remodeling in the control groupcan be explained by the deficient arrival of fibroblasts in the injury area until the 7th day of experimentation.

The scar tissue is characterized by a dense fibrous tissue, which resistance is given by the amount of collagen deposited and fibers disposal, which has only 15% of the tensile strength of the original tissue after 21 days. Thus, the process of tissue remodeling can last for months or years, with the new tissue structure being slowly modeling[46].Although scar formation is a beneficial process to the body, the excess deposition of some proteins such as collagen can cause aesthetic and functional complications, resulting in hypertrophic scars and keloids [47]. Burned patients have a prevalence of hypertrophic scars of about 67%, which leads to high medical costs due to size of the wound surface area [48]. The histological evaluation of liver sections of animals from Group 1 showed no pathological changes resulting from daily topical application for 28 consecutive days of

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100 µl hydrogel containing 100 g Cramoll 1.4 / ml (Figure 7).

Another study related the occurrence of gradual healing process induced by a hydrogel containing Cramoll 1,4 on experimental second-degree burns in rats [49]. On the 7th day of treatment, treated group showed higher edema, exudates, and necrosis. With more 7 days, tissue reepithelialization and moderate autolysis were observed. With more two weeks, tissue epithelialization was completed; and in the 35th day was observed a modeled dense collagen. Recently, it has been demonstrated that Cramoll 1, 4 is able to induce IL-6, IL-17A, IL-22 and IL-23 cytokines better in vitro than Concavalin A, in addition to promoting the generation of immunological memory potential biotechnological tool in the Th17 pathway studies. In fact, the healing potential of cutaneous wounds and thermal burns has been related to the immunomodulatory profile of Cramoll, described in other studies, including proinflammatory action in polymorphonuclear cells, induction of cytokine release, and fibroblast proliferation [50].

Table.1: Effect of topical application of hydrogel containing 100 ug of lectin Cramoll 1.4 (G1) and hydrogel without lectin (G2) in the treatment of deep second-degree burns on the hematological parameters in immunosuppressed male Wistar rats. Mean ± SD, n = 4.
** Statistically different from control group (Student'st-test, p <0.05).*

Parameters	**7th Day**		**14th day**		**21st Day**		**28th day**	
	G1	G2	G1	G2	G1	G2	G1	**G2**
Erythrogram								
Erythrocytes mil/mm3	7.04 ± 0.99	8.2 ± 0.65	6.59 ± 0.67	6.85 ± 0.47	7.05 ± 0.47	7.38 ± 0.97	7.7 ± 0.10	**6.85 ± 0.01**
Hemoglobin g/dl	15.24 ± 0.19	16.94 ± 0.17	14.25 ± 0.01	14.4 ± 0.01	13.66 ± 0.45	14.48 ± 0.74	14.44 ± 0.01	**14.4 ± 0.33**
Hematocrit %	41.1 ± 0.59	46.3 ± 0.99	58.0 ± 0.01	39.9 ± 0.87	39.3 ± 0.45	40.8 ± 0.24	41.2 ± 0.01	**39.9 ± 0.09**
PlateletCount								
Platelets mil/mm3	827000 ± 0.93	692000 ± 0.01	813000 ± 0.01	793000 ± 0.91	958000 ± 0.33	859000 ± 0.81	783000 ± 0.04	**765000 ± 0.31**
WBC								
Leukocytes %	*10300 ± 0.48	6200 ± 0.78	*11400 ± 0.91	7700 ± 0.01	*10600 ± 0.15	8200 ± 0.01	6000 ± 0.43	**5600 ± 0.11**
Neutrophils %	11.2 ± 0.39	12.4 ± 0.01	12.9 ± 0.28	13.6 ± 0.75	8.7 ± 0.67	5.9 ± 0.42	9.2 ± 0.01	**9.0 ± 0.99**
Eosinophils %	0.1 ± 0.11	2.0 ± 0.32	0.1 ± 0.07	0.1 ± 0.44	0.1 ± 0.01	0.0 ± 0.00	0.1 ± 0.01	**0.1 ± 0.01**
Basophils %	0.3 ± 0.02	0.2 ± 0.17	0.0 ± 0.00	0.4 ± 0.21	1.2 ± 0.99	0.3 ± 0.10	0.4 ± 0.01	**0.4 ± 0.01**
TypicalLymphocytes %	87.2 ± 0.39	84.0 ± 0.07	75.5 ± 0.90	84.0 ± 0.15	88.4 ± 0.10	82.2 ± 0.99	88.1 ± 0.31	**88.3 ± 0.20**
AtypicalLymphocytes %	0.0 ± 0.00	0.0 ± 0.00	0.0 ± 0.00	0.0 ± 0.00	0.0 ± 0.00	0.0 ± 0.00	0.0 ± 0.00	**0.0 ± 0.00**
Monocytes %	**1.2 ± 0.10**	**1.4 ± 0.01**	**2.0 ± 0.01**	**1.3 ± 0.00**	**1.6 ± 0.32**	**1.6 ± 0.31**	**2.2 ± 0.99**	**2.1 ± 0.41**

Table.2: Effect of topical application of hydrogel containing 100 µg of lectin Cramoll 1.4 (G1) and hydrogel without lectin (G2) in the treatment of deep second-degree burns on the hematological parameters inimmunosuppressed male Wistar rats. Mean ± SD, n = 4.

Parameters	**7th Day**		**14th Day**		**21st day**		**28th Day**	
	G1	G2	G1	G2	G1	G2	G1	**G2**
Pro-thrombin time %	10.5 ± 0.01	10 ± 0.02	10.6 ± 0.01	10 ± 0.01	9.2 ± 0.21	10 ± 0.10	10.5 ± 0.71	**10 ± 0.02**
Fibrinogen mg/dl	430.5 ± 0.01	437 ± 0.01	413 ± 0.99	400 ± 0.01	412 ± 0.71	436 ± 0.71	468 ± 0.99	**451 ± 0.10**

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Cálcium mg/dl	11 ± 0.10	10 ± 0.63	8.4 ± 0.98	9 ± 0.99	11.6 ± 0.14	11 ± 0.99	11 ± 0.01	**11.5 ± 0.99**
AlkalinePhosphatase U/l	185.6 ± 0.07	196 ± 0.99	212.7 ± 0.42	194 ± 0.83	208 ± 0.71	190 ± 0.01	215 ± 0.34	**233 ± 0.31**
Gammaglutamyltransferase U/l	4 ± 0.01	5 ± 0.99	5.7 ± 0.35	5 ± 0.01	5.8 ± 0.14	5.9 ± 0.62	5.3 ± 0.01	**4.5 ± 0.01**
Oxalic Transaminase glutamic U/l	125 ± 0.01	130 ± 0.99	110 ± 0.05	98 ± 0.99	143 ± 0.48	144 ± 0.99	117.5 ± 0.14	**111 ± 0.01**
Transaminase glutâmico pirúvica U/l	68 ± 0.72	70 ± 0.01	60 ± 0.01	60 ± 0.01	68 ± 0.29	68 ± 0.10	47.5 ± 0.63	**60 ± 0.99**
Urea mg/dl	54 ± 0.65	59 ± 0.98	51 ± 0.31	52 ± 0.99	55 ± 0.53	55 ± 0.04	44 ± 0.09	**46.8 ± 0.331**
Creatinine mg/dl	0.4 ± 0.70	0.4 ± 0.31	0.5 ± 0.07	0.6 ± 0.12	0.4 ± 0.01	0.6 ± 0.53	0.5 ± 0.14	**0.3 ± 0.46**
Amylase U/l	**755 ± 0.14**	**968 ± 0.09**	**971 ± 0.53**	**1153 ± 0.99**	**926.3 ± 0.04**	**1045 ± 0.99**	**968 ± 0.01**	**1120 ± 0.29**

**Statistically different from control group (Student'st-test, p <0.05)*

Table.3: Histopathological evaluation of the degree of inflammatory intensity, presence of granulation tissue and fibrosis in the skin after deep second degree thermal injury.Samples were obtained 7 day, 14 day, 21 day and 28 day after induction of the burn wound in immunocompromised maleWistarrats.G1 = Treatment, G2 = Control.

		Inflammatory response		**Granulation tissue**		**Fibrosis**	
Time	**Animal**	**G1**	**G2**	**G1**	**G2**	**G1**	**G2**
7th day	**1**	++	+	-	-	+	+
	2	++	+	-	-	+	+
	3	++	+	-	-	+	-
	4	++	+	-	-	+	+
14th day	**1**	+++	+	+	+	+++	+
	2	+++	+	+	+	+++	+
	3	+++	++	+	+	+++	+
	4	+++	+	+	+	++	+
21st day	**1**	++	++	++	++	++	+
	2	+	++	++	++	++	++
	3	++	++	++	++	++	++
	4	++	++	+	+	++	++
28th day	**1**	+	+	-	+	++	++
	2	-	-	-	-	++	++
	3	+	+	-	-	++	++
	4	-	+	+	-	++	++

Intensity of the parameters evaluated was scored as: - = absent, + = mild presence, + + = moderate presence, + + + = strong presence.

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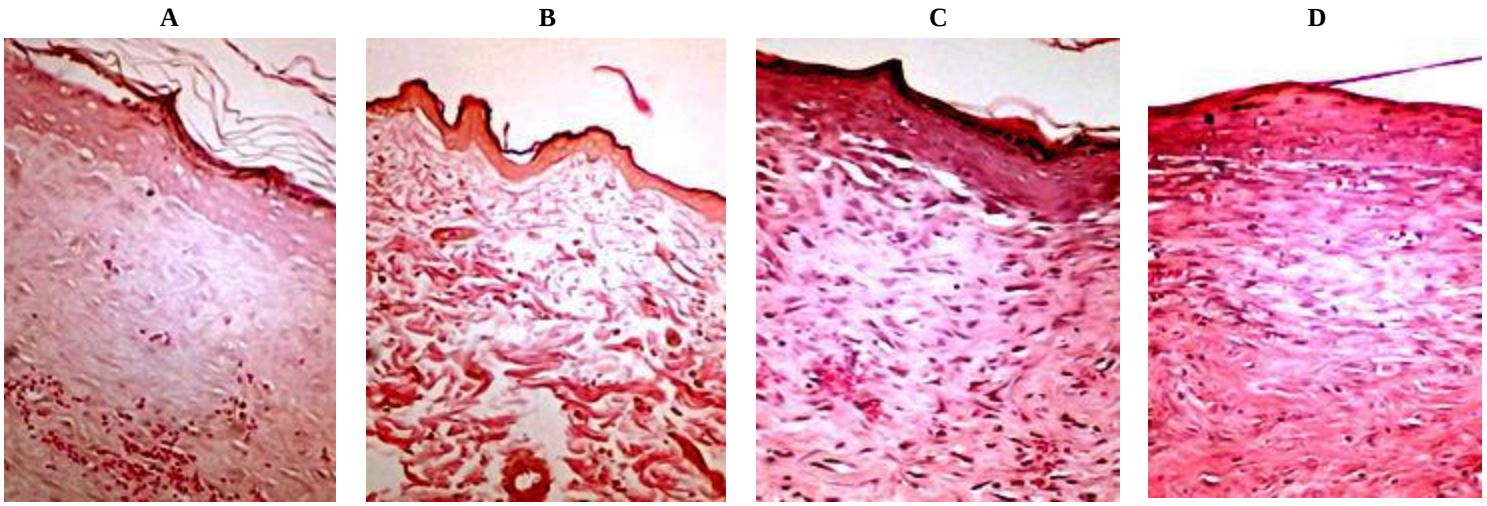

Fig.5: Epithelial tissue of rats in group 1 subjected to second-degree thermal burns. Hematoxilina - Eosina staining. 100x Magnification. A – Histopatological appearance of the lesion at 7 days after thermal injury presenting epithelial tissue with complete destruction of the dermis and epidermis with moderate inflammatory infiltrate and mild fibrosis. B - Histopatological appearance of the lesion at 14 days after thermal injury presenting intense autolysis, neovascularization in the superficial portion of the epithelial tissue, mild fibroblastic proliferation with the presence of not modeled collagen and severe fibrosis. C - Histopatological appearance of the lesionat 21 days after thermal injury presenting tissue reepithelialization, moderateneovascularization, moderate fibroblastic proliferation, presence of dense not modeled collagen and moderate fibrosis. D - Histopatological appearance of the lesion at 28 days after thermal injury showing complete tissue epithelialization, absentautolysis, absent neovascularization, mild fibroblast proliferation, presence of dense and modeled collagen mesh and moderate fibrosis.

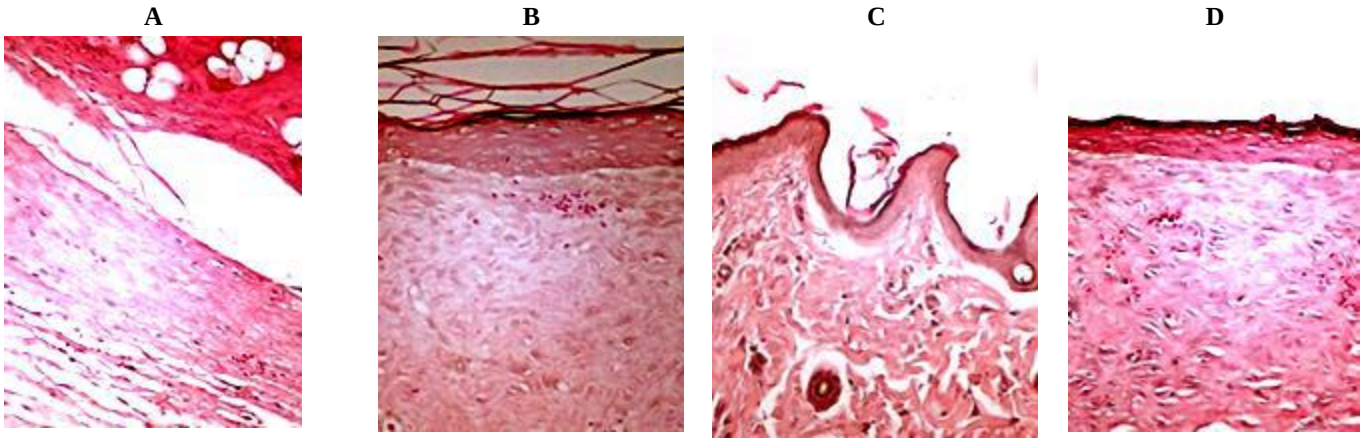

Fig.6: Epithelial tissue of rats in group 2 subjected to second-degree thermal burns. Hematoxilina - Eosina staining. 100x Magnification. A – Histopathological appearance of the lesion at 7 days after thermal injury presenting epithelial tissuewith complete destruction of the dermis and epidermis and mild fibrosis. B - Histopathological appearance of the lesion at 14 days after thermal injury presenting neovascularization, not modeled collagen, and mild fibrosis. C - Histopathological appearance of the lesion at 21 days after thermal injury of tissue showing re-epithelialization, moderate fibroblast proliferation and moderate fibrosis. D - Histopathological appearance of the lesion at 28 days after thermal injury presenting incomplete tissue re-epithelialization, mild fibroblast proliferation presence of not modeled and dense collagen mesh, moderate fibrosis and vascularization present.

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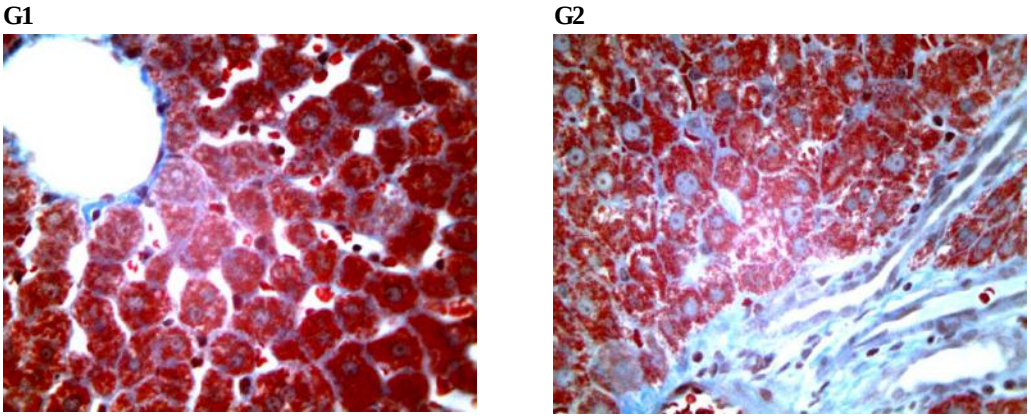

Fig.7: Evaluation of histological sections from liver of the animals in the treated group (G1) and control (G2) with 28 days of experimentation. MassonTrichromestaining. Magnification 100x.

IV. CONCLUSIONS

everal studies have shown the use of lectins in the modulation of biological response. As discussed by Sell and Costa [51] PHA lectin has improved effect in the skin tissue repair process of Wistar rats when compared to *Triticum vulgaris* (WGA) and *Artocarpusintegrifolia* (jacalin) lectins. In fact, studies have affirmed that lectin binding to glycans of the cell surface can cluster target molecules, a pivotal step for initiating cellular signaling pathways [52, 53, 54].Our results showed that the lectin Cramoll 1.4 was effective in the repair of deep second degree thermal lesions induced in experimentally immune depressed mice and may be used in the future as a biotechnological alternative in the development of therapeutic agents.

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Determination of Optimum Location of Rooftop Telecommunication Tower over Multistory Building under Seismic Loading

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Abstract**—** *In the last ten years, the growing trend of telecommunication towers has seen a demanding growth. There have been many competitors among operators that have to enhance network reliability and coverage area. The location of tower is very important because it uses latitudes and longitudes with the specified height of mounted antenna which focus towards the practical necessities of the network. In urban areas, it seems that there is scarcity of land and there is no substitute but to implement roof top towers which satisfies ideal installation conditions with respect to its position and height so that spectrum covers the large area. In this work, the results are obtained in terms of the multistoried building situated in seismic Zone-IV. Staad Pro program is used on the structure which is experiencing seismic forces with telecommunication tower positioned at 5 different placing with respect to square base of tower and optimum location of tower over roof.*

Keywords**— Base shear, Optimum case, Rooftop Telecommunication Tower Location, Seismic Effects, Square base, Staad pro.**

I. INTRODUCTION

The examination of the seismic activities of the earth artificially via structural software reveals that whenever the R.C.C. multistory structure has located around the area of epicenter of any earthquake, the waves creates a harmful effect on it.

Telecommunication towers are self-supporting structures and considered now as four-legged space trussed structures which are normally square or rectangular in plan and are supported on ground or on buildings. These structures act as cantilever part which is fixed from one end and other end is free. These cantilever trusses are analyzed and designed to carry earthquake loads. These towers cover less base area, so that they are suitable in situations where there is scarcity of land in urban areas is very restricted. The most common bracing patterns are chevron and the x-bracing.

When this steel structure transferring its own weight as well as weight of accessories and fixtures over the roof of any multistory structure, the response of the host structure will not be same as before. There is always critical location of structure and along with this; the tower weight creates a disaster effect. To counteract this effect we will have to find a most suitable location of telecommunication rooftop tower placing and this work shows optimum location of the same.

II. OBJECTIVES

In this work, response spectrum analysis method is used for the determination of various response parameters occurred in the building under various location of rooftop telecommunication tower over the building. The objectives under medium soil conditions are as follows:-

1. To determine base shear in X direction (+ optimum case)
2. To find base shear in Z direction (+ optimum case)
3. To find and examine maximum nodal displacement in X, Y, Z direction (+ optimum case)
4. To evaluate maximum axial forces in columns at ground level (+ optimum case)
5. To investigate the maximum shear forces in columns (+ optimum case)
6. To find maximum bending moments in columns (+ optimum case)
7. To compare each location case for story drift in X direction (+ optimum case)
8. To compare each location case for story drift in Z direction (+ optimum case)

III. METHODOLOGY IN SEISMIC ANALYSIS

Base Shear (VB) determination of multistory building is given by

$$V_B = A_h \times W$$

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Where,
Ah = design horizontal seismic coefficient
W = Weight of story

Value of A_h is given by

$$A_h = ZIS_a/2Rg$$

Where,
Z = seismic zone factor
I = importance factor
R = response reduction factor
(Sa/g) = average response acceleration coefficient

This average response acceleration coefficient depends upon fundamental time period Ta

$$Ta = (0.09xh)/(\sqrt{d})$$

The Seismic Base shear will be distributed along the height of the building is given by:-

$$Q_i = V_B \text{ x } (Wihi^2)/ (\Sigma i=1 \text{ to n } Wihi^2)$$

Where,
Q_i = design lateral force,
W_i = seismic weight,
h_i = height of the i^{th} floor measured from base of the multistory building
n = number of stories of the building.

IV. STRUCTURE MODELING

The structural modeling has been designed in Staad pro consist of five different rooftop tower placing. This residential apartment having a plinth area of 369 m^2 has been modeled in Staad pro software and model descriptions as per its properties, material, its geometry, support and loading provided are listed in Table 1. Details of loading provided viz. dead loads and live loads are listed in Table 2. Seismic loading definitions are provided in Table 3. Table 4 shows the details of loading combinations as per IS 1893 recommendations. Details of rooftop tower placing cases in multistory building are shown in Table 5 and Figure 1 shows the locations of rooftop tower placing. Figure 2 to Figure 6 shows different rooftop telecommunication tower location placing that are taken into account in this research work.

Table.1: Description of multistory building

Building configuration	G + 12 (Residential apartment)
Plinth area	369 m^2
Height of building above ground level	47.58 m
Floor height	3.66 m
Depth of footing	3 m deep
Support	Fixed
Size of beam	600 mm x 350 mm
Size of column	500 mm x 450 mm
Slab Thickness	200 mm
Steel Platform Thickness	25 mm
Concrete and Steel Grade	M25 & Fe 415 grade
Height of tower	15 m
Top width and bottom width of tower	1m and 3m

Table.2: Details of Dead and Live loading

Self-weight	Over entire structure
10 mm mortar load on above and below the slab	0.42 KN/m^2
Clay floor tiles (12.5 mm thick)	0.10 KN/m^2
Wall load (Roof Parapet)	13.65 KN/m
Wall load (External)	13.65 KN/m
Wall load (Internal)	7.66 KN/m
Weight of tower platform (25 mm thick)	2.25 KN/m^2
Point load (load consist of ladder, cage, etc.) transferred via 4 tower legs	2.4375 KN
Live load for floor and roof	3 KN/m^2 & 1.5 KN/m^2
Live load on tower (assuming 2 persons of 70 kg. weight contains each of 30 kg wt. with them)	1.9613 m^2

Table.3: Details of seismic loading definitions

Zone Factor	0.24 (Zone IV)
Response reduction factor	5
Importance factor	1
Soil Type	Medium Soil
Damping ratio	5%
Period in X and Z direction	0.9933 sec. and 0.9292 sec.

Table.4: Details of loading combinations as per IS 1893 recommendations

S. No.	Load Combinations
1	1.5 (DL+LL)
2	1.5 (DL+EQ_X)
3	1.5 (DL-EQ_X)
4	1.5 (DL+EQ_Z)
5	1.5 (DL-EQ_Z)
6	1.2 (DL+LL+EQ_X)
7	1.2 (DL+LL-EQ_X)
8	1.2 (DL+LL+EQ_Z)
9	1.2 (DL+LL-EQ_Z)
10	0.9 DL+1.5EQ_X)
11	0.9 DL-1.5EQ_X)
12	0.9 DL+1.5EQ_Z)
13	0.9 DL-1.5EQ_Z)

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Table.5: Details of rooftop tower placing cases in multistory building

CASE A	Tower is located at P1 position
CASE B	Tower is located at P2 position
CASE C	Tower is located at P3 position
CASE D	Tower is located at P4 position
CASE E	Tower is located at P5 position

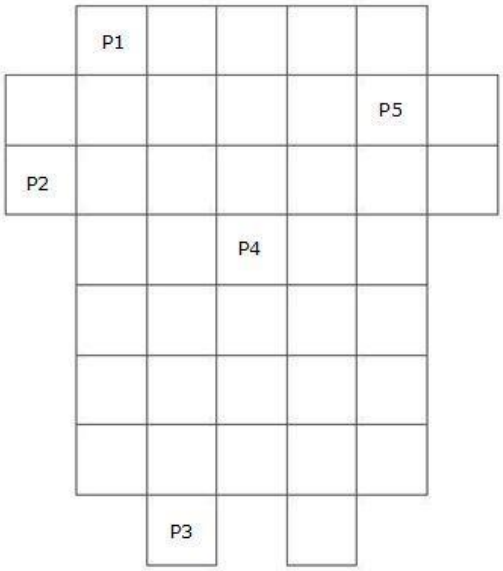

Fig.1: Details of rooftop tower placing

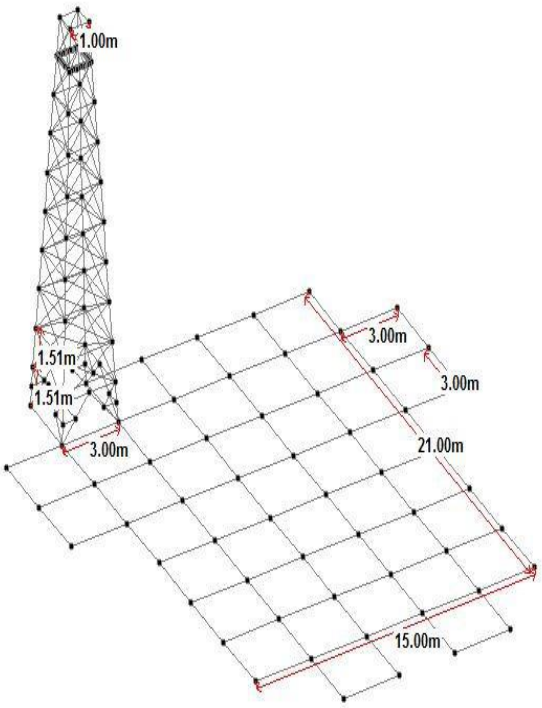

Fig.2: Case A of Telecommunication Tower Over Roof of Position P1

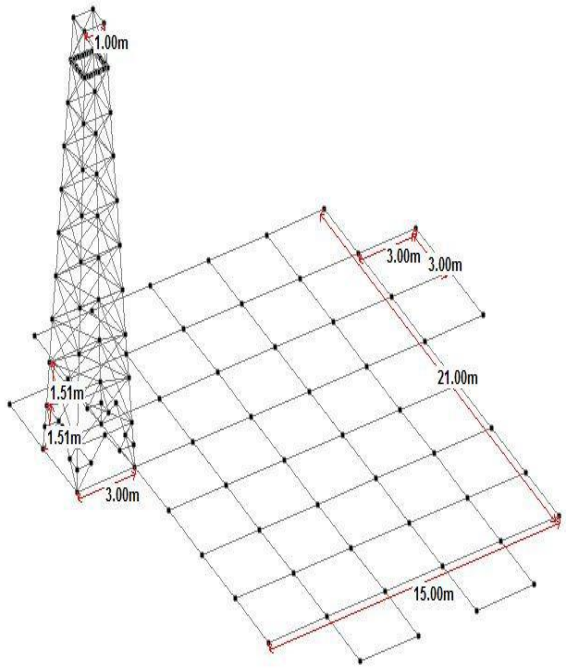

Fig.3: Case B of Telecommunication Tower Over Roof of Position P2

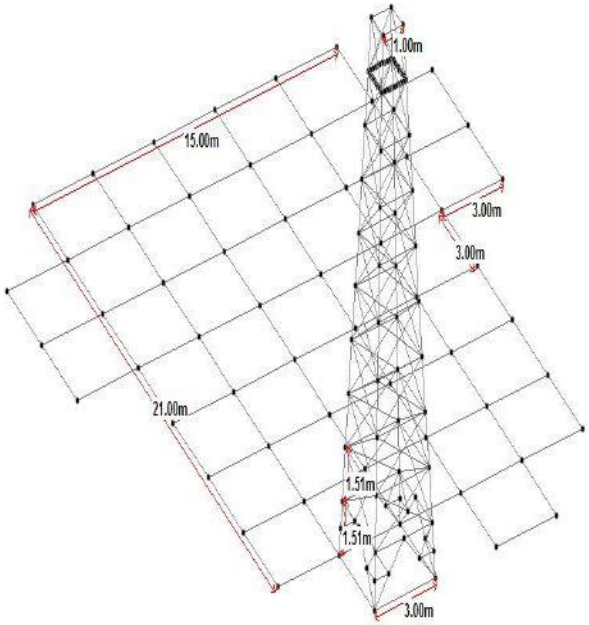

Fig. 4: Case C of Telecommunication Tower Over Roof of Position P3

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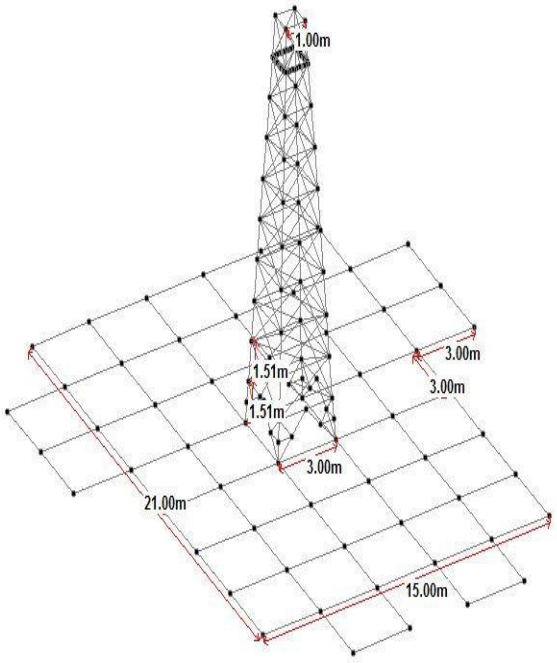


Fig. 5: Case D of Telecommunication Tower Over Roof of Position P4

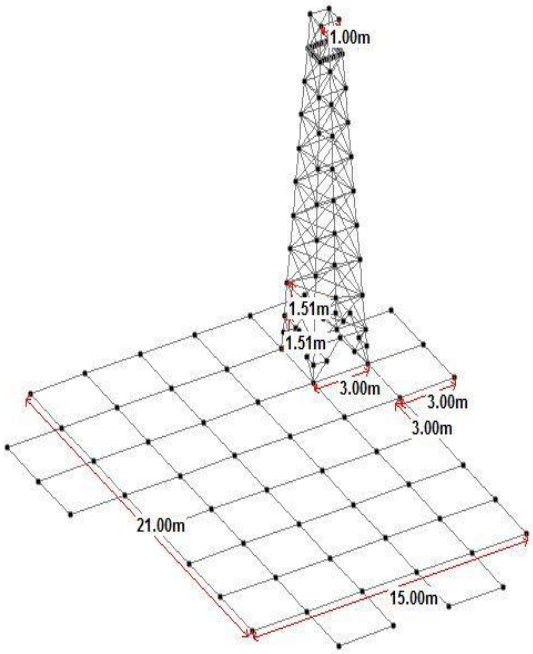


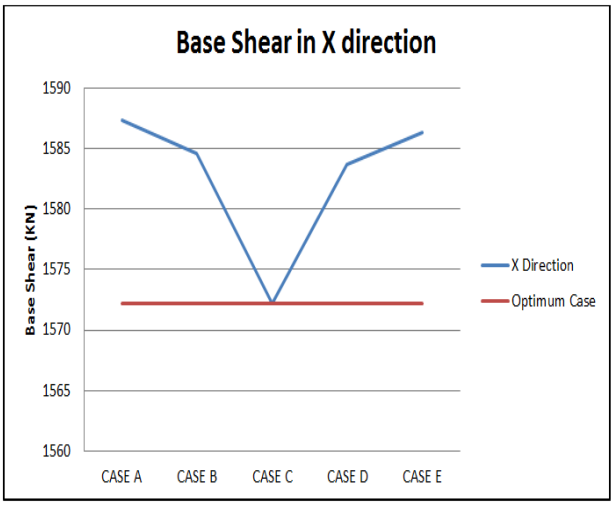
Fig. 6: Case E of Telecommunication Tower Over Roof of Position P5

V. RESULTS AND DISCUSSIONS

After the implementation of earthquake effects over the multistory building contains telecommunication tower on the roof with different location cases, analytic results for medium soil condition under seismic Zone IV are as follows:-

Table.6: Base Shear in X direction for all 5 cases under seismic Zone IV

Tower Location Cases	Base Shear X – direction (KN)	Optimum Case	Remarks
CASE A	1587.34	Case C	Whenever telecommunication tower used in G+12 story building, optimum location case for base shear parameter in X direction will be Case C
CASE B	1584.55		
CASE C	1572.20		
CASE D	1583.71		
CASE E	1586.28		



Graph 1: Graphical representation of Base Shear in X direction for all 5 cases under seismic Zone IV

Table.7: Base Shear in Z direction for all 5 cases under seismic Zone IV

Tower Location Cases	Base Shear Z – direction (KN)	Optimum Case	Remarks
CASE A	1658.39	Case A	Whenever telecommunication tower used in G+12 story building, optimum location case for base shear parameter in Z direction will be Case A
CASE B	1658.48		
CASE C	1658.49		
CASE D	1658.71		
CASE E	1658.57		

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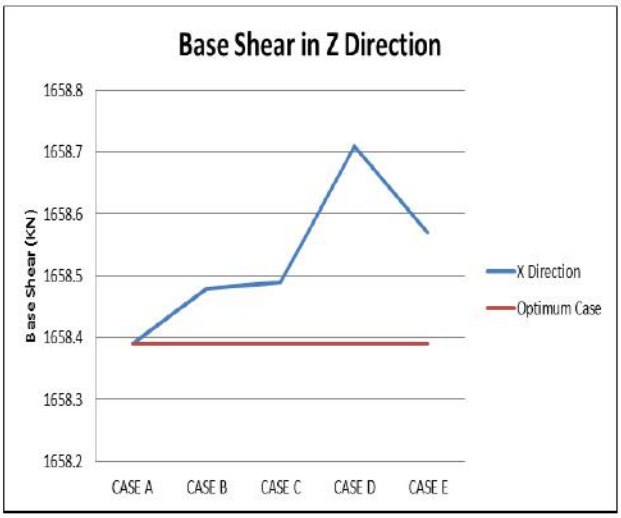
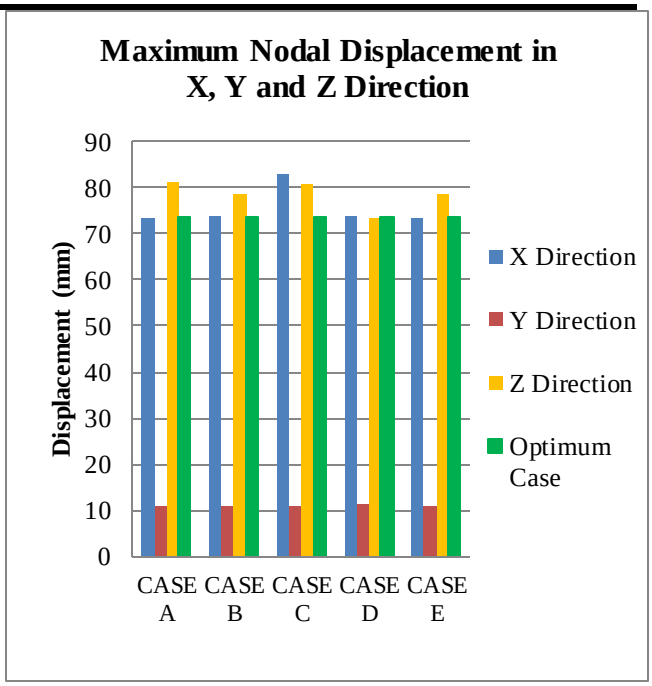


Graph 2: Graphical representation of Base Shear in Z direction for all 5 cases under seismic Zone IV

Table.8: Maximum nodal displacement in X, Y and Z direction for all 5 cases under seismic Zone IV

Tower Location Cases	Maximum Displacement			Optimum Case	Remarks
	X direction (mm)	Y direction (mm)	Z direction (mm)		
CASE A	73.501	10.862	81.328	Case D	Whenever telecommunication tower used in G+12 story building, optimum location case for Maximum nodal displacement will be Case D
CASE B	73.774	10.865	78.838		
CASE C	83.216	10.857	80.720		
CASE D	73.853	11.136	73.381		
CASE E	73.585	10.869	78.554		



Graph 3: Graphical representation of maximum nodal displacement in X, Y and Z direction for all 5 cases under seismic Zone IV

Table.9: Axial Forces in Column at ground story for all 5 cases under seismic Zone IV

Tower Location Cases	Axial Forces in Column (KN)	Optimum Case	Remarks
CASE A	2009.533	Case C	Whenever telecommunication tower used in G+12 story building, optimum location case for Axial forces in Column will be Case C
CASE B	2009.888		
CASE C	2008.655		
CASE D	2011.922		
CASE E	2010.164		

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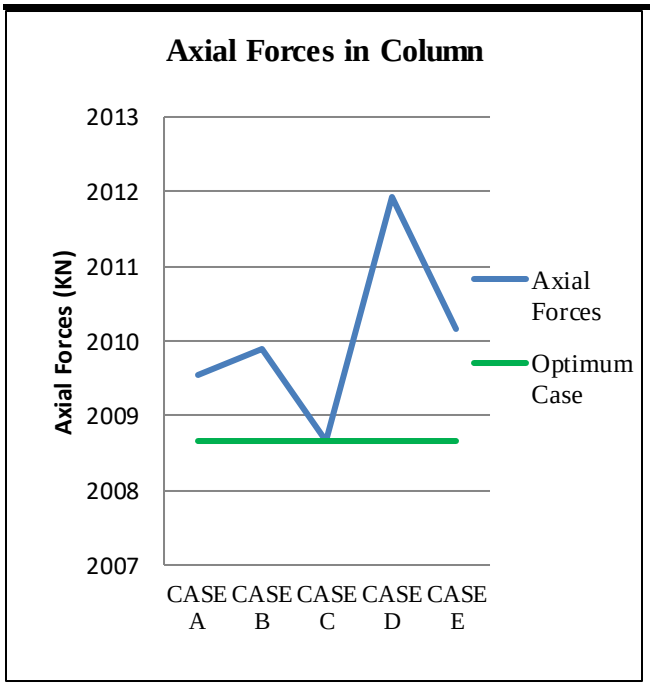
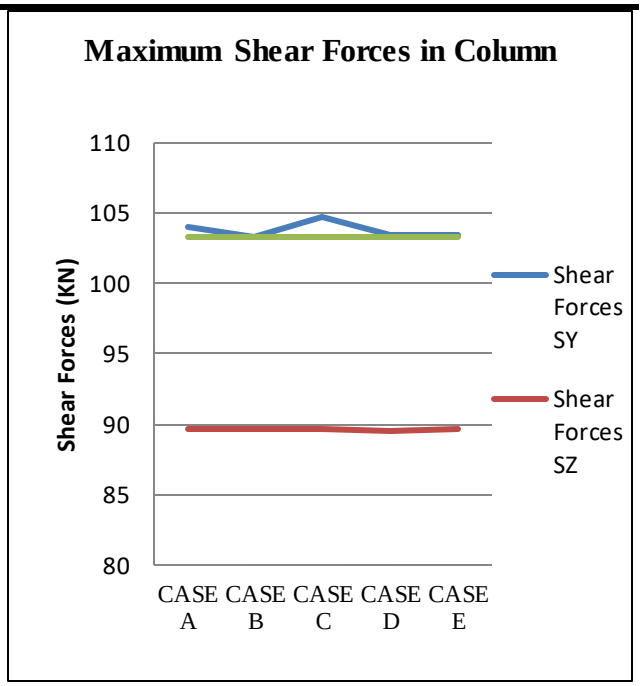


Graph 4: Graphical representation of Axial forces in Column at ground story for all 5 cases under seismic Zone IV



Graph 5: Graphical representation of Maximum Shear Forces in Column for all 5 cases under seismic Zone IV

Table.10: Maximum Shear Forces in Column for all 5 cases under seismic Zone IV

Tower Location Cases	Shear Forces in Column (KN)		Optimum Case	Remarks
	SY	SZ		
CASE A	103.960	89.659	Case D	Whenever telecommunication tower used in G+12 story building, optimum location case for Shear forces Sy and Sz in Column will be Case D
CASE B	103.273	89.673		
CASE C	104.691	89.630		
CASE D	103.395	89.562		
CASE E	103.453	89.651		

Table.11: Maximum Bending Moments in Column for all 5 cases under seismic Zone IV

Tower Location Cases	Bending Moments in Column (KNm)		Optimum Case	Remarks
	My	Mz		
CASE A	164.180	191.152	Case D	Whenever telecommunication tower used in G+12 story building, optimum location case for Bending Moments My and Mz in Column will be Case D
CASE B	164.205	191.754		
CASE C	164.127	194.380		
CASE D	164.005	191.982		
CASE E	164.165	191.354		

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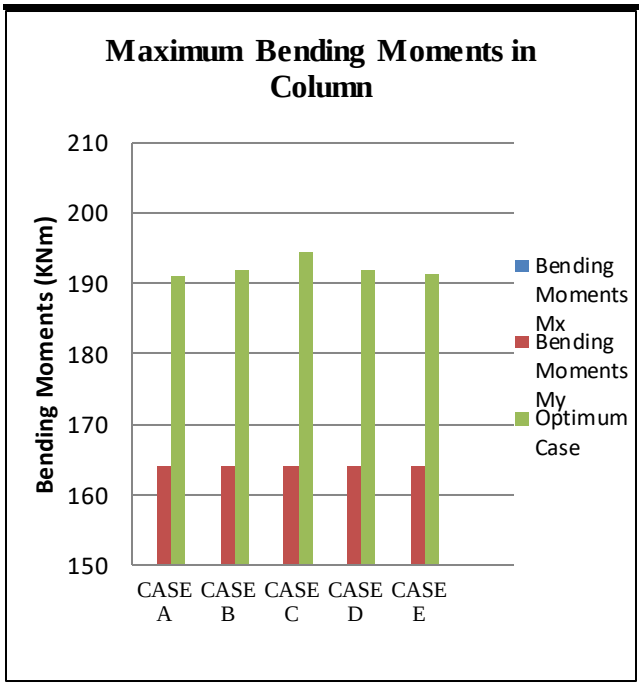
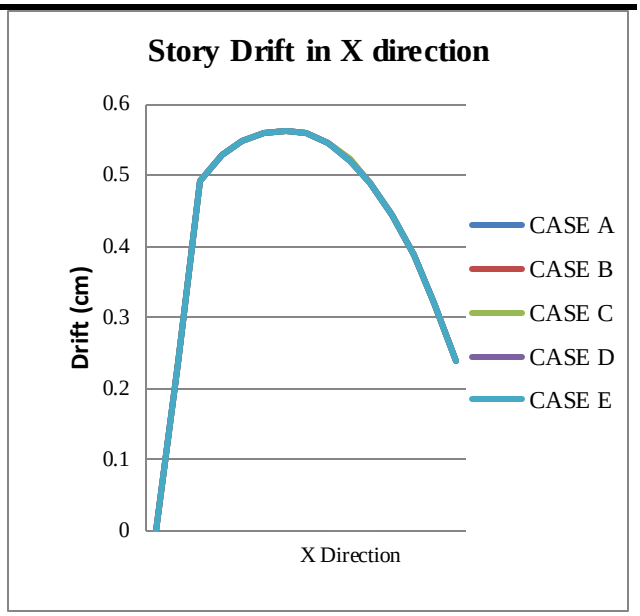


Graph 6: Graphical representation of Maximum Bending Moments in Column for all 5 cases under seismic Zone IV

Table.12: Story drift in X direction for all 5 cases under seismic Zone IV

Height (m)	Story Drift For X Direction (cm)				
	CASE A	CASE B	CASE C	CASE D	CASE E
0	0	0	0	0	0
3.3	0.2366	0.2366	0.2366	0.2366	0.2366
6.66	0.4931	0.4932	0.4932	0.4932	0.4931
10.32	0.5295	0.5295	0.5296	0.5295	0.5295
13.98	0.5481	0.5482	0.5483	0.5482	0.5482
17.64	0.5594	0.5595	0.5596	0.5595	0.5594
21.30	0.5631	0.5632	0.5633	0.5632	0.5631
24.96	0.5585	0.5586	0.5587	0.5586	0.5585
28.62	0.5449	0.5450	0.5451	0.5450	0.5449
32.28	0.5217	0.5218	0.5218	0.5217	0.5217
35.94	0.4881	0.4882	0.4882	0.4881	0.4881
39.60	0.4436	0.4437	0.4437	0.4436	0.4436
43.26	0.3876	0.3877	0.3876	0.3876	0.3876
46.92	0.3193	0.3194	0.3193	0.3193	0.3193
50.58	0.2386	0.2388	0.2385	0.2386	0.2386
Optimum Case	Case A and Case E				
Remarks	Whenever telecommunication tower used in G+12 story building, optimum location case for Story drift in Z direction will be Case A and E with lesser values				



Graph 7: Graphical representation of story drift in X direction for all 5 cases under seismic Zone IV

Table.13: Story drift in Z direction for all 5 cases under seismic Zone IV

Height (m)	Story Drift For Z Direction (cm)				
	CASE A	CASE B	CASE C	CASE D	CASE E
0	0	0	0	0	0
3.3	0.2871	0.2871	0.2871	0.2871	0.2871
6.66	0.5814	0.5814	0.5814	0.5814	0.5814
10.32	0.6114	0.6114	0.6114	0.6114	0.6114
13.98	0.6244	0.6243	0.6244	0.6243	0.6244
17.64	0.6302	0.6302	0.6302	0.6301	0.6302
21.30	0.6283	0.6282	0.6283	0.6282	0.6283
24.96	0.6177	0.6176	0.6177	0.6176	0.6176
28.62	0.5974	0.5973	0.5974	0.5973	0.5974
32.28	0.5666	0.5665	0.5666	0.5665	0.5666
35.94	0.5243	0.5242	0.5243	0.5242	0.5242
39.60	0.4696	0.4694	0.4696	0.4694	0.4695
43.26	0.4017	0.4015	0.4017	0.4015	0.4016
46.92	0.3194	0.3192	0.3194	0.3192	0.3193
50.58	0.2213	0.2210	0.2213	0.2210	0.2211
Optimum Case	Case B and Case D				
Remarks	Whenever telecommunication tower used in G+12 story building, optimum location case for Story drift in Z direction will be Case B and Case D with lesser values				

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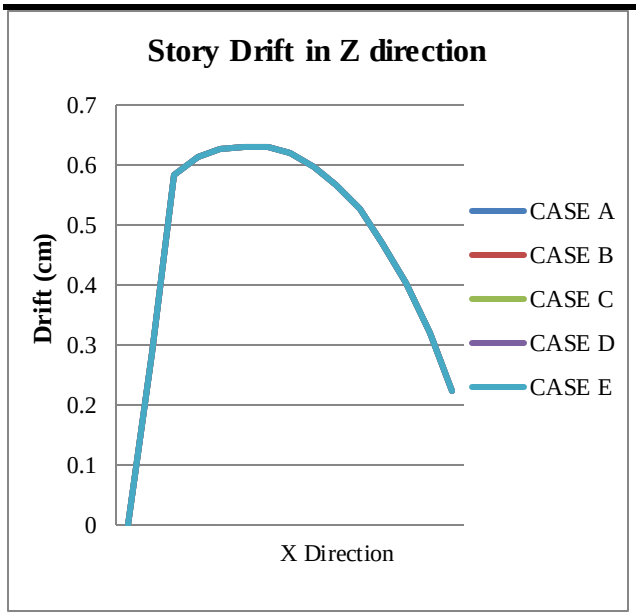

Graph 8: Graphical representation of story drift in Z direction for all 5 cases under seismic Zone IV

VI. CONCLUSION

It has been concluded from the above study that the seismic forces when hit on any structure having a telecommunication tower over it, all location cases considered shows their own values in different parameters under seismic Zone IV are as follows:-

1. In case of base shear in X direction, Case C emerges out to be the best optimal case among all five cases. Since the values keep on decreasing from case A to C and then it again increases. For Z direction, the values are same for all the five different cases.
2. Parametric results achieved in case of maximum nodal displacement shows minimum values in Case D. Comparing nodal displacements in all directions in G+12 story building, optimum location case for Maximum nodal displacement will be Case D.
3. Axial forces in column seems to be increasing first and then its values keeps on decreasing to Case C and then it keeps on increasing. Hence optimum location case for Axial forces in Column at ground story will be Case C.
4. Shear Forces in column in Y direction as Sy seems to be lower in Case D and this case shows again less in Sz i.e. shear forces in Z direction. Concluding the optimum case in this, Case D attains more in this parameter.
5. Again Case D among all location cases seems to be lower in Maximum Bending Moment parameter. Since the values are same in My and Mz, getting into minute values after the decimal place, Case D shows optimal values in columns.
6. Story drift seems to be minimum in Case A and E, showing almost same values under seismic zone IV. On the other hand Case B and Case D show minimum values. Since there was a minute difference between them, at a height of 17.64 m to 21.30 m, the values of story drift keeps on decreasing.

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Measure to Better Manage: Proposal of Performance Indicators

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***Abstract*—** *The construction of performance indicators is an activity that must be performed by public and private administrators. In the public sector, the use of indicators facilitates accountability. This article, the result of a master's dissertation, presents operational performance indicators of the Operational Section of People Management (OSPM) of the Executive Board of INSS in Petrolina. The study is justified by contributing to the professionalization of management in public administration. The construction of the indicators was based on the model synthesized by Palvarini (2010), resulting in the formulation of four performance metrics: Medium Requirements Resolution Time; Medium Time to Distribute Requirements; Percentage of Concession and Rejection of Requirements; Percentage of outstanding or resolved requirements. As a mechanism for collecting data and calculating indicators, an adjustment was made to the OSPM control worksheet. The indicators developed were approved by the Executive Manager of the INSS in Petrolina, institutionalizing their use at the local level. The limiting factors of the present research, the fact that the proposed indicators are approved only for local use, stands out. Future studies can assess the use of indicators as well as the system that is in development to replace the control worksheet*

***Keywords*— Public administration; Performance indicators; Accountability; INSS; Management Reform.**

I. INTRODUCTION

The act of managing an organization, either public or private, involves the practice of various functions such as planning, organization, managing, and control, in a way that efforts undertaken can be directed to the achievement of business' goals. Such administrative functions complement one another, and in some organizational activities it is possible to realize the intersection between them. In the current social context in which the participation of society on the decisions of Public Administration is increasingly demanded and managers of private organizations are charged for damaging actions to the community, societal control of organizations is facilitated by performance measurement.

Organizations stand in a turbulent external environment where they should present quick answers to the constantly-changing scenarios. This fact aroused interest from public and private administrators, since they sustain decision making (CARDOSO et al., 2015). Hoffmann and Lima Filho (2017) indicate double advantage for public organizations to use performance indicators, since it helps the manager on the decision-making process. It also gives conditions pointed to the conception that society should measure effectively the obtained results by public administrators.

Around the world, there are several examples of the use of performance indicators on the public sector. The Ministry of Municipal Affairs and Housing of Canada established the obligation for Canadian municipalities to report thirty-five performance indicators, distributed among nine service areas (Chan, 2004). The author indicates that the central body of accounting of the USA government also adopted provisions to encourage American municipalities to report their financial and non-financial performance. This will allow customers of public services to evaluate the efficiency and effectiveness of the services rendered. Pollit (2005) researched the use of performance indicators in countries of European Union, such as Finland, Netherlands, and Sweden. He showed that many government agencies, like meteorological services, public safety, environment, and social security, applied performance measurement instruments.

In Brazil, examples of performance indicator usage are found on the three levels of government (Federal Government, States, and Municipalities) and on three branches of government (Executive, Legislative, and Judiciary). In this sense, Bitencourt (2010) approaches the example of Municipal Chamber of Criciúma, in Santa Catarina (SC), that used a model based on Balanced Scorecard to build performance indicators. Through the correlation between transparency, organizational strategy, and strategic objectives, the above-mentioned municipality established indicators such as the percentage of families in extreme poverty and the percentage of tax incentive/exemption.

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Regarding the Federal Executive Branch, the National Social Security Institute (INSS) is an example of autarchy that uses performance indicators. The INSS is structured in four hierarchical levels: central administration, superintendence, executive-managements, and agencies of social security. It has indicators that measure aspects related to target activity and support activities of the Institute. Aspects such as mean duration of processing and mean time to service are measured, both analyzed in agencies. It becomes an important tool to support the decision, as well as to allow the comparison of performance among various units of the referred autarchy.

One of the hierarchical units of INSS is the Executive Management (EM), which is linked to Social Security Agencies (APS), where the target activity of the Institute occurs. Many other departments are subordinated to the EM as well, being responsible for managing the support activities of the agency; among them is the Operational Section of People Management (OSPM), responsible for administering the payroll, training, and health and quality of life in the workplace.

OSPMs have performance indicators that, together with the indicators of other departments of the EM, compose the group of performance measures of Managements. However, such indicators do not approach operational aspects of the OSPMs like quantity of analyzed processes in a given period, quantity of processes pending analysis, or the mean time of analysis of those processes. Thus, managers of OSPMs face the absence of performance measures to assist them in decision making and labor organization in the department.

This article, which results from a research to the preparation of a Master's dissertation, pursued to present a proposal of performance indicators to the Operational Section of People Management (OSPM) of Executive-management of INSS in Petrolina. The research is justified by the contribution to professionalize the Public Administration, helping to fulfill the constitutional principle of efficiency, inserted by the Constitutional Amendment 19 (BRASIL, 1998). It promotes the use of management tools arising from private administration in the public sector.

II. THEORETICAL REVIEW

2.1 Schools of Management: from scientific management to strategic management

To many authors, Management as a science arose from the work *Principles of Scientific Management*, written by the American engineer Frederick Winslow Taylor in 1911. For Santos et al. (2017), the work of Taylor is a landmark in management studies, establishing precepts that are still used today.

Besides Taylor, the engineer Henri Fayol is considered one of the classical theorists of management. Ribeiro et al. (2015) point out that Fayol focused his studies on the organizational efficiency with a managerial view of administration, less focused on specific tasks.

The bureaucratic theory, also known as rational-legal theory, was proposed by the German theorist Max Weber, and united assumptions from the proposals of Taylor and Fayol. He directed his studies to the proposition of a rational and efficient organization. Weber (2015) points out that modern bureaucracy has, among other components: legal system formed by laws and regulations, limitation of power and authority by this legal system, and organized hierarchical structures, with positions of authority and control well outlined.

On the other hand, the school of human relations is based on the individual and the motivations that lead them to have, or not, good performance in the company. It refers to the Experiment of Hawthorne, conducted by the Sociologist Elton Mayo. Wickstrom and Bendix (2000) quoted that this experiment indicated that employees change their behavior when observed, affecting variables such as productivity. An alteration of performance unrelated to issues of hygiene at work or financial rewards was noted in the studied group.

Based on assumptions of bureaucratic theory of Weber and school of human relations, the structural approach that pursues to reconcile divergent points of both mentioned theories arises. To De Souza et al. (2016), the structuralist theory represents a development of the classical school, with a proximity to the ideas of the school of human relations.

Using as source the behavioral sciences, the behavioral management theory focuses more in the organizational dynamic and less on its structure, which is the focus of the bureaucratic approach. Matos and Pires (2006) pointed out that the behavioral theory expands the debate on employee motivation, following studies like Maslow's (hierarchy of needs) and Herzberg's (two-factor theory: hygiene and organizational).

The concept of the organic organizational model is appropriate to unstable environments and is subjected to constant changes. It is presented by contingency theory of management. Albuquerque et al. (2009) exemplify an appliance of contingency approach in the people management area of an organization: the way the company will manage its employees will depend on factors such as environment, organizational culture, and strategy.

One of the most modern trends of management is strategic. Mintzberg and Quinn (1991) quoted that the word strategy can assume various meanings, depending on the context in which is used. Camargos and Dias

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(2010) pointed out that the concept of strategy has been broadly and unrestrictedly used in the field of Management. It could mean a course of action that the organization opts to adopt, or the manner in which this organization positions itself in a given environment.

In a more specific way, strategy can also be defined as "an integrated and coordinated group of commitments and actions defined to explore essential competences and obtain competitive advantage" (HITT et al., 2007, p.04).

2.2 Strategic Planning

Kotler (2000) defines strategic planning as a methodology used by managers to direct the organizational actions and increase interaction with the environment. To Albano and Garcia (2015), although there is no model of strategic planning that grantees success of a chosen strategy it is a process that allows the reduction of uncertainties regarding the course of action eventually chosen.

Therefore, it can be noticed that strategic planning should consider both internal and external aspects of the organization. Fernandes et al. (2015) indicated that one of the tools that help on the evaluation of such aspects is the SWOT analysis, which identifies strengths and weaknesses (internal), and opportunities and threats (external).

One of the guiding elements of the strategic planning process is the definition of a mission. To Scorsolini-Comin (2012), the mission is the reason of existence of an organization; it is the main line of action and it gives coherence to organizational actions. Hitt et al. (2007) understand that the mission will indicate the business areas that the company intends to enter, indicating which customers will be served by the organization as well.

The usage of strategic planning is not limited to big private organizations; it can also be applied in small companies and public organizations. Teixeira et al. (2015) point out that this process helps small and medium companies, since it can be implemented with low investments. Poister (2010) indicates that public management should focus on a model of planning that aims at reaching the goals proposed in the strategic plan.

Strategic plans involve the measure of performance as well. When studying the development of performance management mechanisms in a local government in Australia, Kloot and Martin (2000) pointed to the use of four dimensions proposed by the tool *Balanced Scorecard* - BSC to measure the performance of the local government. Steurer and Martinuzzi (2005) researched planning models in the environmental area in Europe. They highlighted the good practices and key features of such processes, focusing on aspects related to the participation and horizontal politic integration.

In Brazil, there are examples of strategic planning usage in the public sector as well. De Araújo e Silva and Gonçalves (2011) investigated strategic plans of some courts of auditors of States and municipalities, and interviewed employees responsible for the plans in those courts. The authors identified that in 14 of the 19 researched courts, the strategic planning involves the usage of performance indicators.

2.3 Performance indicators

The use of performance indicators is widespread in public organizations. The indicators have been used as a tool to support the decision making of public administrators as well, being also used as an instrument of measurement of the reach of objectives and goals proposed on the strategic planning. Speklé and Verbeeten (2014) reinforce the importance of using performance metrics, observing the fact that its effectiveness depends on the way in which it is used by managers.

Boland and Fowler (2000) recall that performance indicators on the public sector should measure three characteristics: economy, efficiency, and effectiveness. To the authors, performance indicators can be used as a motivational tool as well, rewarding the highest performance.

Performance indicators have also been used to measure environmental aspects of organizations. Granero et al (2018) point out that these metrics can measure aspects related to four areas of the companies: product, process, organization, and marketing. For instance, operational indicators of a public organization would be related to its working process.

The usage of environmental indicators allows to classify companies according to the performance in the area. Pilouk & Koottatep (2017) indicated that in Thailand the industrial organizations that aim to reach the status of eco-industrial parks measure their performance through 43 indicators. The authors point out that the metrics for measurement are the main factor of success for the referred parks.

In Brazil, the subject has also aroused interest in public administrators. The Ministry of Planning, through the National Program of Public Management and Debureaucratization (GESPUBLICA), created a guide to the development of performance indicators in Public Administration.

It is a model that was built using the state-of-the-art management literature on performance management (PALVARINI, 2010). Palvarani (2010) synthesized it observing that performance can be defined as the efforts undertaken towards reaching certain results.

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Palvarini (2010) presents ten steps to build a performance indicator, namely: identification of dimension, sub-dimension and measurement goals; establishing indicators; preliminary validation of indicators with stakeholders; building formulas; establishing goals and notes; defining the responsible people; generating a system of data collection; final weighting and validation of indicators with stakeholders; performance measurement; analysis and interpretation of indicators; performance communication.

2.4 Balanced Scorecard

BSC is a performance measurement method widely spread among organizations. To Kaplan and Norton (2004), who developed BSC, it consists in a model of strategic management for integration between mission and strategy of an organization. The result of such integration is the translation of both into tangible goals and measures, which allow the global evaluation of the performance of an organization.

The authors indicate that this expansion of performance measurement to beyond financial aspects was one of the reasons for accepting and using the BSC model by organizations, including governmental organizations. Kaplan and Norton (2001) propose a performance analysis model based on four classical perspectives: financial, customers, internal processes, and learning and growth. The researchers indicate that the perspectives are not immutable, and an adaptation that takes into account the context in which the organization is inserted may occur.

The implementation of a management tool such as BSC in a public organization face challenges. Galas and Forte (2008) identified some of those challenges. Through an exploratory and descriptive research in the form of a case study, the authors pointed out challenges to the implementation of a performance measurement model based on BSC in Brazilian Agricultural Research Corporation (EMBRAPA), pointing out as difficulties to the implementation: organizational culture, the involvement of immediate supervisors, and the inadequate profile of the team responsible for implementing the model.

Still concerning the challenges around the use of BSC in public organizations, it is important to stress that many public managers still do not use the tool. Northcott and Ma'amora Taulapapa (2012) researched the use of BSC in the scope of local governments in New Zealand. Through the application of questionnaires to managers of municipal and district councils, the researchers identified that a large part of the councils researched did not use the tool.

2.5 National Social Security Institute - INSS

The National Social Security Institute - INSS is a federal autarchy instituted by Decree 99.350 on July 27, 1990 (Brasil, 1990). Briefly, the hierarchical structure of the Institute is composed of four levels: Central Administration, to which various Boards of Directors of the institute are connected; Regional Superintendence; Executive-Managements; and Social Security Agencies (APS). APS have many indicators capable of measuring their efficiency. Such indicators also allow for comparisons between agencies, allowing eventual benchmarking for the dissemination of good practices.

Within the scope of the competences of Executive-Managements (EM) is found: to propose, to plan, to coordinate, and to perform activities related to people management area, as well as actions related to training and functional development of civil servants of INSS. Such actions are performed in the EM through Operational Sections of People Management (OSPMs).

III. METHODOLOGY

The OSPM of the EM Petrolina/PE was chosen as the place to conduct and develop this research because of accessibility and convenience. In this sense, this work intends to promote organizational improvements in the department, through the development of indicators that will assist operational performance measurement.

Therefore, it is necessary to identify the operational demands of the OSPM. For this research, operational demand is considered the operational responsibilities that the OSPM receives that are related to civil servants linked to it. For methodological characterization purposes, the research is considered a qualitative study (regarding the approach of the problem), documentary research, and bibliographic review (regarding adopted procedures).

It is a qualitative work in which an analysis based on data from a text or document can occur (CRESWELL, 2010). Considering that qualitative approach inquires specific questions of a reality (MINAYO, 2010), such categorization applies to this research because the performance indicators were developed for the OSPM of the Petrolina EM.

Regarding the procedures, this research can be categorized as a documentary and bibliographic research. Sá-Silva et al. (2009) define document as any record capable of being used as information source by observation, reading, reflection, or criticism, pointing out as primary document the ones that did not received any scientific handling.

Prodanov and Freitas (2013) indicate that bibliographic research is elaborated from previous scientific works. Thus, this work used documents to map the operational demands of the OSPM, and used the

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bibliography to use and adapt a model to develop indicators.

The necessary data for the survey of operational demands of the OSPM were researched in normative acts related to the people management area of INSS, produced by the autarchy. Normative acts produced in the last 5 years were chosen, aiming to delimit the quantity of data to be analyzed.

With the aforementioned data, the analysis was done by describing the demands in themes or categories (Creswell, 2010), through the technique of content analysis, in which the data are numbered and categorized. Thus, several operational demands of the OSPM were identified as normative acts of INSS. After having a list of operational demands, a categorization was made, as shown on the chapter of data analysis.

As the data were delimited, collected (INSS Intranet), and analyzed (analysis of content through categorization of demands), the next stage was the proposition of performance indicators to measure the operational demands of the department. The model used to develop indicators was an adaptation of the one proposed by Palvarini (2010). It is important to highlight that the referred work served as base to the development of indicators, being adapted according to the particular situation observed at the OSPM, in order to better reflect the specific aspects of the research. Figure 01 shows the model used in this work.

Fig.1: Stages to the development of indicators of the OSPM.

Steps	Description
1º Definition of indicator	Establish what would be measured, justifying its importance to the department and describing it
2º Characterization of indicator	The indicator is characterized according to its dimension and sub-dimension, adopting the concepts proposed by Palvarini (2010)
3º Building a formula	Definition of mathematical formulas that will allow the calculation of the indicator
4º Definition of responsible	Definition of who will be responsible for registration of data and the frequency of evaluation of the indicator
5º Creation of the Data Collection System	The design of the system that will be used for both data collection and for the application of the mathematical formula to calculate the indicator
6º Indicator approval	Submittal of the indicator to the responsible authority (in the scope of this work it is the Executive-Manager of INSS in Petrolina) to approve the indicator

Source: Own Elaboration (2018)

IV. RESULTS AND DISCUSSION

In order to identify the operational demands of the OSPM, it was necessary to search the referred normative acts. The data were researched in the internal network of INSS through the tool of rule search. To locate the normative that address the operational demands of the OSPM, the search tool was used through the insertion of filters such as the issuing body and the date of issuance of the rule. It can be highlighted on the scope of regimental competence of the OSPM the "execution administrative activities of people management", which should be carried out observing the guidelines of the People Management Board of Directors (DGP) of INSS (Brasil, 2017b). Besides the DGP, the presidency of INSS can also issue rules in this regard, even though in smaller quantity.

Three thousand eight hundred and ten normative acts that fulfilled the established criteria were located. It is a high number, and among the results, there are acts such as decision decree (in which the DGP decides some demand related to its area of competence) and ordinances (nominating and exonerating civil servants, for instance). Such acts, among others, do not have orientations regarding operational demands of the OSPM; for this reason, it was necessary to insert additional filters on the search tool for rules.

To accomplish this, the filter "type of rule" was added, selecting the Circular Memorandum, which is the usual instrument of orientation and normatization between the boards of Directors and Departments subordinated to it. Thus, 247 acts issued by the DGP that meet the search criteria were located. In order to identify if a normative act was related or not to an operational demand, the description of the rule was analyzed, allowing to check if the act met or not the criteria to be included among the analyzed data. The analysis of circular memorandums indicates that 222 (89.88%) did not approach operational activities of the OSPM. It addresses matters such as setting workday, orientations to access computerized systems of INSS, and communication flows, among other themes that are not the focus of this research. Only 25 (10.12%) of the referred acts address operational demands of the OSPM.

As indicated above, the presidency of INSS also issue acts related to the OSPM. Such normatization occurs through resolutions or normative instructions. The

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first ones, when related to operational demands of several areas of INSS, approve procedure manuals indicating the way to perform certain activities. Normative instructions have the characteristic of regulating the access to a specific right.

Regarding the resolutions issued by the presidency of INSS, the search tool returned with the result of 178 normative acts that met the criteria of selection. Of those acts, only two (1.12%) are related to people management area, according to the description of the rule.

Regarding normative instructions, which are also a responsibility of the presidency of the Institute, 18 were published during the period referred on this chapter. Among which, 4 (22.22%) talk about operational demands of the OSPM. Table 01 synthesizes the information about the quantity of normative acts located.

Table.1: Normative Acts Located on the internal network of INSS

Type of Normative Act	Issuer	Quantity of Normative Acts Located	Act that contain operational demands	Percentage
Circular	Board of Directors of People Management	247	25	10.12%
Memorandum				
Resolution	Presidency of INSS	178	2	1.12%
Normative Instruction	Presidency of INSS	18	4	22.22%

Source: Own Elaboration (2018)

With the referred normative acts, the operational demands of the OSPM were identified, which are object for requirements from civil servants of the department. Thirty-eight operational demands were identified.

When several normative acts that contained provisions regarding the people management area were verified, it became possible to identify that demands from the OSPM sometimes address issues related to financial matters and sometimes related to register and functional life of civil servants. On the other hand, it was observed in the analysis of normative acts that some requirements are resolved by exclusive action of the OSPM, while others depend on the action of other departments or hierarchical instances of INSS.

Thus, it can be verified, among the demands, the possibility of categorization by type and by way of processing. The first classification contain the financial requirements that involve payment or charging of monetary values from the civil servant and the cadastral requirements, which address modifications and registers that do not imply payment of financial values from the civil servants.

The categorization by processing involves resolutive demands when there is no need for another department's resolution, besides OSPM's. It happens through exclusive action of people management area. It also involves dependent demands, when there is a need for manifestation of another department. The proposed categorization is shown at Table 02.

Table.2: Categorization of Operational Demands of the OSPM.

Demands	Type	Processing
Concession of Stay-On Bonus	Financial	Resolutive
Concession of External Service Execution Pay	Financial	Resolutive
Concession of Retirement	Financial	Resolutive
Concession of Funeral Grants	Financial	Resolutive
Concession of Maternity Bonus	Financial	Resolutive
Concession of Preschool Grant	Financial	Resolutive
Concession of Transportation Assistance	Financial	Resolutive
Concession of Registration of Contribution Time	Cadastral	Resolutive
Concession of Bonus for Responsibility of Course or Contest	Financial	Resolutive
Concession of Special Schedule for Students	Cadastral	Resolutive
Concession of Paid Maternity Leave	Cadastral	Resolutive
Concession of Medical Leave	Cadastral	Dependent
Concession of Training Leave	Cadastral	Dependent
Concession of Leave to Participate on External	Cadastral	Dependent

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Course		
Concession of Leave to Participate on Graduate Program	Cadastral	Dependent
Concession of Paternity Leave	Cadastral	Resolutive
Concession of Leave due to Death of Person of the Family	Cadastral	Resolutive
Concession of Bonus Leave for Attendance	Cadastral	Resolutive
Concession of Civil Pension	Financial	Resolutive
Conversion of Unhealthy Time	Cadastral	Resolutive
Compliance of Judicial Decision	Financial or Cadastral	Dependent
To swear in New Civil Servants	Cadastral	Resolutive
Designation and Dismissal of Function	Financial	Resolutive
Issue Certificate of Contribution Time	Cadastral	Resolutive
Instruction of Process of Probationary Phase	Cadastral	Dependent
Payment of Living Allowance	Financial	Dependent
Payment of Additional Bonus for Health	Financial	Resolutive
Payment for Exercise Replacement of Management	Financial	Resolutive
Promoting Administrative Charge to Refund the Treasury	Financial	Resolutive
Conduct Alteration of Bank Account	Cadastral	Resolutive
Carry Out Inclusion of Dependent	Cadastral	Resolutive
Conduct the Vacancy of Public Office (Exoneration and Discharge)	Cadastral	Resolutive
Perform Calculations Solicited by Justice	Cadastral	Resolutive
Register Acts of Provision of Vacancy of Public Office	Cadastral	Resolutive
Requirement of Short Time Working	Cadastral	Dependent
Requirement of Removal	Cadastral	Dependent
Answer to Audit of Control Bodies	Cadastral	Resolutive
Answer to diverse Requirements	Financial or Cadastral	Resolutive or Dependent

Source: Own Elaboration (2018)

The processing category highlights that some requirements do not conclude at the OSPM and depend on the action of other departments of INSS, while others are concluded through exclusive processing in the department. With this criterion, it is possible for the proposed indicators to focus its measurement on the work performed in people management area.

By crossing the two proposed categories it is observed that operational demands of the OSPM can assume four macro classifications: financial/resolutive; financial/dependent; cadastral/resolutive; and cadastral/dependent.

Facing the classifications proposed above, the next stage was the elaboration of performance indicators to the department, using the model presented on the chapter about methodological procedures of this research. Four performance indicators were developed, which will be described in a detailed way below: Mean Time to Resolve Requirements (MTRR); Mean Time to Distribute Requirements (MTDR); Percentage of Concession and Rejection of Requirements; and Percentage of Pending or Resolved Requirements. Subsequently, the process of developing the indicators, organized according to the operational model of research proposed (steps to development of indicators) is listed. Pending or Resolved. The process of development of indicators will be presented according to the stages described on the methodology of this article.

4.1 Step 1: description of indicators

4.1.1 Mean Time to Resolve Requirements (MTRR)

The indicator Mean Time to Resolve Requirements (MTRR) proposes to measure the average time of resolution of requirements submitted to the OSPM of the Petrolina/PE EM. It is an indicator that gives transparency to the department, allowing civil servants that act on people management area to have the possibility of monitoring if their requirements are being resolved in a reasonable time.

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It is an indicator of efficiency, considering that the lower its value, the higher the performance of the OSPM, with a quickly resolution of requirements submitted to its evaluation. On the other hand, if the value is high, it indicates the possibility of poor performance by the department. Eventually, this can lead to the intervention of the manager of the department in order to improve the index.

4.1.2 Mean Time to Distribute Requirements (MTDR)

There are many channels in which requirements are submitted to evaluation of the OSPM; in this regard, it is necessary for the manager of the department to be continuously careful with those channels, and promote the correc distribution of demands among the civil servants of the department.

Therefore, the Mean Time to Distribute Requirements (MTDR) proposes to measure the average time that the OSPM takes to distribute a demand to a civil servant, seeking to quantify part of the work of the manager of department. A high result in this indicator can show an absence of organization of work, since managing and distribution of demands should be one of the main responsibilities of the manager of the OSPM.

It is an indicator that proposes to measure the performance of the department manager; it becomes an instrument for the higher instances of people management area to size the efficiency of their work.

4.1.3 Percentage of Concession and Rejection of Requirements

Rapid execution of a job does not necessarily mean excellence. It is not enough to measure the time spent resolving a demand; it is also extremely important to measure the outcome. Thus, the indicator Percentage of Concession and Rejection of Requirements was developed.

A requirement is conceded when the claim of the civil servant with the OSPM is granted by the department or competent instance (in case of dependent requirements). Contrarily, the demand is rejected when the department or instance regimentally competent gives a denial decision.

The indicator allows the manager of unit or department to visualize the percentage of rejection/concession of requirements submitted to the OSPM. For demands such as the compliance of judicial decisions, in which the OSPM is limited to fulfill what is determined on the process, it is not possible to apply the classification of concession or rejection. Therefore, the indicator does not cover those cases. For those and other requirements that do not fall under the criterion of deferral or rejection, the criterion "not applicable" was created for the referred indicator.

4.1.4 Percentage of Pending or Resolved Requirements

The Percentage of Pending or Resolved Requirements is proposed as a source of management information. It is an indicator that points out a general overview of operational demands of the department. It allows the manager to identify if the productivity of civil servants is as expected.

Pending requirement is one that has not yet been processed or analyzed by the OSPM. A requirement is resolved when the department has concluded its action; it can be closed (resolutive) or forwarded to the competent department to continuation (dependent).

4.2 Step 2: characterization of indicators

In the classification of dimensions proposed by Palvarini (2010), presented on the chapter about methodology, the MTRR is classified as indicator of efficiency. It is inserted in the time sub-dimension which addresses the time gap elapsed between beginning and end of a certain work process. Such classification can also be assigned to the MTDR.

Regarding the indicator Percentage of Concession and Rejection of Requirements, it concerns the metric related to the execution dimension, being related to the accomplishment of processes (PALVARINI, 2010). Indeed, this indicator is correlated with the way demands are performed, and it can indicate compliance or not with the required standards of the legislation in force. The indicator Percentage of Pending or Resolved Requirements also falls within the execution dimension.

In the classification proposed by Palvarini (2010), the indicators referred on the last paragraph cannot be framed in any sub-dimension. Considering that the model of Palvarini was adapted to the reality of the OSPM, to fill this gap, a management sub-dimension was created in the execution dimension. The sub-dimension points out that the indicator proposes to provide a general overview of operational demands of a department serving as source of management information.

4.3 Step 3: Building a formula

To calculate indicators, it was used the control sheet of the OSPM, which was properly adapted for that goal. For the MTRR of the resolutive demands, the formula AVERAGEIFS was used; it calculates the average of a range of cells according to a certain criterion. The cells that had as result the difference in days between the content of column "Date of Conclusion" and column "Date of Receiving" in the OSPM were selected. With the application of the formula, the mean time to resolve the resolutive demands can be found.

For the MTRR of dependent demands, the indicator is calculated from the average of differences between the dates indicated on column "Date of

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Forwarding" by the OSPM and column "Date of Receiving" the demand. The formula used for calculate the referred indicator was also AVERAGEIFS, as explained on the above paragraphs.

To calculate the MTDR, it was necessary to measure the average time that the SOGP takes to distribute the demands to civil servants. For this purpose, the average of the results found when diminished the cells of "Date of Distribution" from the column "Date of Receiving in the OSPM" was used.

In turn, the calculation of percentage of concession and rejection of requirements was done according to the formula COUNTIF, which, in a certain range of cells, is able to count those that meet the given criterion. Therefore, the quantity of requirements labeled "Not Applicable", "Granted", and "Rejected" is counted and later divided by the total of requirements that already have the situation box filled. By dividing the results achieved by the total quantity of requirements with the situation box filled, the results susceptible to measurement by the indicator are obtained.

Lastly, the percentage of pending and resolved requirements was calculated through a combination of formulas. COUNTIF counted the quantity of requirements received, and the formula COUNTA was responsible for indicating the quantity of concluded requirements among them. The result of the division between quantity of received demands and the concluded ones provide the percentage of conclusion and pending demands.

4.4 Step 4: Definition of responsible

Palvarini (2010) points out the importance of establishing who will be responsible to verify the indicators. It can be noticed that, in the OSPM, the managers have an essential role in the distribution of demands and the insertion of data in the control sheet as well as in the work organization. Therefore, it was defined that the manager of the department or regimental substitute is responsible to verify the indicator. It is possible to appoint a specific civil servant for this activity, according to the criterion of the OSPM's management.

4.5 Step 5: Creation of the Data Collection System

As indicated in the steps above, the control sheet of the OSPM was adapted to be the data collection system, since it stores the necessary information to calculate the proposed indicators. Thus, the chosen system to data collection and to calculate the indicators was the control sheet of the department, properly adapted to the goals.

At the same time, the development of a system via web platform was requested to the informatics department of Logistics Department of the Executive Management of INSS in order to control the reception of operational demands of the OSPM. This system will allow the calculation of proposed indicators in this work, in a way that, after its conclusion, it will replace the control sheet of the department as the location for data collection.

4.6 Step 6: Indicator Approval

According to the internal rules of procedure of INSS, it is the responsibility of Executive Managements to perform activities of administration and People Management in its jurisdiction (BRASIL, 2017b). Besides, the EM is the higher unit to which the OSPM is subordinated hierarchically.

Thus, the indicators developed here were submitted to evaluation by the Executive Manager of INSS in Petrolina/PE, through a document named "Performance Indicator Proposal to the OSPM of the Petrolina/PE EM". After proper evaluation, the authority mentioned on this paragraph approved the referred indicators by publication of the Ordinance 22/INSS/EM PTN, of June 29, 2018 in a local service bulletin.

V. CONCLUSIONS AND FUTURE RESEARCH

Although Brazilian Public Administration is still far behind the modernization and efficiency levels necessary for rendering public services with excellence, its evolution on the last decades is notorious. This article, which resulted from a Master's dissertation, proposed to develop operational performance indicators to the Operational Department of People Management of the Executive-Management of the INSS in Petrolina.

To reach the aims of the research, it was necessary to map operational demands of the OSPM according to the analysis of normative acts of INSS that had provisions regarding people management area. Therefore, a documentary research of the rules quoted above was carried out, as well as its analysis. It was noticed that the absence of compilation of the several responsibilities of the department can be an obstacle to managing it, and the identification has the potential of promoting management improvements to the OSPM.

With the mapping, the 38 demands were categorized. This step preceded the development of performance metrics and allowed them to consider the peculiarities of each group. The data analysis allowed categorizing demands by type (cadastral or financial) e by processing (resolutive or dependent). In this context the categorization resulted in four macro classifications: resolutive financial, cadastral financial, resolutive cadastral, and dependent cadastral, thus achieving another of the specific goals.

After the described procedures, the development of four operational performance indicators to the OSPM was

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conducted: Mean Time to Resolve Requirements (MTRR), which measures the average time that the OSPM takes to solve requirements that are under its responsibility; Mean Time to Distribute Requirements (MTDR), responsible for measuring the average time that the manager of the OSPM takes to distribute demands to civil servants of the department; Percentage of Concession and Rejection of Processes; Management Index, which allows the identification of eventual overflows in concession or rejection of requirements; and Percentage of Pending or Resolved Requirements, also managerial, which presents a general overview of demands that are responsibility of the department.

In the context of INSS management, it should be noted that the indicators proposed here were sent to the working group that is discussing new indexes to performance measurement inside the autarchy. Through research conducted with civil servants of the Institute, the working group selected a suggestion of each State. In Pernambuco, the suggestion of indicators developed in this work was the one selected.

As a limiting factor of the present research, the fact that the indicators proposed here were approved to be used only at the local level of the Executive Management of INSS in Petrolina is highlighted. Considering the hierarchical structure of INSS, for its use to be institutionalized within the scope of the OSPMs of the various INSS EM in Brazil, the approval by the Boards of Directors of People Management would be necessary

Another limiting factor was the lack of knowledge of the researcher on the development of computerized systems; so, it was necessary to use the OSPM's control sheet as a tool to collect and measure indicators. Therefore, as pointed out in the data analysis chapter, the IT department of the Logistics Department of the Petrolina EM was required to development a system that allows replacing the department's control sheet.

Further research will be able to evaluate the development of the referred system, as well as, in the case of interdisciplinary research, to collaborate in its development. Thus, such research can promote interdisciplinarity between topics such as Public Administration, management reform, performance indicators, and information technology.

Further studies could also measure the results achieved by the OSPM of the Petrolina EM concerning the developed indicators. In case there is adhesion of such indicators by other OSPMs of the INSS in Brazil, research will be able to compare the results achieved between different departments in Brazil.

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Performance of Rice Crop as Function of Seed Treatment and Irrigation Method

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***Abstract*—** *we aimed with this study to evaluate the performance of irrigated rice plants, as a function of seed treatment composition and crop irrigation management. Two factors were studied in the trial: (A) irrigation management (continuous or intermittent); and (B) seed treatment composition (complete, fungicide only, insecticide only, no treatment + clomazone, and no treatment without herbicide). Standak and Vitavax-Thiram were used as insecticide and fungicide standards, respectively. The Guri Inta CL rice variety, treated three days before planting, was adopted. Irrigation was established twenty days after emergence. In continuous irrigation, a 7 cm mean water layer was maintained during the experimental period; in intermittent irrigation, a 10 cm initial water layer was established and then water supply was interrupted until 10-15% of the plot was aerated, when the 10 cm layer was reestablished. Twelve days after sowing, rice emergence was evaluated. Twenty days after crop emergence, the rice plant height was evaluated. Thirty days after emergence, plant density was again measured. At the end of the crop cycle, grain yield was evaluated. Data were analyzed based on confidence intervals at 95% level. There is no evidence of interference from the differential seed treatment on the agronomic performance of rice, nor differences resulting from their interaction with the irrigation management.*

***Keywords*—** **Oryza sativa, *establishment, development, productivity*.**

I. INTRODUCTION

Rice (*Oryza sativa*) is a staple food for approximately half the world's population. In Brazil, approximately 3 million hectares are cultivated annually, with the Southern region (Rio Grande do Sul and Santa Catarina) accounting for more than 70% of production (Conab, 2017).

In Rio Grande do Sul, the recommended time for planting rice is between September and November, depending on the locality, cultivar cycle and cultivation system, among others (Recommendations..., 2016). In early season planting, the seeds can remain for many days in the soil seed bank until the temperature and humidity conditions that trigger germination are reached. Thus, most producers end up by treating seeds in order to avoid problems of establishment of rice seedlings due to unfavorable climatic conditions (Lobo, 2008), even with no recommendation of this procedure for the South Brazilian rice fields (Recommendations…, 2016). Early season planting promotes the matching of the reproductive period with the greatest solar radiation abundance (December / January), which may contribute to increase the rice grain yields (Mertz et al., 2009).

The action of pre-emergent herbicides, both those affecting the germination process and emergence, as well as those affecting rice seedlings, should also be considered in the initial crop establishment. Among these herbicides, one of the most used in rice cultivation is clomazone. Therefore, damage to the initial plant population, often attributed to pests and diseases, may result from herbicide phytotoxicity. Thus, there are some "protectors", also known as "safeners", which when used in conjunction with seed treatment confer to the plant greater herbicide tolerance (Oliveira Jr and Inoue, 2011).

The mixture of different products in seed treatment, however, has generated complaints by rice farmers, who claim to observe reduction in the stand of rice plants when seed treatment includes two or three chemicals with different purposes. These same farmers raised the hypothesis that this possible negative interaction between products used in seed treatment may be linked to water management in the rice field. The products used for seed treatment in some regions of Brazil include the insecticides thiamethoxam, imidacloprid and fipronil, and the fungicides carboxin and thiram, among others (Lobo, 2008).

II. OBJECTIVES

Thus, the objective of this work was to evaluate the performance of irrigated rice plants, as a function of seed treatment composition and crop irrigation management.

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III. MATERIAL AND METHODS

The experiment was installed in a systematized area of the Embrapa Temperate Climate, Terras Baixas Experimental Station, Capão do Leão-RS, geographic coordinates -31.8153, -52.4698, in strip-plot design (Tantiphanwadi and Ayudthya, 2017), with plots measuring 25 m^2. Two factors were studied: (A) irrigation management, being continuous irrigation (C_), and intermittent irrigation (I_); and (B) seed treatment composition, being complete treatment with fungicide and insecticide (FI); treatment with fungicide only (Fung); treatment with insecticide only (Inset); without seed treatment, with application of clomazone in pre-emergence (Herb); and control without seed treatment and without pre-emergent herbicide (Test). Standak was used as insecticide for seed treatment (120 mL 100 kg^{-1} of seeds); as fungicide, Vitavax Thiram (300 mL 100 kg^{-1} seeds) was adopted.

For the experiment, the rice cv. Guri Inta CL was adopted. All seed treatments (factor B) were carried out three days before planting, effected on November 9, 2016, using a drill with 11 rows spaced in 0.17 m, with each plot of the experiment consisting of three drill passes, 5 m long each. The basic fertilization consisted on the application of 300 kg ha^{-1} of the formula 5-25-25, in the planting row. Topdressing fertilization consisted of two applications of 100 kg ha^{-1} of urea (45% N): beginning of tillering (December 9, 2016) and a few days before panicle initiation (January 13, 2017).

Irrigation was established on December 8, 2016, twenty days after plant emergence (DAE). In continuous irrigation, an average 7 cm of water was maintained during the experiment period, allowing variation from 10 to 5 cm; in the intermittent irrigation an initial 10 cm water layer was established, and then the water supply closed until the plot area was between 10 - 15% aerated (without water layer), when the 10 cm layer was again established.

Weed management was carried out with the application of clomazone in treatments C_Herb and I_Herb, and in the other treatments, only one application of the grass killer (inhibitor of the enzyme ACCase), registered and recommended for the crop, was used (Recommendations..., 2016).

Twelve days after planting, rice emergence was evaluated in four distinct rows of each plot, by counting all plants in 1 m. Live seedlings measuring more than 1 cm high were considered to be effectively emerged. Twenty DAE (beginning of irrigation and tillering), the average rice plant height was assessed, by measuring 10 plants per plot with a ruler. Thirty DAE (10 days after irrigation starts), the plant density was again measured, and four distinct row sections 1 m long were evaluated per plot, similarly to the first assessment. At the end of the crop cycle, rice grain yield was evaluated by harvesting 4 m^2 (4 x 1 m^2) per plot; the impurities were removed and then the yield was weighed and corrected to 13% moisture.

Data presentation was based on the confidence intervals at the 95% level, according to Cumming et al. (2004). By this method, the comparison between treatments is done based on an expected response interval for similar cropping situations, and not based only on the responses of the treatments in the experiment. All analyzes were performed into the statistical environment "R".

IV. RESULTS AND DISCUSSION

The initial number of seedlings emerged twelve days after sowing (Figure 1) was approximately 160 per square meter, as the average of treatments. Although the confidence interval (95% confidence) showed no difference among treatments in soil-climatic conditions similar to those of the experiment, treatment with pre-emergence herbicide presented a smaller number of live plants twelve days after planting .

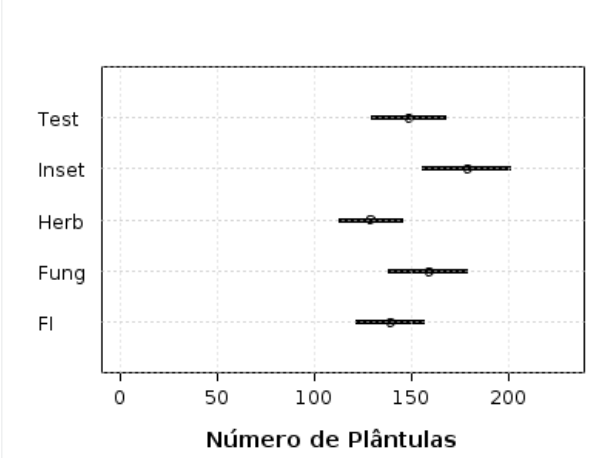

Fig.1: Number of plants emerged 12 days after planting, as function of seed treatment as follows: Fung = fungicide; Herb = no treat. + pre-emergence herbicide; Inset = insecticide; FI = fungicide + insecticide; and Test = control treatment without seed treatment and withouth pre-emergence herbicide. Confidence interval is presented (n = 8). Irrigation management was not considered as it was yet to be applied to the fields at the time of the evaluation.

On the other side, seed treatment with insecticide alone had a higher number of live plants (faster emergence) compared to other treatments, but the confidence interval again reports that this difference may not be supported in field conditions similar to those of the experiment, because there was overlap in the confidence interval bars. Based on the 95% confidence intervals, the only difference was that seed treated with insecticides only performed better than those not treated and submitted to

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clomazone (Herb treatment) (Figure 1). A similar result occurred for the treatment with fungicide, in which a number of live plants were obtained close to that of the insecticide treatment (Figure 1).

For the average height of rice plants, no differences were observed between treatments (Figure 2), most likely because once emerged, the plants (or clomazone survivors) develop normally. If crop damage occurs as function of seed treatment, it may be due to lower plant establishment, with less impact on the growth of surviving seedlings. However, for cotton, it was observed that the higher doses of clomazone reduced plant stand and height (Silva and Santos, 2011). For rice, Concenço et al. (2006) also verified that the application of clomazone in doses higher than those indicated, combined with crop irrigation, caused a greater phytotoxicity to rice plants 19 DAE.

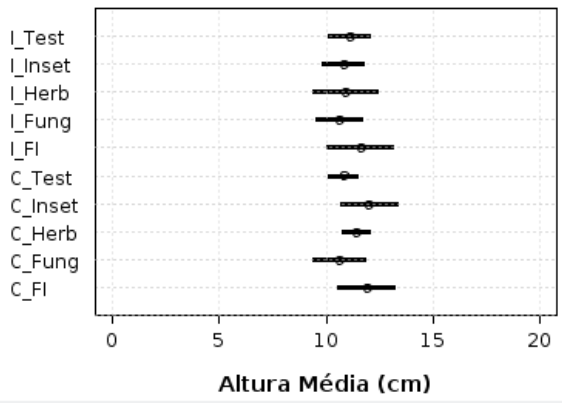

Fig.2: Rice plant height 20 days after emergence, as function of irrigation management (C_ = continuous; I_ = intermittent), and seed treatment as follows: Fung = fungicide; Herb = no treat. + pre-emergence herbicide; Inset = insecticide; FI = fungicide + insecticide; and Test = control treatment without seed treatment and without pre-emergence herbicide. Confidence interval is presented (n = 10).

The number of plants at tillering start (Figure 3) varied between 320 and 430 plants m^{-2}, and the variation of the confidence intervals - due to the small number of samples per treatment (n = 4) for this variable, indicates that the values obtained in the experiment are not conclusive in relation to what could be observed in areas under similar soil and climatic conditions to those of the experiment, thus not allowing a clear differentiation between treatments.

The rice grains yield averaged 8000 kg ha^{-1} (Figure 4), but in field conditions it is possible to obtain productivity of up to 12000 kg ha^{-1} in some situations (95% confidence interval). It should be noted, however, that the number of samples contributed to the wide confidence intervals obtained and should not be considered as conclusive. Rice has compensatory capacity in its production components, counterbalancing some effects generated by the height of the water layer (ROSSO, 2014).

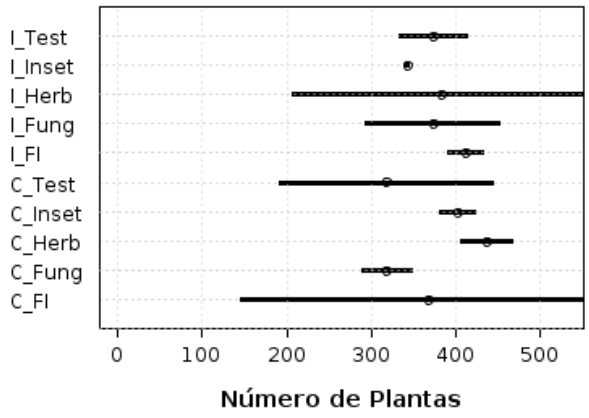

Fig.3: Number of rice plants 30 days after emergence, as function of irrigation management (C_ = continuous; I_ = intermittent), and seed treatment as follows: Fung = fungicide; Herb = no treat. + pre-emergence herbicide; Inset = insecticide; FI = fungicide + insecticide; and Test = control treatment without seed treatment and without pre-emergence herbicide. Confidence interval is presented (n = 4).

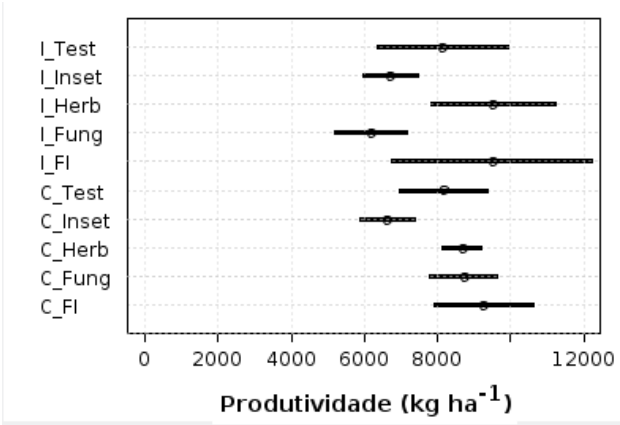

Fig.4: Rice grain yield cv. Guri Inta CL, corrected to 13% humidity, as function of irrigation management (C_ = continuous; I_ = intermittent), and seed treatment as follows: Fung = fungicide; Herb = no treat. + pre-emergence herbicide; Inset = insecticide; FI = fungicide + insecticide; and Test = control treatment without seed treatment and without pre-emergence herbicide. Confidence interval is presented (n = 4).

Barrigossi and Ferreira (2002), also treated seeds with insecticide, and between 20 and 25 days after planting they reported greater number of plants, mainly when used fipronil and furathiocarb, thiamethoxan, thiodicarb and carbosulfan were used, without productivity difference

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among treatments with insecticides. Almeida et al. (2014b), when treating seeds with thiamethoxam and lambdacyhalotrin, reported an increase in germination, especially when seeds were submitted to temperatures between 10 and 13 ºC. Thiamethoxan also optimized seed performance (Almeida et al., 2014a).

In the treatment with the fungicide carboxim + thiram, Lobo (2008) verified that even though there was no blast (*Pyricularia grisea*) control under high pressure in the field, the fungicide helped optimizing seed emergence and performance.

Therefore, treatments that include the association of fungicides and insecticides seem to favor crop establishment (Brzezinski et al., 2015). In corn and wheat, the associated treatments did not affect the initial establishment of seedlings (Dartora et al., 2013), and there was increase in maize grains yield only with application of insecticide (Schlosser et al., 2012). In soybean, seed treatment with insecticides and fungicides helped to maintain the physiological and sanitary seed quality, providing benefits at different stages of growth and development, not reflecting, however, higher crop productivity (Cunha et al. 2015).

It should be emphasized that in none of the variables evaluated in the present study, were there evidences that the differential water management could have affected the performance of the rice crop, since means and their respective confidence intervals were not different between treatments submitted to the continuous or to intermittent irrigation (Figures 1, 2, 3, 4).

The only comment that can be raised in this respect is that crop productivity showed higher confidence intervals - and therefore greater variability in cropping situations similar to those of the experiment, under intermittent irrigation, which may require more attention from farmers to the correct water management, avoiding possible damages to the productivity - damages that were not observed in the present study. This corroborates with Santos et al. (2015), who reported that regardless of the irrigation method, rice yield remained unchanged.

V. CONCLUSIONS

There is no evidence of differential seed treatment interference on the agronomic performance of this crop, nor differences due to its interaction with irrigation management.

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Theoretical Analysis and Molecular Orbital studies of Sulfonamides Products with N-Alkylation and O-alkylation

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Abstract**—** *In this comprehensive study, theoretical investigation was carried out on sulfonamides products with N-alkylation and O-alkylation* ***1-4*** *using DFT/B3LYP method with 6-31G (d,p) basis set. The optimized geometrical parameters were calculated by means of density functional theory. Information about size, shape, charge density distribution and site of chemical reactivity of the molecules* ***1-4*** *has been obtained by mapping electron density iso-surface with electrostatic potential surface. The lowering in the HOMO and LUMO energy gap for compound* ***3*** *explains the eventual charge transfer interactions that take place within the molecule. The chemical reactivity parameters (chemical hardness and softness, electronegativity, chemical potential and electrophilicity index) were discussed clearly and results show that compound* ***3*** *is the most reactive. Mulliken population analysis of atomic charges is also computed and interpreted. A detailed molecular picture of the title compounds and there interactions were obtained from NBO analysis. Nonlinear optical NLO behavior of the examined molecule was investigated by the determination of the electric dipole moment μ, the polarizability α and the hyperpolarizability β.*

Keywords**— Sulfamide; Density functional theory; Computational chemistry; Quantum chemical calculations.**

I. INTRODUCTION

Sulfonamides constitute an important class of antimicrobial agents in the world owing to their low cost, low toxicity and excellent activity against bacterial diseases. Their significance appeared when sulfanilamide, an important analogue of sulfonamide, was reported [1] to be the first metabolite of an antibacterial drug. Many sulfonamide derivatives were synthesized, characterized and tested for antibacterial [2], anti-tumor [3,4] anti-carbonic anhydrase [5,6], diuretic [7,8], hypoglycemic properties [9], antithyroid [10], anti-inflammatory [11], and other biological activities [3,4].

DFT method has extensively used in chemical reaction for the interpretation and prediction of complex system behavior at an atomic scale. Furthermore the DFT calculations are powerful and very reliable tool for calculating various molecular properties. Accordingly, it is necessary to underline that the theoretical approaches deduced form DFT/B3LYP calculation level are more effective and reliable as compared to those inferred from the other methods[11].

In this perspective, the geometrical parameters, molecular electrostatic potential (MEP), frontier orbitals, global reactivity descriptors, Mulliken charges, NBO analysis and nonlinear optical properties (NLO) of the sulfonamides products with N-alkylation and O-alkylation **1-4** described in literature [12] have been calculated by using DFT (B3LYP) method with 6-31G (d,p) basis set to predict their reactivity and applications.

II. MATERIALS AND METHODS

The density functional (DFT/B3LYP) at the 6-31G (d,p) basis set level was adopted to calculate the properties of the title molecules in this work. All the calculations were performed using Gaussian 09W program package [13].

III. RESULTS AND DISCUSSION

3.1. Molecular Geometry:

The optimized geometrical parameters of sulfonamides products with N-alkylation and O-alkylation **1-4** obtained through DFT/B3LYP method using 6-31G (d,p) basis set are listed in Tables 1-4. The molecular structures of these compounds **1-4** are depicted in Fig 1.

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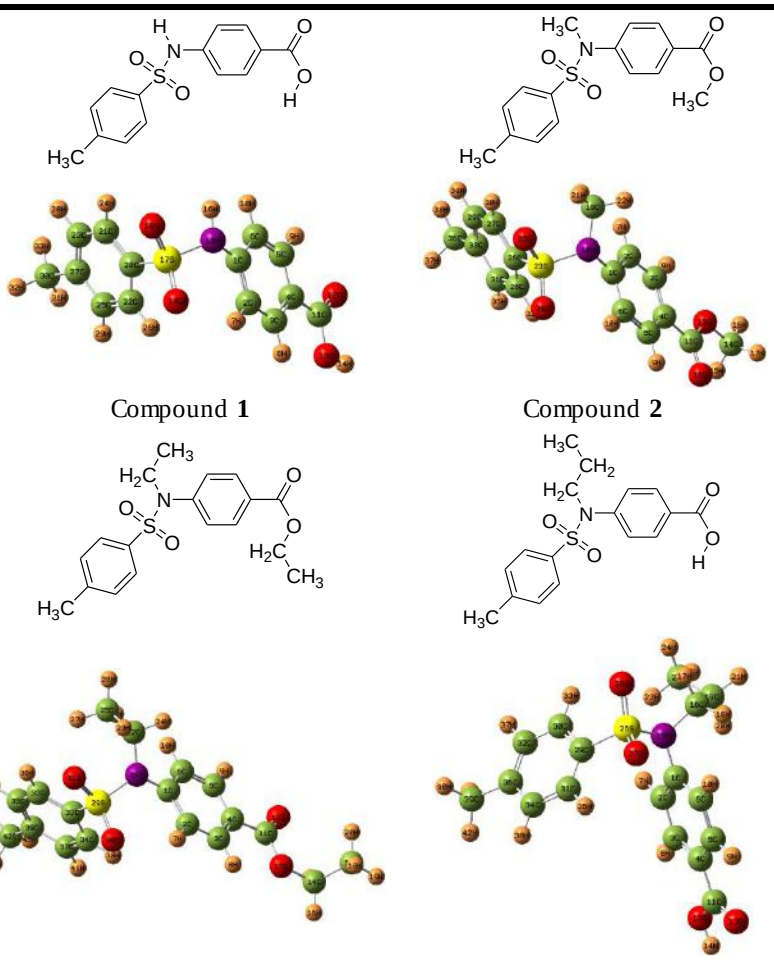

Compound **1** Compound **2**

Compound **3** Compound **4**

Fig.1: Optimized molecular structure of sulfonamides products with N-alkylation and O-alkylation 1-4

*Table.1: Optimized geometric parameters of compound **1***

Bond Length (Å)		Bond Angles (°)		Dihedral Angles (°)	
R(1,2)	1.405	A(2,1,6)	119.607	D(3,4,5,9)	179.919
R(1,15)	1.412	A(2,1,15)	121.621	D(2,1,6,10)	179.894
R(2,7)	1.083	A(4,11,13)	113.108	D(20,21,23,28)	179.639
R(11,12)	1.216	A(12,11,13)	121.912	D(2,3,4,11)	179.456
R(11,13)	1.358	A(11,13,14)	105.616	D(11,4,5,6)	179.441
R(13,14)	0.971	A(1,15,16)	115.463	D(26,22,25,27)	178.776
R(15,16)	1.015	A(1,15,17)	125.515	D(17,20,21,23)	178.720
R(15,17)	1.705	A(16,15,17)	109.369	D(21,23,27,30)	178.591
R(17,18)	1.462	A(15,17,18)	107.298	D(22,20,21,24)	178.567
R(17,19)	1.462	A(15,17,20)	106.557	D(6,1,2,7)	178.132
R(17,20)	1.792	A(18,17,19)	122.683	D(15,1,6,5)	177.284
R(20,21)	1.397	A(18,17,20)	107.842	D(2,1,15,16)	172.147
R(21,23)	1.392	A(21,23,27)	121.186	D(18,17,20,21)	155.434
R(21,24)	1.085	A(21,23,28)	119.340	D(23,27,30,31)	152.733
R(30,31)	1.094	A(27,30,31)	111.492	D(6,1,15,17)	137.111

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Table 2: Optimized geometric parameters of compound 2

Bond Length (Å)		Bond Angles (°)		Dihedral Angles (°)	
R(1,18)	1.429	A(6,1,18)	119.905	D(4,11,13,14)	179.914
R(4,11)	1.488	A(3,4,11)	122.679	D(6,1,2,7)	179.908
R(11,12)	1.216	A(4,5,6)	120.847	D(9,5,6,1)	179.901
R(11,13)	1.355	A(4,11,13)	112.473	D(2,3,4,11)	179.831
R(13,14)	1.436	A(12,11,13)	122.934	D(27,29,33,36)	179.553
R(14,15)	1.093	A(11,13,14)	115.088	D(26,27,29,34)	179.421
R(18,19)	1.470	A(13,14,15)	110.675	D(35,31,33,29)	179.401
R(18,23)	1.719	A(1,18,19)	118.214	D(11,4,5,6)	179.166
R(19,20)	1.099	A(1,18,23)	118.645	D(2,1,6,10)	178.933
R(23,24)	1.462	A(18,19,20)	113.433	D(32,28,31,33)	178.728
R(23,25)	1.464	A(18,23,24)	107.209	D(23,26,27,29)	178.515
R(23,26)	1.793	A(18,23,26)	105.650	D(28,26,27,30)	178.258
R(26,27)	1.395	A(24,23,25)	121.794	D(18,1,2,3)	177.289
R(27,30)	1.084	A(23,26,28)	119.519	D(1,18,23,25)	174.729
R(36,38)	1.093	A(33,36,37)	111.048	D(23,18,19,22)	166.611

Table 3: Optimized geometric parameters of compound 3

Bond Length (Å)		Bond Angles (°)		Dihedral Angles (°)	
R(1,21)	1.426	A(2,1,6)	118.837	D(29,32,33,35)	179.984
R(4,5)	1.400	A(2,1,21)	121.110	D(5,4,11,13)	179.907
R(4,11)	1.488	A(3,4,11)	122.897	D(2,1,6,10)	179.770
R(11,12)	1.217	A(4,11,12)	124.135	D(32,33,35,40)	179.686
R(11,13)	1.354	A(12,11,13)	123.575	D(11,4,5,6)	179.481
R(13,14)	1.447	A(11,13,14)	116.503	D(16,14,17,20)	178.977
R(14,17)	1.521	A(13,14,17)	111.410	D(33,35,39,42)	178.936
R(17,20)	1.093	A(14,17,18)	110.891	D(15,14,17,18)	177.525
R(21,22)	1.483	A(1,21,22)	120.241	D(21,1,6,5)	177.333
R(21,29)	1.703	A(1,21,29)	121.202	D(13,14,17,19)	175.674
R(22,25)	1.530	A(22,25,27)	111.069	D(1,21,29,31)	174.601
R(29,30)	1.464	A(21,29,32)	106.348	D(29,21,22,24)	164.211
R(29,31)	1.465	A(30,29,31)	121.283	D(30,29,32,33)	140.557
R(29,32)	1.796	A(37,39,42)	120.577	D(2,1,21,22)	139.697
R(39,42)	1.509	A(39,42,44)	111.518	D(6,1,21,29)	137.965

Table 4: Optimized geometric parameters of compound 4

Bond Length (Å)		Bond Angles (°)		Dihedral Angles (°)	
R(1,15)	1.442	A(2,1,6)	119.807	D(4,11,13,14)	179.945
R(4,11)	1.487	A(4,11,12)	124.878	D(16,19,22,25)	179.853
R(11,12)	1.215	A(4,11,13)	113.066	D(29,31,34,38)	179.829
R(11,13)	1.357	A(12,11,13)	122.056	D(11,4,5,6)	179.794
R(13,14)	0.972	A(11,13,14)	105.681	D(38,34,36,32)	179.764
R(15,16)	1.487	A(1,15,16)	115.883	D(3,4,11,12)	179.754
R(15,26)	1.719	A(1,15,26)	115.381	D(5,4,11,13)	179.684
R(16,17)	1.092	A(16,15,26)	115.802	D(6,1,2,7)	179.481
R(26,27)	1.470	A(15,16,18)	110.213	D(31,29,30,33)	178.474
R(26,28)	1.467	A(15,16,19)	111.614	D(1,15,26,28)	175.760
R(26,29)	1.791	A(16,19,22)	113.837	D(27,26,29,30)	163.950
R(29,31)	1.394	A(15,26,29)	101.965	D(16,15,26,29)	149.351
R(31,35)	1.084	A(27,26,28)	120.237	D(2,1,15,26)	108.120
R(36,39)	1.509	A(27,26,29)	107.606	D(15,26,29,31)	102.605

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R(39,40)	1.097	A(36,39,40)	110.867	D(1,15,16,19)	73.487

3.2. Molecular Electrostatic Potential (MEP):

The molecular electrostatic potential is related to the electronic density and a very useful descriptor for determining sites for electrophilic attack and nucleophilic reactions as well as hydrogen-bonding interactions [14-16]. MEP surface diagram is used to understand the reactive behavior of a molecule, in that negative regions can be regarded as potential electrophilic sites, whereas the positive regions are nucleophilic centers. In Fig 2, using the DFT/B3LYP method and 6-31G (d,p) basis set, the electrophilic site was presented by negative (red) regions and nucleophilic center was shown by the positive (blue) regions of MEP of the compounds **1-4**.

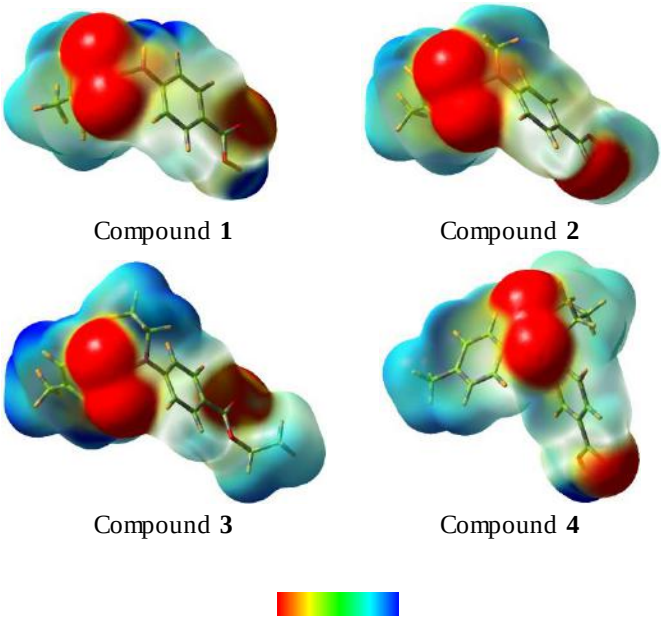


Fig 2: *Molecular electrostatic potential surface of sulfonamides products with N-alkylation and O-alkylation* ***1-4***

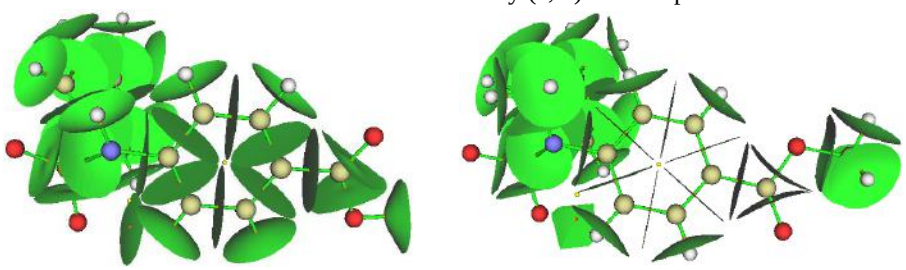
In all molecules, the regions exhibiting the negative electrostatic potential are localized on sulfamide function and on acid function for compound **1** and compound **4** and on ester function for compound **2** and compound **3**; while the regions presenting the positive potential are localized vicinity of the hydrogen atoms.

3.3. Basin Analysis:

The concept of basin was first introduced by Bader in his atom in molecular (AIM) theory, after that, this concept was transplant to the analysis of ELF by Savin and Silvi. In fact, basin can be defined for any real space function, such as molecular orbital, electron density difference, electrostatic potential and even Fukui function.

A real space function in general has one or more maxima, which are referred to as attractors or (3,-3) critical points. Each basin is a subspace of the whole space, and uniquely contains an attractor. The basins are separated with each other by interbasin surfaces (IBS), which are essentially the zero-flux surface of the real space functions; mathematically, such surfaces consist of all of the points **r** satisfying $\nabla f(\mathrm{r}).\,\mathrm{n}(\mathrm{r}) = 0$, where n(r) stands for the unit normal vector of the surface at position r.

Interbasin surfaces (IBS) dissect the whole molecular space into individual basins, each IBS actually is a bunch of gradient paths derived from a (3,-1) critical points (CP). The interbasin surfaces of compounds **1-4** generated by (3,-1) critical points are illustrated below.



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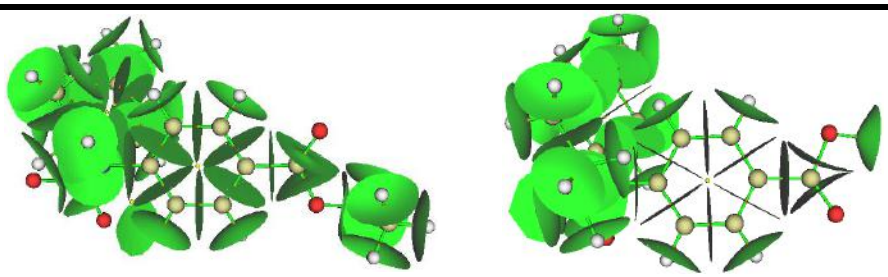

Compound **3** Compound **4**

Fig.3: Plots of the interbasin surfaces of compounds 1-4

The number of interbasin surfaces is 35, 41, 49 and 44 for compounds **1-4** respectively.

3.4. Frontier Molecular Orbitals (FMOs):

The frontier orbitals, HOMO and LUMO determine the way the molecule interacts with other species and the gap between them helps in characterizing the chemical reactivity as well as kinetic stability of the molecule. The HOMO illustrates the ability to donate an electron, LUMO as an electron acceptor represents the ability to obtain an electron. The electronic absorption corresponds to the transition from the ground to the first excited state and is mainly described by one electron excitation from the HOMO to the LUMO, the smaller the energy gap of the LUMO and HOMO, the easier it is for the electrons of HOMO to be excited. Fig 4 described the distributions and energy levels of the HOMO-1, HOMO, LUMO and LUMO+1orbitals computed at the B3LYP/6-31G (d,p) level for the compound **3** which is the most reactive.

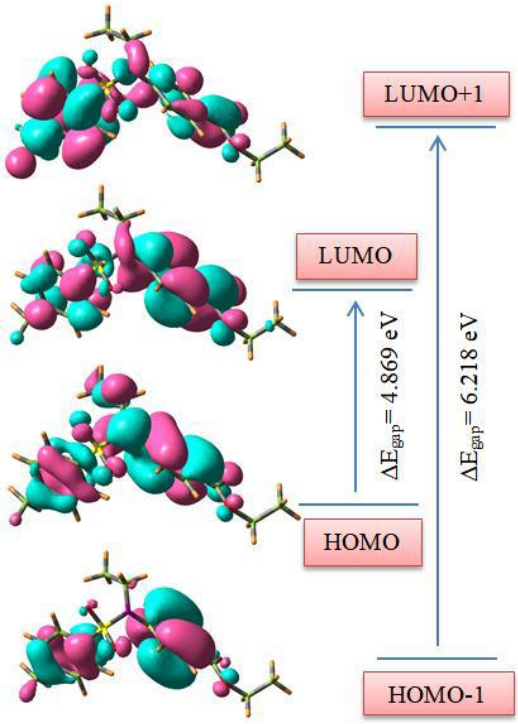

Fig.4: HOMO-LUMO Structure with the energy level diagram of compound 3

HOMO-1, HOMO, LUMO and LUMO+1 orbitals are almost confined over the whole molecule for compound **3** which gives charge transfer process in the molecular system.

3.5. Global Reactivity Descriptors:

The estimation of the reactivity of chemical species is one of the main purposes of theoretical chemistry and a lot of work has been carried out in the same line. Density functional theory has been successful in giving theoretical background of accepted qualitative chemical concepts. In this framework, several reactivity descriptors have been projected and used to analyze chemical reactivity and site selectivity. Hardness, global softness, electro negativity, potential ionization and affinity are the global reactivity descriptors widely used to understand the global nature of molecules in terms of their stability and it is possible to obtain knowledge about the reactivity of molecules. The global reactivity properties such as; E_{HOMO}, E_{LUMO}, ΔE_{gap}, the ionization potential (I), the electron affinity (A), the

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absolute electronegativity (χ), the absolute hardness (η) and softness (S) for the sulfonamides products with N-alkylation and O-alkylation **1-4** have been calculated at B3LYP/6-31G (d,p) basis set and the result are given in Table 5.

Table.5: Quantum chemical descriptors of sulfonamides products with N-alkylation and O-alkylation 1-4

Parameters	Compound 1	Compound 2	Compound 3	Compound 4
E_{HOMO} (eV)	-6.503	-6.383	-6.244	-6.725
E_{LUMO} (eV)	-1.503	-1.430	-1.374	-1.611
ΔE_{gap} (eV)	5.000	4.953	4.869	5.114
I (eV)	6.503	6.383	6.244	6.725
A (eV)	1.503	1.430	1.374	1.611
μ (eV)	-4.003	-3.906	-3.809	-4.168
χ (eV)	4.003	3.906	3.809	4.168
η (eV)	2.500	2.476	2.435	2.557
S (eV)	0.200	0.202	0.205	0.196
ω (eV)	3.205	3.081	2.980	3.398

The compound which has the lowest energy gap is the compound **3** (ΔE_{gap} = 4.869 eV). This lower gap allows it to be the softest molecule. The compound that has the highest energy gap is the compound **4** (ΔE_{gap} = 5.114 eV). The compound that has the highest HOMO energy is the compound **3** (E_{HOMO} = -6.244 eV). This higher energy allows it to be the best electron donor. The compound that has the lowest LUMO energy is the compound **4** (E_{LUMO} = -1.611 eV) which signifies that it can be the best electron acceptor. The two properties like *I* (potential ionization) and *A* (affinity) are so important, the determination of these two properties allows us to calculate the absolute electronegativity (χ) and the absolute hardness (η). These two parameters are related to the one-electron orbital energies of the HOMO and LUMO respectively. Compound **3** has the lowest value of the potential ionization (*I* = 6.244 eV), so that will be the better electron donor. Compound **4** has the largest value of the affinity (*A* = 1.611 eV), so it is the better electron acceptor. The chemical reactivity varies with the structure of molecules. Chemical hardness (softness) value of compound **3** (η = 2.435 eV, **S** = 0.205 eV) is lesser (greater) among all the molecules. Thus, compound **3** is found to be more reactive than all the compounds. Compound **4** possesses higher electronegativity value (χ = 4.168 eV) than all compounds so; it is the best electron acceptor. The value of ω for compound **4** (ω = 3.398 eV) indicates that it is the stronger electrophiles than all compounds. Compound **3** has the smaller frontier orbital gap so, it is more polarizable and is associated with a high chemical reactivity, low kinetic stability and is also termed as soft molecule.

3.6. Mulliken Analysis:

Atomic charges for molecule can be derived in multiple ways with a high level of convergence to the same values and only then, knowing the remaining uncertainty, are suited for molecular simulations. Mulliken charges arise from the mulliken population analysis [17,18] and provide a means of estimating partial atomic charges from calculations carried out by the methods of computational chemistry. The Mulliken atomic charges of compound **3** which is the most reactive are calculated by DFT/B3LYP method and 6-31G (d,p) basis set and detailed in a Mulliken's plot as visualized in Fig 5.

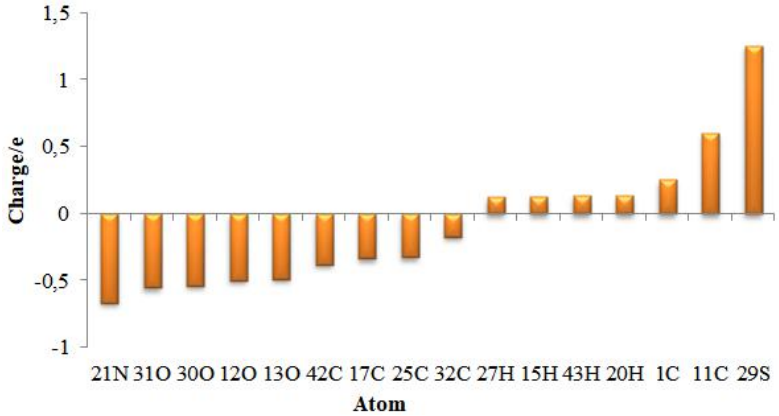

Fig.5: Mulliken's plot of compound 3

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The atom 21N shows more negative (-0.665192e) charge and 29S more positive (1.257995e) charge, which suggests extensive charge delocalization in the entire molecule. Negatively charged oxygen (31O, 30O, 12O and 13O) atoms shows that charge is transferred from sulfur to oxygen and from carbon to oxygen. Carbon atoms 42C, 17C, 25C and 32C are more negatively charged which indicate that the charge transfer on the whole molecule. The maximum atomic charge of carbons is obtained for 1C and 11C. This is due to the attachment of negatively charged 21N and (12O, 13O) respectively. The positive charges are localized on the hydrogen atoms. Very similar values of positive charges are observed for the hydrogen atoms (27H, 15H, 43H and 20H (0.129123, 0.130262, 0.136093 and 0.136652e) respectively) bonded to the negative atoms (25C, 14C, 42C and 17C) respectively.

3.7. Natural Bond Orbital Analysis (NBO):

The importance of the NBO method is originated from it gives information about the intra- and intermolecular bonding and interactions among bonds. Furthermore, it provides a convenient basis for investigating the interactions in both filled and virtual orbital spaces along with charge transfer and conjugative interactions in molecular system [19]. The delocalization effects are treated as the intramolecular charge transfer (ICT) from the highest occupied bonding orbitals into unoccupied anti-bonding orbitals and their importance can be more quantitatively characterized through a second-order perturbative treatment. The stabilization energy E (2) values of the titles compounds were calculated on the basis of second-order Fock matrix perturbation theory using DFT/B3LYP method with 6-31G (d,p) basis set. The larger E (2) values were listed in Tables 6-9.

Table.6: Second order perturbation theory analysis of Fock matrix on NBO of compound 1

Donor(i)	ED/e	Acceptor(j)	ED/e	E(2) Kcal/mol	E(j)-E(i) a.u	F(i.j) a.u
LP (2) O13	1.82543	π*(C11-O12)	0.26186	45.75	0.34	0.114
LP (2) O12	1.84573	σ*(C11-O13)	0.09933	33.73	0.61	0.129
π (C25-C27)	1.62459	π*(C20-C22)	0.39527	26.13	0.26	0.074
π (C3-C4)	1.63486	π*(C11-O12)	0.26186	23.86	0.26	0.073
π (C1-C2)	1.62238	π*(C3-C4)	0.38416	23.82	0.29	0.074
π (C3-C4)	1.63486	π*(C5-C6)	0.38416	22.63	0.28	0.072
π (C5-C6)	1.68415	π*(C1-C2)	0.38364	22.45	0.28	0.072
π (C21-C23)	1.66157	π*(C25-C27)	0.32651	21.67	0.29	0.071
π (C20-C22)	1.68588	π*(C21-C23)	0.30315	21.27	0.30	0.071
LP (1) N15	1.82113	π*(C1-C2)	0.38364	19.27	0.33	0.076
LP (3) O18	1.77022	σ*(S17-O19	0.14523	18.87	0.57	0.095
LP (3) O19	1.78101	σ*(S17-O18)	0.15524	18.85	0.57	0.094
LP (2) O12	1.84573	σ*(C4-C11)	0.06673	18.47	0.69	0.103
π (C21-C23)	1.66157	π*(C20-C22)	0.39527	18.25	0.27	0.063
π (C3-C4)	1.63486	π*(C1-C2)	0.38364	18.23	0.27	0.063
π (C25-C27)	1.62459	π*(C21-C23)	0.30315	18.14	0.28	0.064
LP (2) O19	1.81478	σ*(S17-C20)	0.20616	18.00	0.45	0.081
LP (2) O18	1.81877	σ*(S17-C20)	0.20616	17.56	0.45	0.080
LP (3) O18	1.77022	σ*(N15-S17)	0.27308	16.83	0.40	0.074
LP (3) O19	1.78101	σ*(N15-S17)	0.27308	16.29	0.40	0.073

Table.7: Second order perturbation theory analysis of Fock matrix on NBO of compound 2

Donor(i)	ED/e	Acceptor(j)	ED/e	E(2) Kcal/mol	E(j)-E(i) a.u	F(i.j) a.u
LP (2) O13	1.79647	π*(C11-O12)	0.26278	47.60	0.33	0.114
LP (2) O12	1.84587	σ*(C11-O13)	0.10298	34.02	0.62	0.132
π (C29-C33)	1.63559	π*(C26-C27)	0.38941	25.47	0.26	0.074
π (C3-C4)	1.64155	π*(C11-O12)	0.26278	22.49	0.26	0.071
π (C5-C6)	1.65673	π*(C1-C2)	0.38815	22.26	0.27	0.070
π (C1-C2)	1.65042	π*(C3-C4)	0.37422	21.84	0.29	0.072
π (C28-C31)	1.66447	π*(C29-C33)	0.32434	21.71	0.29	0.071

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π (C26-C27)	1.69323	π*(C28-C31)	0.29325	20.60	0.30	0.070
π (C3-C4)	1.64155	π*(C5-C6)	0.27771	20.11	0.29	0.070
π (C3-C4)	1.64155	π*(C1-C2)	0.38815	19.18	0.27	0.065
π (C5-C6)	1.65673	π*(C3-C4)	0.37422	18.72	0.28	0.065
LP (3) O24	1.77279	σ*(N18-S23)	0.28903	18.72	0.39	0.078
LP (3) O25	1.78112	σ*(N18-S23)	0.28903	18.69	0.39	0.078
LP (2) O25	1.81373	σ*(S23-C26)	0.20849	18.58	0.45	0.082
LP (2) O24	1.81500	σ*(S23-C26)	0.20849	18.35	0.45	0.082
π (C28-C31)	1.66447	π*(C26-C27)	0.38941	18.29	0.27	0.063
LP (2) O12	1.84587	σ*(C4-C11)	0.06466	18.14	0.69	0.102
π (C29-C33)	1.63559	π*(C28-C31)	0.29325	17.84	0.28	0.064
LP (3) O24	1.77279	σ*(S23-O25)	0.14628	17.79	0.57	0.092
LP (3) O25	1.78112	σ*(S23-O24)	0.14828	17.27	0.57	0.090

Table.8: Second order perturbation theory analysis of Fock matrix on NBO of compound 3

Donor(i)	ED/e	Acceptor(j)	ED/e	E(2) Kcal/mol	E(j)-E(i) a.u	F(i.j) a.u
LP (2) O13	1.79164	π*(C11-O12)	0.26966	48.63	0.33	0.115
LP (2) O12	1.84618	σ*(C11-O13)	0.10153	33.25	0.63	0.131
π (C35-C39)	1.63420	π*(C32-C33)	0.38818	25.41	0.27	0.074
π (C3-C4)	1.63275	π*(C11-O12)	0.26966	22.81	0.26	0.071
π (C1-C2)	1.62838	π*(C3-C4)	0.38015	22.46	0.29	0.072
π (C3-C4)	1.63275	π*(C5-C6)	0.30204	21.91	0.28	0.071
π (C34-C37)	1.66451	π*(C35-C39)	0.32671	21.65	0.29	0.071
π (C5-C6)	1.67420	π*(C1-C2)	0.37485	21.23	0.28	0.069
π (C32-C33)	1.69074	π*(C34-C37)	0.29810	20.71	0.30	0.070
π (C3-C4)	1.63275	π*(C1-C2)	0.37485	19.61	0.27	0.065
LP (3) O30	1.76709	σ*(S29-O31)	0.14477	18.84	0.56	0.094
LP (2) O31	1.81299	σ*(S29-C32)	0.20689	18.38	0.45	0.082
π (C34-C37)	1.66451	π*(C32-C33)	0.38818	18.31	0.27	0.064
LP (3) O31	1.78844	σ*(S29-O30)	0.15764	18.13	0.57	0.092
π (C35-C39)	1.63420	π*(C34-C37)	0.29810	18.05	0.28	0.065
LP (2) O12	1.84618	σ*(C4-C11)	0.06459	18.05	0.69	0.102
LP (2) O30	1.81920	σ*(S29-C32)	0.20689	17.46	0.45	0.080
π (C1-C2)	1.62838	π*(C5-C6)	0.30204	17.33	0.29	0.064
π (C5-C6)	1.67420	π*(C3-C4)	0.38015	17.31	0.29	0.064
LP (3) O31	1.78844	σ*(N21-S29)	0.27749	17.30	0.41	0.076

Table.9: Second order perturbation theory analysis of Fock matrix on NBO of compound 4

Donor(i)	ED/e	Acceptor(j)	ED/e	E(2) Kcal/mol	E(j)-E(i) a.u	F(i.j) a.u
LP (2) O13	1.82352	π*(C11-O12)	0.25212	46.11	0.34	0.114
LP (2) O12	1.84545	σ*(C11-O13)	0.09927	33.80	0.61	0.130
π (C34-C36)	1.63617	π*(C29-C31)	0.37927	25.45	0.27	0.074
π (C3-C4)	1.63974	π*(C11-O12)	0.25212	22.30	0.26	0.070
LP (3) O28	1.79291	σ*(N15-S26)	0.28669	21.91	0.40	0.085
π (C5-C6)	1.64359	π*(C1-C2)	0.35205	21.83	0.27	0.069
π (C30-C32)	1.66734	π*(C34-C36)	0.32322	21.71	0.29	0.071
π (C1-C2)	1.65107	π*(C3-C4)	0.36671	21.03	0.29	0.070
π (C29-C31)	1.69031	π*(C30-C32)	0.29539	21.01	0.30	0.071
π (C3-C4)	1.63974	π*(C1-C2)	0.35205	19.84	0.28	0.066
π (C3-C4)	1.63974	π*(C5-C6)	0.27958	19.69	0.29	0.069

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π (C5-C6)	1.64359	π*(C3-C4)	0.36671	19.66	0.28	0.066
LP (3) O27	1.77819	σ*(N15-S26)	0.28669	19.32	0.39	0.079
LP (2) O12	1.84545	σ*(C4-C11)	0.06778	18.73	0.69	0.104
LP (2) O28	1.80545	σ*(S26-C29)	0.19763	18.69	0.45	0.082
LP (2) O27	1.80864	σ*(S26-C29)	0.19763	18.38	0.45	0.081
π (C30-C32)	1.66734	π*(C29-C31)	0.37927	17.99	0.27	0.063
π (C1-C2)	1.65107	π*(C5-C6)	0.27958	17.89	0.29	0.066
π (C34-C36)	1.63617	π*(C30-C32)	0.29539	17.79	0.28	0.064
LP (3) O27	1.77819	σ*(S26-O28)	0.14346	17.71	0.56	0.091

The intra molecular interaction for the title compounds is formed by the orbital overlap between: π (C25-C27) and π*(C20-C22) for compound **1**, π (C29-C33) and π*(C26-C27) for compound **2**, π (C35-C39) and π*(C32-C33) for compound **3** and π (C34-C36) and π*(C29-C31) for compound **4** respectively, which result into intermolecular charge transfer (ICT) causing stabilization of the system. The intra molecular hyper conjugative interactions of π (C25-C27) to π*(C20-C22) for compound **1**, π (C29-C33) to π*(C26-C27) for compound **2**, π (C35-C39) to π*(C32-C33) for compound **3** and π (C34-C36) to π*(C29-C31) for compound **4** lead to highest stabilization of 26.13, 25.47, 25.41 and 25.45 kJ mol^{-1} respectively. In case of LP (2) O13 orbital to the π*(C11-O12) for compound **1**, LP (2) O13 orbital to π*(C11-O12) for compound **2**, LP (2) O13 orbital to π*(C11-O12) for compound **3**, LP (2) O13 orbital to π*(C11-O12) for compound **4** respectively, show the stabilization energy of 45.75, 47.60, 48.63 and 46.11 kJ mol^{-1} respectively.

3.8. Nonlinear Optical Properties (NLO):

The non-linear optical properties of the organic molecules are associated to the delocalized π electrons that move along molecule. The increase of the conjugation on molecule gives rise to an increase in its non-linear optical properties. One another way to increase non-linear optical properties is to add donor and acceptor groups. If the donor and acceptor groups are powerful, delocalization of π electron cloud on organic molecules increases and as a result of this the polarizability and first hyper-polarizability of organic molecules increase [20]. The dipole moment (μ), polarizability (α), anisotropy of polarizability (Δα) and first hypepolarizability (β_0) of sulfonamides products with N-alkylation and O-alkylation **1-4** were calculated using DFT/B3LYP method with 6-31G (d,p) basis set and illustrated in Table 10.

Table.10: Nonlinear optical properties of sulfonamides products with N-alkylation and O-alkylation 1-4

Parameters	Compound 1	Compound 2	Compound 3	Compound 4
β_{xxx}	10.1879	42.8963	72.7392	-13.1469
β_{yyy}	53.0159	47.2709	28.4891	30.4972
β_{zzz}	11.3645	13.7123	7.8813	11.9986
β_{xyy}	5.8714	24.2109	-8.0498	18.5791
β_{xxy}	45.8341	98.8568	59.0868	63.8974
β_{xxz}	-47.1180	67.3212	-27.2668	70.7141
β_{xzz}	4.1576	-4.3122	8.2628	11.4853
β_{yzz}	-1.8291	-3.0512	-6.6454	9.1439
β_{yyz}	-5.5542	2.6668	10.3103	9.6574
β_{xyz}	-17.5447	13.5678	-1.0398	23.0215
β_0 (esu)x10^{-33}	112.8079	177.2564	109.3349	139.7808
μ_x	-1.1682	-0.3538	-0.2435	-0.2088
μ_y	4.4313	5.4070	2.7319	2.9856
μ_z	0.9318	4.1778	2.1331	4.4819
μ (D)	4.6765	6.8422	3.4746	5.3894
α_{xx}	-121.2508	-131.4657	-134.6974	-144.8960
α_{yy}	-126.6992	-129.8462	-140.2193	-125.6791
α_{zz}	-115.6411	-133.1144	-152.0142	-145.2273
α_{xy}	-16.3967	-7.5930	-12.6363	-9.2442
α_{xz}	-13.1709	0.8616	-19.8395	-2.2152
α_{yz}	-8.7559	-5.5399	-9.9334	-1.2229

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α(esu)x10^{-24}	40.6040	16.5913	46.8039	25.5213
$\Delta\alpha$(esu)x10^{-24}	6.0175	2.4588	6.9363	3.7823

Since the values of the polarizabilities ($\Delta\alpha$) and the hyperpolarizabilities (β_0) of the GAUSSIAN 09 output are obtained in atomic units (a.u.), the calculated values have been converted into electrostatic units (e.s.u.) (for α; 1 a.u = 0.1482 x 10^{-24} e.s.u., for β; 1 a.u = 8.6393 x 10^{-33} e.s.u.). The calculated values of dipole moment (μ) for the title compounds were found to be 4.6765, 6.8422, 3.4746 and 5.3894 D respectively, which are approximately four, six and three times respectively than to the value for urea (μ = 1.3732 D). Urea is one of the prototypical molecules used in the study of the NLO properties of molecular systems. Therefore, it has been used frequently as a threshold value for comparative purposes. The calculated values of polarizability are 40.6040 x 10^{-24}, 16.5913 x 10^{-24}, 46.8039 x 10^{-24} and 25.5213 x 10^{-24} esu respectively; the values of anisotropy of the polarizability are 6.0175, 2.4588, 6.9363 and 3.7823 esu, respectively. The magnitude of the molecular hyperpolarizability (β_0) is one of the important key factors in a NLO system. The DFT/6-31G (d,p) calculated first hyperpolarizability value (β_0) of sulfonamides products with N-alkylation and O-alkylation are equal to 112.8079 x 10^{-33}, 177.2564 x 10^{-33}, 109.3349 x 10^{-33} and 139.7808 x 10^{-33} esu. The first hyperpolarizability of title molecules is approximately 0.32, 0.34, 0.31 and 0.40 times than those of urea (β of urea is 343.272 x10^{-33} esu obtained by B3LYP/6-311G (d,p) method). The above results show that all studied compounds **1-4** might have not the NLO applications.

IV. CONCLUSION

We have reported in this review, a complete computational study of sulfonamides products with N-alkylation and O-alkylation **1-4** by DFT/B3LYP method and 6-31G (d,p) basis set. The optimized molecular structures were obtained by same method. In addition, a molecular electrostatic potential map (MEP) of the title compounds has been analyzed for predicting the reactive sites and from the MEP contour map we note that the negative electrostatic potential are localized on sulfamide function and on acid function for compound **1** and compound **4** and on ester function for compound **2** and compound **3**. The HOMO-LUMO energy gap of the compound **3** is low and hence we conclude, according to the global reactivity properties analysis that it is the more reactive compared to other compounds. Mulliken's net charges have been calculated and results show that 21N is the more negative and 29S is the more positive charge, which Indicates extensive charge delocalization in the entire molecule. Natural bond orbital analysis has been carried out to analysis the stability of the molecules arising from hyper-conjugative interactions and charge delocalization. The nonlinear optical properties are also addressed theoretically. The title compounds may be not a potential applicant in the development of NLO materials.

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Determinants of Innovation and Productivity in Brazil: An Empirical Analysis of the Period 1996-2018

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Abstract *—Empirical studies regarding the determinants of innovation and productivity in developing countries, including Brazil, have demonstrated the negative impact of high inflation rates on the industrial capacity. However, the recent Brazilian experience clearly shows that stabilization, in and of itself, is not capable of recovering the investment rates. With this in mind, this study's goal is to answer, with the help of econometric simulation models, the questions: (i) what are the key-drivers to assess the Brazilian economy?; and (ii) what are the key-factors to be considered when investments are made, particularly in innovation and productivity? To answer the questions we evaluated the impacts of macro-economic variables on private investments, using a strategic bias and a long term vision plan. The estimates demonstrate empirical crowding-in evidence of public investments in infrastructure over private investments as a real impact to innovation and productivity. As for public investments (non-infrastructural) we suggest that the crowding-in impact dislocates private investments. All these indicators were obtained as presented in the therory, with the exception of the real interest rates variable (r), in which we observed that the coefficient is positive and insignificant in the estimated equation.*

Keywords — Econometric models, Innovation, Private investment, Productivity, Simulation Models.

I. INTRODUCTION

Several studies show the necessity of developing econometric models, using reliable information, in order to obtain further determinants related to innovation and productivity in Brazil, especially since the period related to the implementation of the Real Plan until now. The econometric model is only possible by taking into account the advances in the theories regarding simulation and the national macro-economic principles. Consequently, we have an interesting combination of information, simulation models and analysis that enable decision-making processes, which can be seen in Pereira (1999), Lenderman, *et. al* (2000), Serven (2002), Ribeiro and Teixeira (2001), and Luporini and Alves (2010).

Over the last few years several organizations have been making efforts to apply simulation models in their businesses. Thus, the objective of this article is to elaborate an econometric simulation model, focused on innovation and productivity and with true possibilities of economic growth during the coming years, due to increases in internal consumption. The econometric models presented can be used for macro-economic analysis, as well as for investment decisions, and especially for the analysis of the scenarios hereby presented.

It is noteworthy that the data used refers to the period between 1996-2018, due to the implementation of the Real Plan, and the unfolding of the ongoing international economic crisis of 2007.

According to Terra (2003), the econometric model presented does not take into account the variables related to imports and exports, which justifies this methodological option, due to the fact that any analyses will be directed towards the internal market, with a high percentage of consumption and service sales, thus increasing the economy's need of profound adjustments in order to achieve sustained and long term growth. We presume that private investment is a function of the GDP growth, however, we will not evaluate the impact of international economies on the Brazilian economy.

However, we will use the real exchange rate as a proxy for the existence of external restrictions, represented by the external debt/GDP rate, in order to investigate the impact of external conditions on private investments in Brazil.

The performance of the proposed econometric model is the result of the variables utilized, of their restrictions, of the temporal series, and of the long-term estimates of associated risk. However, the suggested evaluations are

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subject to further studies, which may determine the impact of productivity in the economy. The results achieved by the proposed model are consistent, according to the proposed theory, as well as the results generated with empirical evidence for the decision makers.

This study is divided in five sections: the first is the introduction and revising the literature describes the literature related to private investments in Brazil. Section 2 presents the material and method that describes the Cross-Section model, which is proposed to assess the impacts of macro-economic variables on innovation and productivity in Brazil. Section 4 presents the results of the econometric simulation for the period 1996-2018 and lastly, section 5 presents our conclusions.

1.1 Revising the literature:

The goal of the econometric model in question is to test the hypothesis that the series of private investments, governmental investments, the GDP, interest rates, inflation, among other factors, are correlated, which enables the modeling of long term behavior of innovation and productivity. Using empirical studies, we will try to identify if there is an inhibiting factor for private investments derived from the macro-economic instability and from governmental investments.

The vital role of capital formation in sustainable economic growth is widely recognized. However, in Brazil and in many other developing countries the investment rates were reduced until the mid 1990's, a fact which was a result mainly of the external debt crises and of lack of inflationary control.

The gross formation of fixed capital in relation to the Brazilian GDP, measured at constant prices, had an average decrease of 23% in the 1970's, of 18.5% in the 1980's and of 15.2% in the 1990-1995 period (IPEA, 2012).

In 1998 Brazil's economy felt the impacts of the so-called Asian crises, and in 2008 the great international financial crises happened. Due to the deceleration of the GDP in 2011 it is quite possible that other fiscal measures will be adopted by the government, in an attempt to stimulate the level of economic activity, especially those related to the increase in credit for 2012 and the years ahead.

The econometric results obtained in other studies related to investments themes, and its determinants in Brazil and in other countries are presented in Table 1. They summarize the works used as a foundation for the empirical research of this article.

The study of investment behavior, specifically in the private sector, results from the fact that this is a typically endogenous variable and from the observation that the adoption of specific economic actions in the market will increase the relative importance of productivity in the creation of aggregated capital. Particularly important dimensions of this problem are related to measuring the effects of macro-economic instability on the levels of investments in the private sector, and the identification of the type of relationship that exists between public investment and private investment.

II. MATERIAL AND METHOD

We tried to not only explain the theoretical model underlying the regression analysis, but also to test the existence of stationary and the co-integration between the temporary series we used.

The proposed econometric model combines the use of a series of data related to economic performance - observing organization's behaviors, productive aspects and growth.

In this model we will present data related to the 1996-2018 period, as this timeframe is relevant for the determination of sector analysis in Brazil, and also to indicate in future studies, the insertion of financial products for organizations.

Table.1: Comparison of the macro-economic variables used in Brazil and abroad

Methods and Variables	Luporini and Alves (2010)	Santos and Pires(2007)	Pereira (2005)	Serven (2003)	Schmukler and Serven (2002)	Melo and Rodrigues Júnior (1998)	Rocha and Teixeira (1996)
Sampled country	Brazil	Brazil	Brazil	61 Countries	USA	Brazil	Brazil
OLS	X	-	X	-	-	X	X
Private investment	X	X	X	X	X	X	X
Innovation and Productivity	-	-	-	-	X	-	-
Tributes	-	X	X	-	-	-	-
Util. of Ind. Cap.	X	-	X	-	X	-	-
Credit	X	-	X	X	X	-	-
Public Investment	X	X	X	X	X	X	X

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I_pb/Y (--)	-	-	-	X	-	-	-
Relative Prices of Capital Goods	-	X	X	-	-	X	X
Inflation (Uncertainty)	X	-	X	X	-	X	-
GDP	X	X	X	-	X	X	X
Cost of Capital (r)	X	-	X	X	-	X	-
Dummies	X	-	-	-	-	-	-
External Debt	X	-	-	-	-	-	-
R^2	0.92092	-	0.9521	N/D	N/D	0.89	0.85
Log Variables	Yes (Except r)	Yes	Yes (Except r)	Yes (Except r)	Yes	Yes (Except r)	Yes

Source: Authors.

Section "revising the literature" shows the importance of economic assessment. Thus, the present section tries to conduct a bibliographical survey, with the objective of extracting the relevant data to execute the econometric study. The goal of the econometric model in question is to test the hypothesis that the series of private investments, governmental investments, the GDP, interest rates, inflation, among other factors, are correlated, which enables the modeling of long term behavior of productivity. Using empirical studies, we will try to identify if there is an inhibiting factor for private investments derived from the macro-economic instability and from governmental investments, over the course of the timeframe.

The vital role of capital formation in sustainable economic growth is widely recognized. However, in Brazil and in many other developing countries the investment rates were reduced until the mid 1990's, a fact which was a result mainly of the external debt crises and of lack of inflationary control. The gross formation of fixed capital in relation to the Brazilian GDP, measured at constant prices, had an average decrease of 23% in the 1970's, of 18.5% in the 1980's and of 15.2% in the 1990-1995 period (IPEA, 2012).

The study of investment behavior, specifically in the private sector, results from the fact that this is a typically endogenous variable and from the observation that the adoption of specific economic actions in the market will increase the relative importance of private investments in the creation of aggregated capital. Particularly important dimensions of this problem are related to measuring the effects of macro-economic instability on the levels of investments in the private sector, and the identification of the type of relationship that exists between public investment and private investment.

III. ECONOMETRIC MODEL

To explain the issue of private investments we chose the following data as part of the functional form: GDP, utilization of industrial capacity, public investments in infrastructure, public investments in non-infrastructural areas, innovation and productivity, real interest rates, relative prices of capital goods, inflation, a credit availability proxy, tax burden, external restrictions and exchange rates.

The GDP and the utilization of industrial capacity are commonly used factors when specifying equations for level investments, as they reflect the conditions of the demands of the economy and are used to measure the accelerating effect of investment and possible economic cycles. Typically pro-cyclic economies, such as the ones in developing countries, tend to show a strong correlation between private investments and the variables related to demand.

To measure the impact of public investments on private investments we used public investments in a disaggregated form, separating public investments in infrastructure from the investments in electric energy, telecommunications and transportation. All other public investments are considered as non-infrastructural. It is crucial to verify if there is empirical evidence of the crowding-in theoretical effect of public investments in infrastructure over Brazil's private investments, and if not, does the expected crowding-out effect occur.

The possible crowding-in effect of public over private investments in infrastructure is theoretically explained by the fact that such investments increase the innovation and productivity of capital for future investmentand save private investors from additional investments they would otherwise have to make in these areas. As for the crowding-out effects of non-infrastructural public investments, these can be theoretically explained by the competition between them for scarce resources available for investments.

A frequently used variable to explain private investments is the real interest rate, the first theoretic proxy of the cost of capital opportunity. This justifies the choice of this

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variable as a pre-candidate to compose the final functional form.

The relative price of capital goods is also a key-variable in investment decisions, because it directly affects the cost of capital opportunity. It can assess the effects of low competition in the industry of capital goods that result in increasing the prices of these goods above the prices practiced in the rest of the economy, which would negatively impact investments.

Inflation is a commonly used variable as a proxy for uncertainties in the economies of developing countries. This variable was included in the study conducted by Rodrigues Júnior (1998) to assess the impact of Brazil's macro-economic stability over investments.

A proxy variable for the availability of credit in the economy is also commonly used in investment studies, especially in developing countries, in which credit access is very limited. Obtaining credit or not is, in many projects, a key-element for the impact of credit itself. Thus, the availability of credit should also be taken into account as a pre-candidate variable. In this article we considered the volume of annual disbursements of the BNDES as a proxy for credit availability in Brazil.

The total tax burden (as a percentage of the GDP) should be used as a possible explanatory variable for private investments. Very few empirical articles use this variable, but in the Brazilian case it may be quite relevant, especially with the significant increase of taxes over the last few years. The motivation for using this variable is due to the fact that economic agents of the public and private sectors have been complaining about the excessiveness of Brazilian taxes as being one of the major obstacles for private investments.

As for external influences, several indicators were used on the empirical work, such as deviation of products from their long-term trends, the volatility of the stock exchange, the variability of inflation rates and/or of the exchange rates in relation to the debt/GDP, with negative results for private investments, Studart (1992).

And finally, Cardoso (1992) uses the relationship between external debt and exports to investigate the effects of external conditions on private investments in Brazil, and in other Latin American countries, confirming the negative results already uncovered in other studies. More recently, Johansen and Juscelius (1998) investigated the relationship between exchange rates and private investments. The results indicate that the exchange rates affected negatively and significantly private investments over the analyzed timeframe, which was from 1956 to 1996.

Taking Table 1 into consideration, we propose the following generic theoretical model:

Priv_Investments = f(Y, UCAP, Pub_Infra_Invest, Non_Pub_Infra_Invest, Innovation_Productivity, r, P_rel_bens_k, IGP-DI, Emprest_BNDES, t, EE, E) (1)

In which:

Priv_Investments= *strictusensu* gross investment of the private sector (excludes state organizations);

Y = Real Gross Domestic Product;

UCAP = average utilization of the industrial capacity;

Pub_Infra_Invest = public investments in infrastructure;

Non_Pub_Infra_Invest = non-infrastructural public investments;

Innovation_Productivity = innovation and productivity, as a function of capital, technology and human capital investments;

r = real interest rate;

Rel_Prices_K = relative prices of capital goods;

IGP-DI= Inflation

BNDES_Dis = Real disembursement of the BNDES;

T = Tax burden as a percentage of the GDP;

EE = External restriction, using as a proxy the series Debt Service/GDP (%);

E = Real exchange rate;

Dummy = control variable for times of international crises

Based on this expression, we estimate the following econometric equation for the 1996-2011 timeframe, with expresses variables in natural logarithms (except for the real interest rates variable), in order to directly obtain the elasticity of the variables:

$$LInvest\_priv_t = \beta_0 + \beta_1 LY_t + \beta_2 LUCAP + \beta_3 LPub\_Infra\_Invest + \beta_4 LNon\_Pub\_Infra\_Invest + \beta_5 LInnovation\_Productivity + \beta_6 Lr + \beta_8 LReal\_Prices\_K + \beta_9 LIGP\text{-}DI + \beta_{10} LBNDES\_Dis + \beta_{11} LT + \beta_{12} LEE + \beta_{13} LE + \varepsilon_t \quad (2)$$

In which ε_t is a random disturbance.

In conformity with the model of the investment accelerator, we expect that the increased GDP will generate an increase in productivity, because increased production requires more investments and innovation. The effect of the interest rate is negative and reflects the adverse impact of the cost of capital utilization over investment decisions. Used as a proxy for uncertainty and instability, we expect that the elevation in the inflation rates will decrease investments in the private sector; here the implicit hypothesis is that instability increases the *waiting price* for new information and increases business risks. The relationship between the Private Investment and Public Investment variables is ambiguous, because both crowding-in and crowding-out can predominate between the two types of investment.

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Table 2 presents a summary of the pre-candidate variables used to explain private and R&D investments in annual series since 1996 and what are the theoretic expected signals.

Table 2 - Pre-candidate variables

Pre-candidate variable	**Expected signal**
Real GDP	Positive
Average utilization of industrial capacity	Positive
Public investments in infrastructure	Positive
Non-infrastructural public investments	Negative
Innovation and Productivity	Positive
Real interest rates	Negative
Relative prices of capital goods	Negative
Inflation	Negative
Real disbursements of the BNDES	Positive
Tax burden as a percentage of the GDP	Negative
External restrictions	Negative
Real exchange rates	Negative

Source: authors.

III. RESULTS AND DISCUSSION

For the econometric analysis all variables, with the exception of the real interest rates variable, were log-linearized using the natural logarithm, and the remaining series were calculated using the fixed prices of 1995. Because the series used in the estimations of the investment equations are temporal series, we presume that these series are random variables ordered over time. The usual methods of estimation and inference presume that these variables are stationary. The non-stationarity of a stochastic process is due to the existence of a unit root or a stochastic trend in the auto-regressive process (AR), which generates the presence (or absence) of stationarity in the variables used in the estimations.

3.1 Stationarity tests

Initially the series were subjected to augmented Dickey and Fuller (ADF) unit root tests (Dickey; Fuller, 1981), in level and in first difference. The ADF test is well known and will be described in this section (see Hayashi, 2000, p. 573). It should be remembered that the test statistic is similar to the t-student test.

The aim of the tests is to show statistical evidence of the integration order of the variables and are, in fact, pre-tests for co-integration, since theoretically only variables with the same integration order can co-integrate.

According to Maddala& Kim (1998), the null hypothesis is that $\alpha=0$, in which α is the coefficient associated to the first lag range of the series, which enters as a regressor AR(p) for the first difference of the hypothesis. The criterion of rejection indicates rejecting H_0 if $|ADF|>VC$, in which VC is the critical value of the distribution. As in the case of the existence of a unit root, the asymptotic distribution of t is not the same if the series is stationary (in this case the i of student). Thus, we used critical values tabulated by MacKinnon (1996). The correct choice of lags is important, as they can influence the performance of the tests. What we did was choose a number which was sufficient to eliminate any possible serial correlation of residues. The choice was made by minimizing information criteria.

The Table 3 bellow summarizes the results of the stationarity tests. For the timeframe being analyzed the results of the tests favor the hypothesis of a unit root and also indicate that the series contains a stochastic trend.

The unit root tests for the selected on level variables do not reject the possibility of the existence of a unit root in all cases at a 1% level, the only rejection occurred in the LnIGP-DI variable. In other words, there are no statistical evidences that the variables are I(0). The analyses of the results indicates that the series for private investments (Ln Priv_Investments), GDP (LnY), utilization of industrial capacity (LnUCAP), public investments (LnPub_Infra_Invest and Ln Non_Pub_Infra_Invest), Innovation and Productivity (Ln_Innovation_Productivity), real interest rates (r), relative prices of capital goods (Rel_Prices_K), loans from the BNDES (LnBNDES_Dis) and taxation (LnT), may all be considered stationary.

Based on this, one can say that there is statistical evidence that the variables in question can be treated as I(1), and that regressions without their levels (log on level, in the case of the specification used here) are possible and will not present dubious results, as long as the conditions of co-integration are verified. The theory suggests the possibility of a trend, besides the constant, for the formulations of the unit root tests for the GDP and investments, and that was properly considered.

Considering the other in level significances, we observed that there were rejections for the variables: LY for 5% and 10%, LnUCAP for 10%, LnBNDES_Dis for 5 and 10%, and LnIGP-DI for 1%, 5% and 10%. A possible explanation for this fact is that the stationarity tests are susceptible to the specification and the measure unit of the variables, which creates difficulties for the analysis of results. Furthermore, the unreliability of the tests makes it difficult to discriminate stochastic series with high dependencies. The real exchange rate (LnE) can be considered stationary with the ADF of -2.6534 with the rejection of the null hypothesis at a 10% level of significance. For the EE variable we have an ADF, in level, of -2.2719 with an integration order I(1).

Given these characteristics, the investment equations were estimated by means of the Ordinary Least Squares

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methodology. Some of the studies of investment determinants presented in literature use the co-integration technique by means of a systemof auto-regressive vectors (VAR). The estimator of Ordinary Least Squares is one of the few estimators whose properties are solidly established in specialized literature.

For the unit root tests of the selected variables in first difference we observed that the results repeat themselves, as they do not reject the possibility of the existence of a unit root in all of the cases at a level of 1%, the only rejection occurred in the DLnIGP-DI variable. In other words, there are no statistical evidences that the variables are I(0).

The main objective of the estimations presented on Table 3 is to test the hypothesis of the crowding-in effect of public investments on infrastructure over private investments.

Table 3. Results of the stationarity tests for the pre-candidate variables on the productivity model using annual data from 1996-2018

Variables	**t-ADF**	**Critical value test 1% significance**	**Critical value test 5% significance**	**Critical value test 10% significance**	**p-value**
On level variables					
LnPriv_Invet	- 1,874	- 4,0579	- 3,1199	- 2,7011	0,332
LnY	- 3,433	- 3,9591	- 3,0810	- 2,6813	0,026
LnUCAP	- 2,342	- 3,9591	- 3,0810	- 2,6813	0,172
Ln_Pub_Infra_Inves	- 1,169	- 3,9591	- 3,0810	- 2,6813	0,658
Ln_Non_Pub_Inv_I	- 0,771	- 3,9591	- 3,0810	- 2,6813	0,797
Ln_Innovation_Productivity	- 1,764	- 4,0483	- 301134	- 2,6017	0,262
R	- 1,842	- 3,9591	- 3,0810	- 2,6813	0,347
Ln_Real_Prices_K	- 1,206	- 3,9591	- 3,0810	- 2,6813	0,642
LnIGP-DI	- 5,265	- 4,2000	- 3,1753	- 2,7289	0,002
Ln_BNDES_Dis	- 3,982	- 4,0044	- 3,0988	- 2,6904	0,010
LnT	- 2,062	- 4,0579	- 3,1199	- 2,7011	0,260
First difference variables					
DLnInv_Priv	- 1,874	- 4,0579	- 3,1199	- 2,7011	0,087
DLY	- 3,433	- 3,9591	- 3,0810	- 2,6813	0,004
DLnUCAP	- 2,342	- 3,9591	- 3,0810	- 2,6813	0,035
Ln_Pub_Infra_Inves	- 1,169	- 3,9591	- 3,0810	- 2,6813	0,263
Ln_Non_Pub_Inv_I	- 0,771	- 3,9591	- 3,0810	- 2,6813	0,454
Ln_Innovation_Productivity	- 1,783	- 4,8309	- 3,2991	- 2,7011	0,059
Dr	- 1,842	- 3,9591	- 3,0810	- 2,6813	0,088
DP_Real_Prices_K	- 1,206	- 3,9591	- 3,0810	- 2,6813	0,249
DLnIGP-DI	- 5,265	- 4,2000	- 3,1753	- 2,7289	0,000
DLnBNDES_Dis	- 3,982	- 4,0044	- 3,0988	- 2,6904	0,001
DLnT	- 2,062	- 4,0579	- 3,1199	- 2,7011	0,069

Source: authors.

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3.2 Final functional form for annual data related to 1996-2018

The Table 4 bellow shows a summary of the pre-candidate variables used to explain productivity in Brazil, in annual series from 1996 onwards, and the expected signals for the relationship between each one of them and private investments.

Contrary to the study performed by Corrado and Mattey (1997), this analysis opted for including the variables that presented low significance in the final model. The model presented low significance for the variable that assesses uncertainties (LnIGP-DI), which was also confirmed by the stationarity tests, and also for the total tax burden variable (LnT).

Furthermore, our analysis specified a dynamic model, including the lag in the private investment variable (DLnInv_Priv(-1)), because by using contemporaneous variables the model would present problems with the auto-correlation of residues. The first lag of the private investment variable is commonly used in several studies, due to the fact that some investments cannot be completed in only one year, which explains the use of this variable to assess the inertia effect on investments.

In the first equation estimated we inserted a control variable for times of political instability, represented by a dummy (D1), which assumes unitary values for the years of 1997 (Asian Crises), 1998 (Russian Crises), 1999 (Argentinean Crises and the Brazilian Currency Devaluation) and 2008 (World Financial Crises).

Overall the model presented a satisfactory explanatory rate (R^2 = 0.95), which is a result coherent with the majority of the studies shown in Table 1. One can also observe the importance of the irreversibility of the investment, reflected in the coefficient of the first lag of private investment, which was positive and significant, indicating that current investments depend on their past values.

This evidence indicates the existence of lags in the decision makingprocess and in the implementation of private investments, and suggests that current investments not only reflect partial adjustments of current capital to desired levels, but also tend to happen in an accumulated manner or clustered in time (lumpiness).

The signs found for the estimated coefficients were positive, statistically significant and are in accordance with the economic theory, which indicates income increase (LnY) and increase in economic activity (LnUCAP), encouraging and increasing productivity in the country. In the case of the utilization of industrial capacity (LnUCAP) we observed the extremely pro-cyclic characteristic of the Brazilian economy, with a high and positive coefficient (2.86).

This result is compatible with the majority of the existing empirical studies concerning the determinants of investments in Brazil and in other developing countries, where the variables used to assess the conditions of demand were also significant and relevant in the estimated models.

The results show empirical evidence of the crowding-in effect on public investments in infrastructure (Ln_Pub_Infra_Invest) over private investments, a positive sign. This means that a stimulus of 1% in public investments for infrastructure will result in a 0.113% increase in private investments.

As for non-infrastructural public investments (Ln_Non_Pub_Infra_Invest) the sign obtained is also correct (negative), which suggests that the impact of the crowding-out effect dislocates private investments. This means that a stimulus of 1% in non-infrastructural public investments will result in a 0.0741% decrease in private investments.

Table 4. Productivity determinants

Ordinary Least Squares - Dependent Variables: Private Investment (1996-2018)			
Explanatory Variables	**Coefficients**	**Expected signal**	**Obtained signal**
Constant	- 9,3598 (-6,0383) [0,0000]	Negative	Negative
DLnProv_Inv(-1)	0,4876 (3.76613) [0,0009]	Positive	Positive
LY	0,510 (1,8263) [0,0697]	Positive	Positive
LnUCAP	2.866 (9,7258) [0,0000]	Positive	Positive
Ln_Pub_Infra_Invest	0,113 (7,3445) [0,0000]	Positive	Positive
Ln_Non_Pub_Inv_I	-0,0741 (-8,0360) [0,0000]	Negative	Negative
Innovation_Productivity	0,107 (7,3575) [0,00000]	Positive	Positive
R	(7,3445) [0,0000] [0,0527]	Positive/ Negative	Positive
Ln_Real_Prices_K	-1,3593 (-9,8211) 0,0000	Negative	Negative
LnIGP-DI	-0,0474	Negative	Negative

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Ordinary Least Squares - Dependent Variables: Private Investment (1996-2018)

Explanatory Variables	Coefficients	Expected signal	Obtained signal
	(0,0522) [0,0000]		
Ln_BNDES_Dis	0,1705 (9,791057) [0,0000]	Positive	Positive
LnT	- 1.1800 (0,008) [0,0000]	Negative	Negative
LnE	-0.09251 (-2.19204) [0.03720]	Negative	Negative
Dummy 1	-6,45 (-3,0061) [0,9951]	Negative	Negative
R^2	0.956458		
Adjusted R^2	0,953631		
DW	2.59		
Log Likelihood	338.5426		
Statistic F	338.2824		
Prob(F)	0,0000		

Source: Elaborated by the authors

Note: t statistics are between parentheses and p-values are between brackets.

However, the theory suggests that after the initial perverse effect of the competition for resources between private and non-infrastructural public investments, it is reasonable to suppose that these investments can also contribute (even if just a little, when compared to the infrastructural investments) to increase the productivity of private capital to be invested in the future (public investments in education, innovation, productivity and each other).

In the case of the real interest rates variable (r) we observed that the coefficient is positive and non-significant in the estimated equation. Although the estimated coefficient signal goes against what was theoretically expected, the coefficient is numerically very close to zero (and non-significant), which indicates that this proxy for capital use costs did not contribute to innovation and productivity. This evidence was also found by Luporini and Laves (2010), who also estimated equations using macro-economic data for the 1972-1996 and 1970-2005 timeframes, respectively.

Although capital cost is theoretically important for the determination of innovation and productivity, the difficulty to obtain significant coefficients with negative signs for this variable is widely spread in specialized literature. In the Brazilian case, especially, cost capital coefficients so close to zero can be explained, on one hand, by the organizational tradition of not seeking external financing for the company, and on the other hand, by the volatility of the interest rates during periods with high inflation, which made interest rates a negligible reference for calculating the opportunity costs of investments.

Literature also indicates that if interest rates rise and if competition for limited resources increases this will result in the dominance of the crowding-out effect over the crowding-in effect. This can be partially explained by the progressive deterioration of the Brazilian's government capacity to invest in infrastructure, because it is the type of public spending that presents the most evident complementarities with private inversions.

Results indicate that an increase in the offer of credit (Ln_BNDES_Dis), by means of elevating credit operations aimed at the private sector, will increase private investment in the subsequent years, which confirms the hypothesis that Brazilian organizations face credit restrictions. The results obtained are consistent with the studies performed by Sundararajan and Takur (1980), Blejer and Khan (1984), Garcia (1987), Left and Sato (1988), Studart (1992), Jacinto and Ribeiro (1998), and Ribeiro and Teixeira (2001), which include financial variables in their empirical studies and indicate that credit availability is one of the relevant variables for private investments in developing countries.

The uncertainties caused by international crisis (assessed by the Dummy 1 "International Crisis" variable) were also relevant in the determination of investments in Brazil, and the negative coefficient obtained indicates that in times of international economic crisis private investments decrease. Thus, the implementation of responsible and consistent policies over the course of time is crucial to minimize economic uncertainties and to encourage private investments in the country.

We tried to investigate the impact of external conditions on private investments in Brazil, using the External restriction variable (EE), having as a proxy the series Debts of Service/GDP (%). As for external conditions, we suggest that external debts of service did not affect private investments in a significant way during the analyzed timeframe. In fact, the effect of this variable was insignificant in the model and thus, was not included in the final model. One possible explanation for this result is the participation of the public sector in obtaining resources during periods of external crisis, acting as a guarantor for loans contracted by the private sector, and financing investments during periods of external restrictions, and even encouraging the improvement of conditions for external financing.

Finally, the estimated coefficient for exchange rates (LnE) was significant and presented a negative sign,

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indicating that increased (or devalued) exchange rates do not encourage imports of capital goods, and consequently reduces economic investments. This result is confirmed by Ribeiro and Teixeira (2001), who obtained results indicating that the first difference of exchange rates has a significant and negative effect over private investments in Brazil.

IV. CONCLUSION

This article analyzed the major determinants of private investments in Brazil for the period of 1996 to 2018, using data obtained from the Novo Sistema de Contas Nacionais do IBGE (New System of National Accounts of the IBGE), which were recently published by the IPEA. We proposed the elaboration of a model of econometric simulation, focused on private investments connected to the real possibilities of economic growth for the coming years.

The empirical evidence obtained in the models tested confirm the predominance of quantitative variables, such as product and capacity of use, which indicates that increases in income and in economic activity encouraged innovation and productivity in Brazil over the course of the studied period. The accelerating effect observed is complemented by the existance of lags in the decision making processes and in the implementation of private investments, which suggests the hypothesis of irreversibility of invetsment.

The estimation shows evidence that if interest rates are increased and/or if the competion for real limited resources increases, this will cause the dominance of the crowding-out effect over the crowding-in effect.

The cost of capital utilization, measured by the real interest rates, was not significant, which indicates that the real interest rates do not contribute to reduce private investments, which is a result consistent with the elevated volume of auto-financing by Brazilian organizations. On the other hand, in a wider perspective, the volume of credit for the private sector demonstrated its importance by positively affecting private investment. In this aspect, expanding long term financing lines, adequate for the creation of fixed capital by the organizations, would be extremely important to increase the rate of economic investments.

Besides credit, external factors and exchange devaluations caused, in general, adverse effects on the gross formation of fixed capital in the private sector and on the Brazilian economy during the timeframe analyzed. These reults indicate the existence of credit restrictions for Brazilian organizations and also indicate the importance of macro-economic stability and the execution of public policies as an encouraging factor for productivity.

The analysis conducted identified very few articles conducive to econometric studies analyzing sector performance, especially on the productivity and in the insertion of products or services. As a result of these analysis, it is essential that data surveys be conducted to simulate the impacts of macro-economic variables on the productivity, by regions and by sectors in Brazil, adopting the Monte Carlo simulation models, in an attempt to obtain long term estimates. And finally, we hope that this article encourages new studies, with strategic biases and long term vision of innovation, in order to propose innovation strategies.

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Participatory Budgeting: Reflections on Your Role in Social Management

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Abstract—*Over the years there has been a growing interest in the study of Social Management in the field of public administration, especially in the scope of Participatory Budgeting. Given this scenario, this article aims to describe the importance of Participatory Budgeting in Social Management based on experiences consolidated in Brazil. The technical procedures were delineated by the bibliographical research with a qualitative approach, based on a review of literature taking into account the main concepts on the subject. The results found point to the indispensability of the Participatory Budgeting in the context of Social Management and proposes a theoretical background that will allow future discussions on the theme. This work presents itself as a collaboration for reflection and discussion on aspects considered essential for the understanding of Social Management within the scope of public administration.*

Keywords—Participatory Budgeting, Social Management, Public Management.

I. INTRODUCTION

The current context of changes in the economic, political and social segments, coupled with the technological transformations and the speed of the mass media, started to demand from the public administration a better performance in relation to the management of its resources. Public policies, government programs, actions, or any activities undertaken by the state need to be well formulated, monitored and evaluated so that they can achieve the expected results and objectives.

The Participatory Budgeting began in 1989 in Porto Alegre, state of Rio Grande do Sul, Brazil, with the aim of transferring power to the organized working class that would participate in the city's management and not only the elections that occur every four years. In the 2000s, the Participatory Budgeting was present in more than 100 Brazilian municipalities and some international experiences, such as in Uruguay (Montevideo), Argentina (Córdoba), France (Saint-Demi) and Peru [13].

In this line, the objective of this work is to describe the importance of Participatory Budgeting in Social Management based on consolidated experiences in Brazil. The problem revolves around the indispensability or not of the Participatory Budgeting when it comes to Social Management.

Observing the literature on the researched subject, it is verified that Peres and Mattos [31] analyzed the process of the Participatory Planning and Budgeting Cycle (PPBC) in the city of São Paulo. Silva and Amorim [36] studied Participatory Budgeting in order to understand possible complementarities and / or conflicts resulting from the tools: Plurianual Plan (PPA),Budgetary Guidelines Law (BGL) and Annual Loan Law.

Other works observed the Participatory Budgeting from local realities: Anjos, Vieira and Abrantes [2], taking into account the municipalities of Porto Alegre (RS) and Belo Horizonte (MG), Marin and Guerrini [22] with focus on the municipality of São Paulo (SP), Abreu and Pinho [3] analyzing the Digital Participatory Budgeting (DPO) of Belo Horizonte (MG). Souza and Silva [40] discussed the democratic quality of the Participatory Budgeting based on an empirical study of the administrative region of Ceilândia (DF).

Oliveira [28] analyzed policies among transnational connections, networks and the dissemination of the Participatory Budgeting. Novaes and Santos [27] discussed the possibilities of the Participatory Budgeting (PB) to expand the democratization of public management and to effectively interfere in the allocation of municipal resources. Frezatti, Beck and Silva [15] analyzed the subject budgeting reserve from the point of

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view of rhetoric, in an approach of interpretative approach.

In the international literature the Social Management has already been studied as a practice of concertation of the problems arising from the implementation of a governmental program [26]. Within the Brazilian context, Theodosius [42] analyzed the collaborative interactions that are established between the actors of the State, civil society organizations and Social Management. Drumond, Silveira and Silva [9] verified a hybridism of elements characteristic of public administration models: bureaucratic, managerial and societal, with predominance of the latter in Brazilian public policies.

Part of the existing literature studied Social Management linked to innovation, as in the case of Silva and Pacheco [35] who sought to highlight the convergences and divergences between theories of Social Management and social innovation. Silva et al. [34] studied the presence of attributes of Social Management as deliberative democracy, intersubjectivity and dialogicity. Garcia [16] identified several gaps and limitations in the understanding on the public sphere by studies in the field of Social Management.

The present research is justified by the lack of literature in the literature on the interaction between Participatory Budgeting and Social Management. The Participatory Budgeting, as an indispensable instrument of Social Management, has not received the deserved attention from the academic community.

This article is divided into four sections. The first section is introductory. The second section presents a brief review of the literature on Budgeting and Social Management. In the third section the methodology used in the work is presented. The fourth section presents the final considerations, where the limitations of the study are recognized, as well as the opportunities for the development of future research related to the topic.

II. REVIEW OF LITERATURE

Participatory Budgeting

Initially, it becomes necessary to conceptualize public budget, before speaking about Participatory Budgeting. This study sought in the literature concepts ranging from 1991 to 2010, as a way to enable a greater understanding of the theme, as shown in Table 1.

Table. 1: Budgeting Concepts (Authors, 2019).

Concepts
"It is an instrument of control of the Legislative Power over the Executive Power, in the constitutional form" [18].
"(...)the budget is a formal law, which only provides for public revenues and authorizes expenditures, without creating subjective rights and without modifying tax and financial laws (...)"[43].
"The purpose of the budget is to present a financing plan and to provide detailed information about it, thus presenting itself as a planning tool" [23].
"The budget is a formal authorization and an instrument of planning, and it is up to the ruler, in the face of unforeseen or exceptional situations ..." [30].
"The budget will establish who will be responsible for paying the expenses, how much the government will collect from society, as well as determine what will be done and who will be the beneficiaries of these investments"[24].
"The public budget is characterized by having a multiplicity of political, legal, accounting, economic, financial, administrative aspects. Its concept has undergone significant changes over time [...]"[17].
"The public budget is a document that gives authorization to receive and to spend financial resources," and "be linked to planning activities" [19].
"The budget stands out as a law directed to the Public Administration, imposing on it duties, whose nonobservance can generate the sanctions of political intervention and configuration of crime of responsibility" [20].

The origin of the public budget goes back to the days of old, when the king or emperor was the state itself. There was no distinction between the private and the public, with the growth of the state it became necessary to organize their revenues and expenses better, and thus the public budget. Its importance for the balance of antagonistic interests around power only increased with its improvement [32].

The public budget is an extremely important instrument of action for the study of decision-making in public policies, it is perceived that the budget is a structuring instrument of governmental action, since this instrument is a filter for analyzing the feasibility of executing the public policies [1].

Due to the financial crisis, in the 1980s, there was great international pressure on Brazil's budgeting process. Governments would begin to seek a leaner, more effective and efficient management model, a state reform as close as possible to the managerial model. The inclusion of the budget in the national charter was the result of this pressure, which was due to an improvement in the implementation of public resources [38].

Cavalcante [7] states that the budget is a process of choosing between several demands and that even in the best times, public resources are not enough to meet all the demands. It is then up to the Executive Power to define priorities, expressly or indirectly. Preparing a budget is an extremely complex, tense and controversial task, since countless actors and interests are involved.

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In turn, the Participatory Budgeting created in 1989 was a first experience of social participation in local governments implemented in Brazil, a policy that has gained prominence in the international scenario, nowadays the Participatory Budgeting is present in more than 2,500 cities in the world. The UN in 1996 considered the Participatory Budgeting of Porto Alegre as one of the 40 best urban management experiences in the world, an experience that was later also recognized by the World Bank [28].

The example of Porto Alegre was a model of public administration that broke with the authoritarian and patrimonial tradition, the direct participation of the population from the preparation to the budgetary implementation was one of the strategies used to consolidate this policy. A common feature of the Participatory Budgeting processes in Porto Alegre and the others, including the successful experience of Belo Horizonte, is the existence of regional assemblies, a practice common to the community movements and popular mobilizations of the 1970s and 1980s that sought to expand participation [27].

It is difficult to find in the literature a unique definition of Participatory Budgeting, due to the innumerable experiences and different contexts of its existence. Although it is possible to raise some fundamental characteristics in its process: participatory arrangement, decision-making system, democratic form, a political institution, participatory mechanism, governmental process involving participatory democracy, deconcentration of the decision-making power of the State, executive power for the citizen, the intervention of the citizen in the budgeting allocation and the priorities of the governmental action [40].

Social Management

Since there is no consensus regarding the conceptualization of Social Management, this section of the paper sought to structure a theoretical framework as a form of support and grounding on the theme researched before history.

Several researchers are striving to define the concept of Social Management, as well as research on experiences and theoretical studies on the field itself [25]. The field of interest of Social Management has developed in the Brazilian context since the period of the country's redemocratization, and has been put into practice as an alternative model of public management by social movements, left-wing parties and nongovernmental organizations [29].

Social management can be conceptualized, at its heart, from collective decision-making, without the use of coercion, based on dialogue and enlightened understanding as process, transparency of acts as a presupposition and emancipation as the ultimate goal [5].

Fig.1: Elements of Social Management, 2012 [4].

In Figure 1 the main constituent elements of Social Management are evident, whether in the public or private sphere, such elements as democratic values, participation, justice, equity, social welfare and dialogue are essential.

Esse movimento de Gestão Social buscou a ampliação da participação cidadã, a discussão de problemas coletivos de cunho social e garantia de direitos, tendo seu ápice nos anos 80. Nessa década apareceram as primeiras experiências que buscavam romper com a centralização e a postura autoritária entre Estado e sociedade [29].

From the 90's began the discussion about Social Management in the academic environment, when researchers perceived in Social Management a possibility of innovation in the fields of research and teaching of Administration [4]. Institutions such as FGV, UFRGS, UFBA, USP and PUC-SP are some of the pioneers to explore this theme [5].

Social Management presents itself as a space for action by civil society, and the way of management is practiced by organizations that do not belong to the market or to the State. Such organizations do not have economic objectives, configuring themselves only as a means to reach the main goal, which can be linked to culture, politics, ecology, or according to the nature of each organization's performance. The term Social Management came to be widely used to denominate social practices originating not only from the governmental sphere, but from non-governmental organizations and even from companies that started to have concern regarding their social responsibility[12].

Table.2: shows the evolution of the concept of Social Management over time:

Table. 2: Concepts of Social Management (Authors, 2019).

Concepts
"Social management refers to the actions" that intervene in the different areas of social life to meet the

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needs of the population, ranging from the issue of "abandoning children" to the issue of the labor crisis"[39].
"The transformation of society, where economic activity becomes the means and social welfare the end of development" [8].
"Social management is, in fact, the management of the demands and needs of citizens. Social policy, social programs, projects are channels and responses to these needs and demands "[6].
"A process of mediation that articulates multiple levels of individual and local power" [10].
"A set of social processes with the potential to enable emancipatory and transformative societal development" [21].
"Social management refers to what is elaborated in a public space, be it state or corporate, or even, at the confluence between them, represented in the articulation between State and society" [12].
"As the dialogical management process in which decision-making authority is shared between the participants of the action [...]" [41].
"Social management can be defined as that oriented to social (as purpose) and social (as process), guided by principles of ethics and solidarity" [11].
"[...] it is a field of knowledge in construction in an even preliminary stage in which the multidisciplinary character prevails, tending to interdisciplinarity" [4].
"Social management, [...] refers to a process in which individuals themselves become social subjects, expressing in their acts of language their demands and desires, and bringing the State closer to the true sense of the "social" that walks together with public management "[14].

III. METHODOLOGY

The research adopted a qualitative approach, being the data obtained through bibliographic research in the platforms 'spell' and 'academic google', using as keywords the following terms: "Participatory Budgeting"; and "Social Management". As a temporal criterion, we worked with the period of the last 10 years (the filter from October/2008 to October/2018).

As for qualitative research, the bibliographic review is not limited only to the initial stage, but plays a role of extreme importance throughout the research. The need to search for literature was also detected in books, dissertations and theses to broaden the basis of the research.

According to Severino [33], the bibliographic research are studies conducted through available and properly published records of previous research, which address the proposed theme. In addition, it provides a better understanding of the phenomena and contributes to new readings, being possible through the theoretical basis chosen

From the methodological point of view, we sought to study and understand the main parameters and form of application employed in the studies found. Thus the present work is inserted in the perspective of contributing to the development of the thematic under analysis.

IV. CONCLUSION

The evidences identified in this study point to the need to implement the Participatory Budgeting in the context of Social Management. From this, public management can be more effective in combating the problems and dilemmas faced by public administration.

It is worth emphasizing, within the time frame of this research, the importance of understanding the issue of Participatory Budgeting in a society that is increasingly complex and full of latent social problems, where it is still possible to find public managers with a high degree of centralization of decisions and with projects that are not subject to any type of evaluation, thus losing its effectiveness.

Therefore, the Participatory Budgeting becomes an indispensable instrument for Social Management, and some adjustments are still needed by the public administration for an efficient use, due to its complexity.

Finally, this work brings a reflection on aspects considered essential for the understanding of Social Management as a model of public administration and proposes as future works, studies that can further enrich the subject addressed, as well as investigate the existence of applied Social Management cases in Brazil.

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An Evaluation of Beach Management through Bibliometric Techniques

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Abstract*—Several bibliometric tools are being used to complement the literature review with application in the field of research, allowing to relate authors, works, research institutions, countries, among other topics. However, there was a lack of publications on beach management, governance, beach indicators and sustainability indicators. The aim of this work, within a descriptive and bibliographic approach, is to present through a bibliometric study using the VOSviewer tool, in Scopus Database, which authors are working on these topics, the most relevant journals, which universities are studying this subject and which countries have published the most in relation to the proposed theme. Despite the limitations related to bibliographic methods, the VOSviewer tool allowed us to present the evolution over time of which authors are publishing together with different disciplinarities, the most relevant publications, the degree of relationship between authors and between topics and journals.*

***Keywords*— beach management; governance; sustainability; indicators; VOSviewer.**

I. INTRODUCTION

Bibliometry, over the past decades, is presented as a measure of academic performance in the construction of maps made from bibliographical data, having application in the field of research, with these different types of maps, showing the relationship between authors, documents, journals and keywords. (Van Eck et al. [11])

In this way, bibliometrics, through algorithms, searches for existing relationships by identifying the similarities between authors, documents, and keywords, using techniques such as citation, co-citation, biliographic coupling, coauthor and co-word, among the main ones.

Therefore, bibliometric methods allow to relate works, authors, institutions, countries, keywords, according to some metrics. They map these units of analysis according to the intensity of the proposed metric and project their results from this information.

There are few works on bibliometrics that have been done about beach management. Botero and Hurtado [1] carried out a bibliometrics analysis based on Science Direct and SciELO databases using the keyword "Beach Management" and the keywords "Beach" and "Classification" together, considering a time window from the year 2000. They have resulted in 21 occurrences, being 14 and 7 respectively the results of evidence related to the searches with the mentioned keywords. Of these 21 works, 19% cover geomorphology, 19% marine biology and 19 tourist beaches. They noted that few authors wrote about beach types and some of them mixed the classification.

In another bibliometric research, Botero et al. [2] evaluated environmental quality in tourist beaches, in a time window from 1997 to 2011, which resulted in 40 documents. Therefore, there was a lack of publications on beach management, governance, beach indicators and sustainability indicators.

The motivation and justification found for this work comes from the search for knowledge inherent to the theme of coastal management, through bibliometrics, specifically in matters related to beach management, governance, beach indicators and sustainability indicators, given the shortage of publications involving all these topics within the same context.

Thus, the objective of this work is to identify, through a bibliometric tool, which authors most influenced the research of the beach ecosystem considering the point of view of its management, its governance, its sustainability and its indicators.

In addition, this study, within a qualitative approach and a descriptive and bibliographical research, has the specific objectives of presenting which journals and disciplines have the most impact in this research area, who are the specialists in this area, what can be known about this area, the most influential works in the Scopus database, in which countries this theme is researched and which organizations are involved, which are the most influential authors and their degree of relationship with

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beach management, which authors are quoted together and what are their works and their latest research in this proposed theme.

The work is divided into four parts. The first, this introduction. The second part specifically addresses the methodology and the theoretical basis used. The third part presents the results and the discussion invoking a practical application of the VOSviewer tool in a bibliometric survey with the beach management subject. And finally, the conclusion of the research is presented showing the specific objectives met, the limitations of the use of this tool, besides the suggestion for future studies.

II. BIBLIOGRAPHIC REVIEW

Given the wide availability of articles in several databases and through the significant growth of academic content and search engines, the challenge for researchers shifts from the scarcity of information to the selection of the most pertinent and adequate articles in the construction of the argumentation of this work (ANDRADE & FARIAS FILHO [4])

In this context, bibliometry presents itself as a field of knowledge called scientometrics, according to evidences found in Boyack et al. [5] "mapping the backbone of Science".

Nonetheless, Scientometrics is a technology based on quotation, justified by the fact that when an author quotes another author the research provides information about the relationships between these authors, their ideas, the journals and the institutions involved in their research. Scientometrics grew in use after its application in the creation of the Science Citation Index (SCI), performed by Eugene Garfield in 1950, which helped not only the editors and databases in the evaluation of their research, but also the researchers in the search for the best literature sought. (MINGERS & LEYDESDORFF [6])

Yoshida [7] reports that bibliometrics is usually related to the counting of publications or quotations found in scientific and academic publications, and does not necessarily elaborate a content analysis, although it can apply the tracking of all the content of the publications. In this case, the algorithm that supports the bibliometric method searches for patterns or explanations for unstructured behaviors and makes a wider sweep to quantify the number of occurrences of the terms within the texts and eventually calculates the semantic distance between them.

In the literature there are two approaches presented by researchers of this subject. The approach focused on bibliographic methods, explored by Zupic & Cater [8] and the approach that shows bibliometrics as a process, that is, developed to map the progress of knowledge in a field, explored by Cobo et al. [9].

The method proposed by Zupic & Cater [8] uses bibliometrics to examine how disciplines, fields, subjects and articles are related to one another by means of a spatial representation consisting of geographical maps and analogies found. The goal is to create a representation of the research structure by partitioning the elements (documents, authors, articles, words) into different groups.

Bibliometric methods use a systematic, transparent and reproducible review that uses a quantitative approach to the description, evaluation and monitoring of the published research, avoiding the bias obtained when using qualitative methods supported by a bibliographic review and improving the quality of the bibliographic review. (Zupic & Cater [8])

Wilsdon et al. [10] report that the quality and impact on research have been attributed by peer review and a variety of quantitative indicators. Peer review has been more widely used, but over the last 20 years the use of metrics has emerged as a potential approach.

Zupic & Cater [8] point out that bibliometric methods allow researchers to find their results from aggregated data provided by other researchers using citation, co-citation and primary data, and from this, emit their opinion contemplating, in their analyzes, structured fields, social networks and focal interests.

Yoshida [7] mention that choosing the database is a limitation of the search. In the work of this author he mentions that the content of the Scopus and Web of Science (WoS) bases generate very similar results, with high correlation (R2 approximately 0.99), a fact that is scientifically proven. This fact helps to confirm the choice of using the Scopus database for research in this work.

Zupic and Cater [8] believe that bibliometric methods do not replace but rather complement traditional methods of reviewing structured literature and meta-analysis.

Notwithstanding, Van Eck et al. [11], in the comparison between two techniques of bibliometric mapping, Multidimensional Scaling (MDS) and VOS, concluded, from three experimental datasets involving co-citations and co-occurrence of keywords, that, in general, maps constructed using the VOS technique provide a better representation of the data than those constructed with MDS. However, it is not the scope of this paper to present the theoretical mathematical discussion about these techniques referenced by these authors.

Based on this, it was sought, in this research, to use the technique of VOS and it was verified that this technique can be implemented through the tool VOSviewer available free in the VOSviewer site [12] in Internet, by Van Eck & Waltman, their authors. At the time of this research, this tool was in version 1.6.4, version available

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on April 7, 2016, at www.vosviewer.com. This version includes citation search, co-occurrence of words, support for Web of Science, Scopus and PubMed database files, as well as support for RIS files available in the Mendeley, BibSonomy, Zotero and Perish databases.

According to information available on the product website, the software also allows automatic adjustment and approximation of the values of the parameters presented on the screen, besides having a friendlier interface than previous versions. It is feasible to import and export Pajek and GML files, besides allowing the use of clustering techniques and network layout techniques. (VOSviewer [12])

VOSviewer has the ability in create keyword co-occurrence maps based on a set of documents. This map determines the distance between words, which indicates the level of relationship between them. The smaller the distance between two terms, the greater the relation between them (Van Eck &Waltman 2014).

2.1 Methodology

The methodology has a quantitative approach and shows how a bibliometric analysis, carried out through an appropriate tool, could contribute to the literature review focusing on a scientific research in the field of beach management.

The work was carried out with data collection in the Scopus database, in peer reviewed journals, addressing the topics beach management, governance, sustainability and indicators. The research was done with temporal limitation for the last 5 years, which pointed out 104 documents as a result.

The choice of the Scopus database is justified by the fact that it covers a referential source of peer-reviewed journals, using more than 46 million records, with approximately 22,000 content titles from more than 5,000 publishers, on fields involving areas of science, technology, social sciences, among others (SCOPUS, [3]).

Regarding the method, this research is divided into two parts. The first is performed on the Scopus website and the second on the user's machine. On the Scopus website, a tree was created composed of the four keywords of the research (beaches management, governance, beach indicators and sustainability indicators) linked by "AND" type Boolean connectors. As a result, only 3 documents were returned, all linked to surfing. In this way, the opposite situation with all the Boolean connectors set to type "OR" was used, considering the absence of temporal limitation, which returned as a result 104 documents.

Therefore, it was chosen on the last research to use open connectors, making only one adjustment of peer-reviewed literature. In this way, after adjustment of the time window for the last 5 years from 2012 until the date of July 20, 2016 and the withdrawal of repeated documents, a file with 48 documents was generated by the Scopus database. It was exported as a csv file to a directory created on the researcher's own machine.

In the second part, the software VOSviewer version 1.6.4.0 was installed on a computer with the following configuration: Intel i7 processor, 8GB memory, 500 GB hard disk, running under Windows 8.1 operating system. After installing VOSviewer, the software was initialized and pointed to the file previously imported with the csv extension, indicating the type of analysis desired for the search.

III. RESULTS AND DISCUSSION

Following the systematics suggested by Zupic and Cater [8], from the research question a keyword tree was created that meets the research criteria. To do this, the following key was inserted in the subject field in the Scopus database: beaches management OR beaches governance OR sustainability indicators. This resulted in 104 documents contained in a time window from 2012 until July 20, 2016.

Then the VOSviewer tool was installed, generating a map based on bibliographic data that can be visualized in fig. 1. To do this, the file with csv extension generated and exported by the Scopus database was selected. This file was previously extracted in the query with 104 documents returned and defined by the previously established keywords in the time window corresponding to the last 5 years.

In selecting the parameters to work with the VOSviewer tool, one must first choose the bibliometric method that will be used, according to the research question that is to be answered, as reported above. Applying the methodology with the tool VOSviewer, for the type of co-citation analysis, the "references cited" analysis unit and the "total count" method were chosen in the software. In the next screen of the VOSviewer has to choose the tendency (reduction of network) by means of the minimum number of citations that meet this reference. By clicking on "Finish", the network visualization in the form of mapping can already be seen and still allows customization. The software allows to know the visualization by density showing the hot areas, and their references, with some of them containing the DOI of the document that allows its opening.

Fig. 1 and Fig.2 show the mapping created in density and network view, respectively. It shows the strength of the clusters through the density of the network, where the greatest connection strength represents a concentration in a measure of heat. The strongest evidence of the terms with the highest number of citations and the highest

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density of relations are represented by the colors that gradually intensify to the red color and group together. As a solution for questioning the most cited authors, the citation mapping was performed, evidencing the following authors: Ariza, Botero, Lucrezi, Cervantes, Botero, Martin and Sardá. Therefore, these are the authors who most influenced this research supported by the keyword tree created and are divided into two clusters.

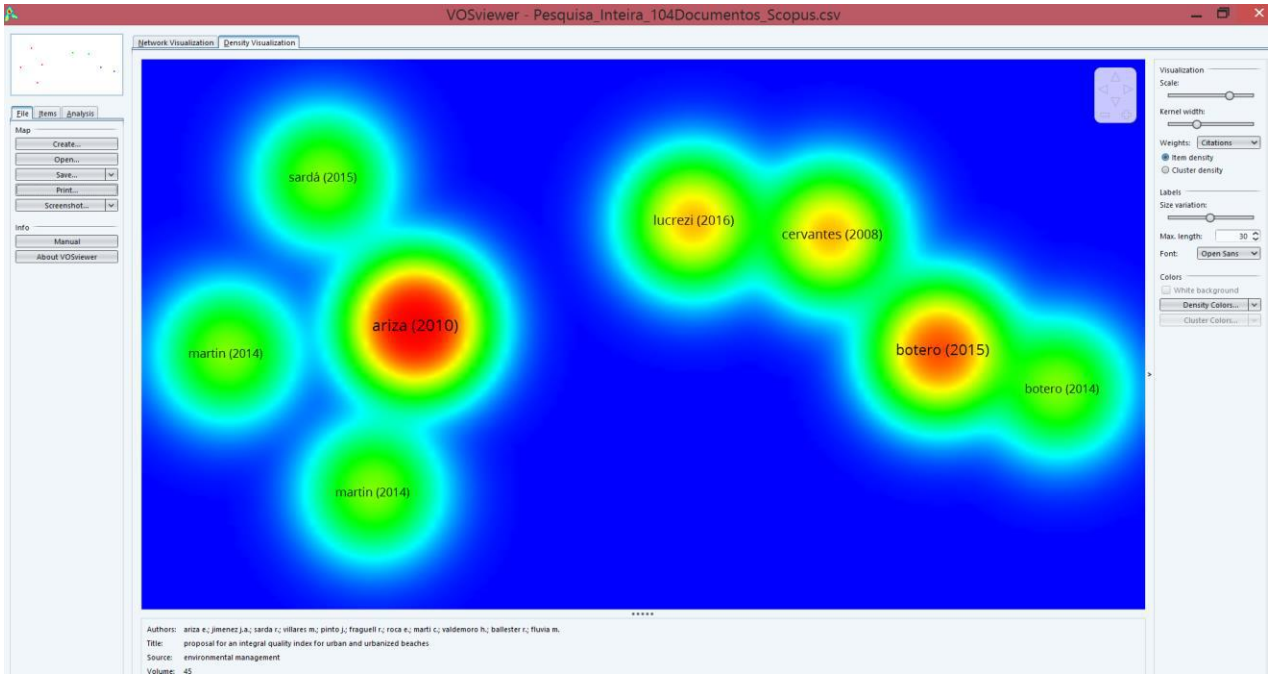

Fig. 1: Density Visualization (Source: Authors based in VOSviewer version 1.6.4)

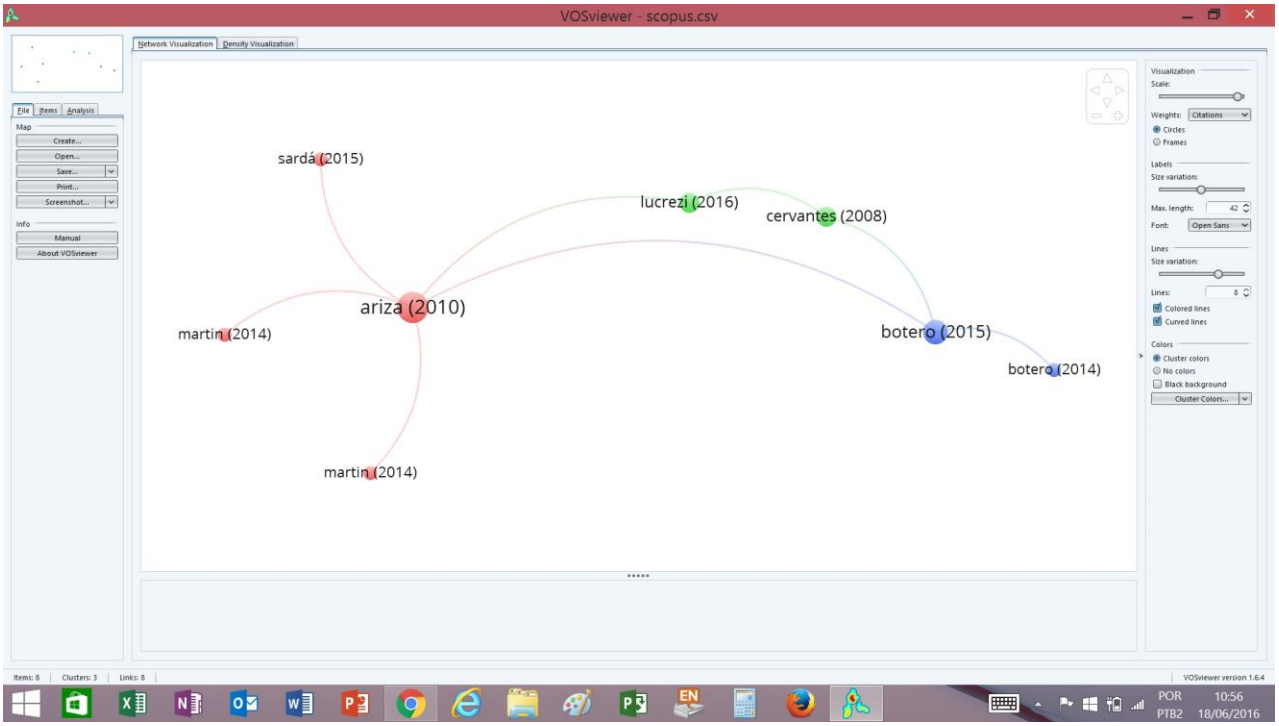

Fig. 2: Network Visualization (Source: Authors based in VOSviewer version 1.6.4)

In the same way, the software allows an adjustment for the type of analysis "source" and, adjusting the minimum of documents in the source in "3", presented the following results: Journal of Coastal Research (4); Environmental Monitoring and Assessment (4) and Estuarine, Coastal and Shelf Science (4), Ecological Indicators (3) and Natural Hazards (3).

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In the density visualization mode (fig.2), we can see the relationship between authors. Relevant conclusions from the observation of this mapping are:

a) the author Ariza and the author Botero present a higher density in the visualization and these authors are related through the authors Lucrezi and Cervantes.

b) the author Ariza stands out in the field of indicators for beach management, Botero in the field of Environmental Monitoring of Beaches, Cervantes in the Integrated Coastal Assessment and Lucrezi in the evaluation of sustainability indicators in beaches.

c) as an essential reading recommendation for the beach management is suggested the work "Proposal for an Integral Quality Index for Urban and Urbanized Beaches", by Eduard Ariza et al. (2010), available in the journal Environmental Management, v.45, n.5, p.998-1013. This indication is given by the number assigned to the force of the largest link that originates from the author Ariza.

Also in relation to the citation mapping, in choosing the type of analysis and counting method in VOSviewer, it is possible to select the type of analysis "citation", the analysis unit "organizations" and, selecting the minimum number of documents published by a organization as "2", the results presented were as follows: East China Sea Center of Environment Monitoring in Shanghai, China; Key Laboratory of Marine Integrated Monitoring and Applied Technologies of Harmful Algal Blooms in Shanghai, China and Prince of Songkla University in Phuket, Thailand.

Likewise, in citation mapping it is possible to select the type of analysis "citation" with the unit of analysis "countries" and, by adjusting the minimum number of documents published by country as "5", the following result was obtained: United States (13); Brazil (10); Spain (8); China (7); Italy (7); Portugal (7); United Kingdom (5); France (5); India (5) and Mexico (5).

In the mapping strategy based on co-authorship, after configuring VOSviewer to group clusters for authors with at least three shared documents, it was observed that of the 389 authors, only 2 authors have at least 3 co-authorship works: Martin and Assenov.

The co-authorship mapping, considering the same keyword tree, showed another cluster with the author Erzini, however this cluster pointed out that this author has 3 works, but all without co-authorship.

In the view by Bibliographic Coupling, VOSviewer identified, from the total of documents surveyed, that less than half were related to this technique. The main authors that used this technique were: Martin, Botero, Lucrezi, Sardá, Alexandrakis, Di Paola, González and Cardoso.

In relation to the networks of relationship using the technique of Bibliographic Coupling, it is verified:

a) a strong relationship between Cervantes and Lucrezi (strength grade 9), Gonzalez and Lucrezi (strength grade 8), Ariza e Lucrezi (strength grade 7), Cardoso e Lucrezi (strength grade 7), Botero and Lucrezi (degree of strength strength 6), Cardozo and Reyes-Martinez (strength level 5).

b) a medium relationship between Sardá and Ariza (degree of force 3), Sardá and Lucrezi (strength level 3), Ariza and Gonzalez (strength level 2) and Alexandrakis and Lucrezi (strength level 2).

c) a weak relationship for the other authors with degree of strength 1, being considered irrelevant.

Regarding the mapping using the co-citation technique, it was verified that of the 4438 references, considering a minimum of three citations for a given reference, Martin and Assenov were the authors that stood out the most.

In addition, it was noticed that all the network relationships between the authors are with a force factor 3, with no relation that stands out. In the mapping of visualization by density it is verified that all authors have the same density and no researchers are perceived as central or peripheral.

In the analysis of co-occurrence by words, the software used as a analysis unit all the keywords. Of the 1521 keywords analyzed, VOSviewer considered "5" the minimum number of occurrences for a given keyword, allowing the presentation of 48 keywords.

Regarding the strength of the relationship between the co-occurrences, it was verified that between the keywords "beaches" and "coastal zone" there is a force factor 10, between beaches and water pollution, the force factor is 5, between "beaches" and "environmental monitoring" is 5, between "bathing beaches" and "water quality" is 6, between "sediment" and "water pollution" is 5 and between "environmental monitoring" and "nonhuman" is 6 and between "nonhuman" and "water quality" is 7.

In the visualization of density co-occurrence mapping, we verified the following highlights with more than 100 occurrences: article (184), nonhuman (136), water pollution (134), beaches (131), water quality (116) and environmental monitoring (114).

In relation to the word-based mapping, the type of co-occurrence analysis and the "all words" analysis unit were configured in the VOSviewer. Then the minimum number of occurrences of a word was set to "6", which automatically converged the software to 32 words out of a total of 1521 keywords.

In the network visualization we verified some relations between keywords and their respective factors of strength: beaches and coastal zones (10); bathing beaches and environmental monitoring (6); environmental monitoring and water quality (8); beaches and

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vulnerability (4); coastal zones and erosion (3); beaches and erosion (3); seashore and sediment (5); water quality and bioindicator (4); water pollution and water quality (7); bathing beaches and nonhuman (6); nonhuman and water pollution (9); humans and nonhumans (4); sediment and water pollution (5); water analysand and nonhuman (6); beaches and environmental impact (4) and environmental impact and coastal zones (3).

In the mapping based on words, with density visualization, we observed hot areas in the following words with their occurrences: beaches (24), beach (12), seashore (10), article (23), nonhuman (13), (15), water quality (14), bathing beaches (8), sediment (7), seawater (9) and humans (6).

In relation to the first question about which authors most influence the research from the point of view of its management, its governance, its sustainability and its pertinent indicators, it is verified, after the analysis of the hot areas of fig. 1, that in the mapping based on citation, VOSviewer, analyzing its database containing a universe of 389 authors, the following authors are the ones that most influenced the research in the proposed theme: Ariza, Botero, Lucrezi and Cervantes. In addition, the author Ariza and the author Botero presented a higher density in the visualization in relation to the mapping by citation. Regarding co-authorship, of the 389 authors, it was verified that only 2 authors have at least 3 works in co-authorship: Martin and Assenov.

In relation to the publications that have more impact for this research, it is verified that the periodicals Estuarine, Coastal and Shelf Science and Journal of Coastal Research are more relevant containing 4 published documents and 1 citation each.

In relation to the most influential subjects in the research, the most cited and co-cited keywords in descending order of frequency were: beaches, article, water pollution, coastal zones, water quality, nonhuman, beach, bioindicator, environmental monitoring, seashore, vulnerability, seawater and bathing beaches.

Regarding the specialists in a research area, one can notice that the most influential works are related to the most cited authors, that is, Ariza, Botero, Lucrezi and Cervantes. From the authors, Ariza et al. present an essential reading recommendation for the management of beaches - Proposal for an Integral Quality Index for Urban and Urbanized Beaches, by authors Ariza et al. (2010), available in the journal Environmental Management, v.45, n.5, p.998-1013.

In relation to the technique of Bibliographic Coupling, we can see that there is a strong relationship between Cervantes and Lucrezi (strength level 9), Gonzalez and Lucrezi (strength level 8), Ariza and Lucrezi (strength level 7), Cardoso and Lucrezi (degree of strength 7), Botero and Lucrezi (strength level 6), Cardozo and Reyes-Martinez (strength level 5).

In relation to the co-citation, it was perceived as more relevant the relation between the authors Martin and Assenov. Another factor that deserves to be highlighted is that all the network relationships between the authors have a force factor 3, with no relationship that stands out. Still in relation to this method it was verified that the authors have the same density and no researcher is perceived as central nor as peripheral.

Regarding the co-occurrence research method, it was verified that the most relevant relationships with their respective degrees of strength are between the keywords "beaches" and "coastal zone" with a force factor of 10, between "nonhuman" and "water quality" with a force factor of 7 and between "bathing beaches" and "water quality" with a force factor of 6.

The relationship between beaches and coastal zone is evident as reported in the introduction and dispenses comments (force factor 10). The relationship between nonhuman factors and water quality reflects water pollution by other impacts not derived from human action and deserves to be investigated. Regarding the relationship between beaches for bathing and water quality, the contribution in relation to beach management is important and becomes evident.

In relation to the co-occurrence research method, the following keywords with more than 100 occurrences are verified in the density mapping: article (184), nonhuman (136), water pollution (134), beaches 131), water quality (116) and environmental monitoring (114). This suggests that the nonhuman scientific field, which is very relevant in this mapping, is investigated in the study of beach management.

In the mapping based on words configured with the type of analysis by co-occurrence, the main relationships between the 32 highlighted words that deserve attention are: beaches and coastal zones, with force factor 10; nonhuman and water pollution, with force factor 9; environmental monitoring and water quality, with force factor 8; water pollution and water quality, with force factor 7. Of these relationships the most surprising would be the relation nonhuman and water pollution, which relates water pollution by nonhuman factors that was already evidenced previously.

In the same type of word-based mapping, in a density analysis, the keywords water pollution, water quality, nonhuman and seashore are the ones that deserve greater prominence, besides the word beaches itself, in the management research of beaches.

Regarding organizations in which the subject of beach management under the governance, sustainability and

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performance indicators, the Universities of China in Shanghai are more involved in this field of research.

Finally, in relation to the geographic sites that are researching this subject, it is verified that the main countries are United States, Brazil and Spain.

IV. CONCLUSION

As mentioned above, due to the large number of publications available in the main databases, the selection of the most pertinent and appropriate articles on the construction of the theoretical research argument becomes the fundamental point.

For this, VOSviewer software, supported by algorithms that meet the citation, co-citation, biliographic coupling, co-author and co-word search methods, becomes a great option as it allows, with relative ease, the handling and extraction of information. The software presented a smooth installation and excellent performance, with no incompatibilities, well documented and available for use by the scientific community at no additional cost.

In relation to the objective of this work, the results of the last years, from 2010 to 2016, presented 138 authors and 26 journals, revealing the authors Ariza, Botero, Lucrezi and Cervantes as the ones that most influenced this research, being the first two with a higher density. From these experts the result pointed out that the work elaborated by Ariza et al. (2010), Proposal for an Integral Quality Index for Urban and Urbanized Beaches, is presented as an essential reading recommendation for the subject of beach management. In addition, the results of the research allowed pointing out the periodicals Estuarine, Coastal and Shelf Science and Journal of Coastal Research as the most relevant journals for the subject of this research.

Regarding the universities and the most active countries, the result showed that the Universities of China in Shanghai are more involved in the subject of this research, while the United States, Brazil and Spain were the countries that published the most to the proposed subject.

Regarding the disciplines that are pertinent to the subject of the research, it has been found that beaches, article, water pollution, coastal zones, water quality, nonhuman, beach, bioindicator, environmental monitoring, seashore, vulnerability, seawater and bathing beaches, are among the more relevant.

Of these disciplines, it was also verified that "beaches" and "coastal zone" have a strong connection with a force factor 10; "Nonhuman" and "water pollution" have a strong bond with a force factor 9; "Nonhuman" and "water quality" have a strong connection with a force factor 7 and "bathing beaches" and "water quality" have a median connection with a force factor 6. Of these relations it is important to emphasize the strong relation between the nonhuman factors and water quality and water pollution that merit future research.

However, in relation to density the most relevant disciplines are nonhuman (136), water pollution (134), beaches (131), water quality (116) and environmental monitoring (114).

Regarding the works produced in co-authorship, it was verified that the authors Martin and Assenov are the most relevant with 3 published works. The result showed that there is a strong relationship between Cervantes and Lucrezi; between Gonzalez and Lucrezi; between Ariza and Lucrezi and between Cardoso and Lucrezi. There is a moderate relationship between the authors Botero and Lucrezi and between Cardozo and Reyes-Martinez.

The results presented, as mentioned previously, should be understood as a complement to traditional methods of literature review and meta-analysis and not as a substitution of these.

This work has some limitations such as the method of bibliometry used (VOS), translated by a wider scan without performing a content analysis in the documents; and the research methods (citation, co-citation, biliographic coupling, coauthor and co-word), reported as weak points in Table 1; and the specific use of the Scopus database, since it does not involve subjects from all fields of science, and no longer provides subsidies for the intrinsic interdisciplinarity of the research theme. As future work, it is suggested that other studies with the same subject and keyword tree be applied in this database and in other databases and with other software for comparison of results.

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Illustrating the autocorrelation effect in T^2 control chart of Hotelling by means of geometric approach

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***Abstract*—** *Using a geometric approach with ellipses, results warn that the autocorrelation presence reduces the* T^2 *chart performance, restricting the chart ability to signal a special cause that is acting in the process. A control chart is one of the main techniques of statistical control of process and using this technique means auto correlation absence among the data of measured quality characteristics. Some examples are presented to illustrate the detrimental effect of* T^2 *chart when autocorrelation is present in the process. This article discusses effect of correlation and autocorrelation in Hotelling* T^2 *chart when there are two quality characteristics X and Y, whose autocorrelation and correlation structure is represented by a VAR(1) model.*

***Keyword*— Autocorrelation; Hotelling T^2 chart; VAR(1) model; statistical process control.**

I. INTRODUCTION

The independence among observations over time is one of the basic assumptions for control charts use. Nevertheless, in some cases, quality characteristic measures of neighboring items, according to the time they were produced, may present some dependence degree among the observations. This phenomenon is called autocorrelation. According to Sullivan[1], many industrial operations of streaming present autocorrelation and one of the possible reasons is the gradual wear of critical components of process. Gani[2]states that independence hypothesis among observations of a variable can be violated by the high production rates that generate correlation and dependence among observations of neighbor products according to the manufacturing instant.

The performance of traditional control charts can be affected by autocorrelation [3].Recent studies present alternatives to monitor these types of processes. Some authors[4] proposed a control chart based on the minimum euclidean distance to detect deviations on the average in auto correlated processes. Others[5] considered the economic design of control chart ARMA, used in auto correlated processes. Franco et al. [6] used the AR(1) model to describe the oscillatory behavior of the average and showed the optimal parameters of $\overline{X}$ chart using the Duncan model .Lee et al.[7] also used the AR(1) model to investigate the effect of oscillatory behavior of the average in the performance of $\overline{X}$ chart with double sampling. In order to reduce the negative effect of autocorrelation on the $\overline{X}$ chart performance, Hu et al.[8] presented a technique of systematic sampling called s-skip.

With advanced technology and high production rates modern systems generated complex processes that are multidimensional, that is, many quality characteristics are measured and controlled. Pan[9] describes some of these processes that may have correlated and auto correlated observations.

The use of T^2 statistics for monitoring the mean vector in multivariate processes is suggested by Hotelling [10]. Seven decades later, Chen [11,12] showed the adaptive schemes that improve the performance of the T^2 chart. According to Hwang et al.[13], autocorrelation increases the false alarms rate, while correlation decreases the control graph power. The combined activity of autocorrelation and correlation in the performance of T^2 chart is worthy of investigation.

The aim of this article is to graphically evaluate the effect of autocorrelation in two characteristics of measurable quality X and Y when there is correlation between observations of X and Y.The VAR(1) model was

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adopted to represent the structure of correlation and autocorrelation.It was considered in evaluating that the shift in the mean is the most important in the whole process and that the mean vector and the covariance matrix are known or estimated accurately.

The article is organized as following way: section 2 describes the model that represents quality characteristics when there is autocorrelation in the process; section 3 presents some characteristics of the Hotelling T^2 chart; the effect of autocorrelation in bivariate processes is discussed and evaluated in section 4 and, finally, it is concluded about the work in section 5.

II. AUTOREGRESSION MODEL AND CROSS-COVARIANCE MATRIX

The classical control procedures in multivariate processes consider the basic assumption that the observations follow a multivariate normal distribution and are independent, with mean vector $\boldsymbol{\mu}_0$ and variance-covariance matrix Σ.

$$\mathbf{X_t} = \boldsymbol{\mu_0} + e_t \qquad t = 1, 2, ..., T \tag{1}$$

where: $\mathbf{X_t}$ represents observations by a vector of order *p x 1* (*p* is the number of variables); e_t are independent random vectors of order *p x 1* with multivariate normal distribution whose mean is zero and variance-covariance matrix Σ_e.

In many manufacturing processes, the independence assumption is violated. Autoregression vectors of first order - VAR(1) are used to model multivariate processes with temporal correlation among observations of the same variable and correlation among observations of different quality characteristics[14-21] The VAR(1) model is represented by:

$$\mathbf{X}_t - \boldsymbol{\mu} = \Phi(\mathbf{X}_{t-1} - \boldsymbol{\mu}) + \boldsymbol{\varepsilon_t} \tag{2}$$

being $\mathbf{X}_t \sim \mathrm{N_p}(\boldsymbol{\mu}, \Gamma)$ the vector of observations of dimension $(p \times 1)$ at instant t (*p*is the number of variables), $\boldsymbol{\mu}$ is the mean vector, $\boldsymbol{\varepsilon_t}$ is a random vector with independent observations and multivariate normal distribution with zero mean and covariance matrix Σ and Φ is a matrix with autocorrelation parameters of order $(p \times p)$.

ForJarrett[3], the $\mathbf{X}_t$ cross-correlation matrix has the following property: $\Gamma = \Phi\Gamma\Phi' + \Sigma$. After some algebraic manipulation, it is possible to obtain the relationship:

$$Vec\ \Gamma = \left(I_{p^2} - \Phi \otimes \Phi\right)^{-1} Vec\ \Sigma \tag{3}$$

where $\otimes$ is the product operator ofKronecker and *Vec*is the operator that transforms a matrix into a vector by stacking its columns.

In order to study the effect of correlation and autocorrelation of T^2 chart, it was considered a bivariate process(*p*=2):

$$\Phi = \begin{bmatrix} a & 0 \\ 0 & b \end{bmatrix}; \Sigma = \begin{bmatrix} 1 & \rho \\ \rho & 1 \end{bmatrix} \tag{4}$$

From (2) and (3), it follows that:

$$\Gamma = \begin{pmatrix} \sigma_X^2 = (1-a^2)^{-1} & \sigma_{XY} = \rho(1-ab)^{-1} \\ \sigma_{XY} = \rho(1-ab)^{-1} & \sigma_Y^2 = (1-b^2)^{-1} \end{pmatrix} \tag{5}$$

III. T^2 CONTROL CHART OF HOTELLING

One of the most known control schemes to detect deviations in the mean of multivariate processes I the T^2 control chart of Hotelling[10]. When the mean vector $\boldsymbol{\mu}_0=(\mu_{01},\mu_{02})$ and the matrix Σ are known, the T^2 monitoring statistics of Hotelling is represented by:

$$T^2 = (\mathbf{X} - \boldsymbol{\mu}_0)' \Sigma^{-1} (\mathbf{X} - \boldsymbol{\mu}_0) \tag{6}$$

With the process in control, $T^2 \sim \chi_p^2$,if occurs a special cause that induces change in the mean vector for $\boldsymbol{\mu}_1=(\mu_{11},\mu_{12})$, $T^2 \sim \chi^2_{(p,\lambda)}$ with non-centrality parameter $\lambda^2 = \boldsymbol{\delta}' \Gamma_{\bar{X}}^{-1} \boldsymbol{\delta}$, being $\boldsymbol{\delta} = (\delta_1 = \mu_{11} - \mu_{01}, \delta_2 = \mu_{12} - \mu_{02})$, see Liu et al.[22]. When the mean vector and the covariance matrix are unknown and must be estimated, the control limits are calculated according to the monitoring phase [23].

Some authors [24, 25, 26,]use the non-centrality parameter (λ^2) as a displacement measure in the process mean vector. In this case, the chart performance is measured by:

$$ARL = \left\{1 - \left[\Pr\left(\chi^2_{(p,\lambda)}\right) < LC\right]\right\}^{-1} \tag{7}$$

where: ARL is the average number of samples up to the signal; CL is the control limit of the T^2 chart. The ARL measures the average number of samples until the occurrence of a false alarm if $\lambda^2 = 0$. When the process is out of control, the chart with the smallest ARL detects faster a process change.

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IV. *AUTOCORRELATION* EFFECT IN BIVARIATE PROCESSES

To be used when the independence hypothesisamong observations of one or more quality characteristics is not violated, the Hotelling T^2 chart was designed. Excluding the effect of this hypothesis is quite detrimental to the control chart performance. To study the autocorrelation effect, it was considered the distance from $\mathbf{X}$ vector to the μ mean vector called Mahalanobisdistance [27]. The Mahalanobis distance is given by:

$$D^2 = \left(\mathbf{X}-\boldsymbol{\mu}_0\right)' \Sigma^{-1} \left(\mathbf{X}-\boldsymbol{\mu}_0\right) \tag{8}$$

Ratio between cross-covariance matrix (Γ) and the elements of matrices Φ and Σ is calculated using equation (3). In presence of autocorrelation and correlation, the Mahalanobis distance is given by:

$$D^2 = \left(\mathbf{X}-\boldsymbol{\mu}_0\right)' \Gamma^{-1} \left(\mathbf{X}-\boldsymbol{\mu}_0\right) \tag{9}$$

Without generality loss, considering bivariate case where $\Phi = \begin{bmatrix} a & 0 \\ 0 & b \end{bmatrix}$ and

$\Sigma = \begin{bmatrix} 1 & \rho \\ \rho & 1 \end{bmatrix}$, when $\boldsymbol{\mu_0} = \left(\mu_{01}=0; \mu_{02}=0\right)$ and the vector $\mathbf{X} = \left(x; y\right)$ the distance D^2 is equivalent to:

$$D^2 = \frac{\left(-a^3bx^2 + 2\rho a^2b^2xy + a^2x^2 - 2\rho a^2xy - ab^3y^2 + abx^2 + aby^2 - 2\rho b^2xy + b^2y^2 - x^2 + 2\rho xy - y^2\right)}{\left(ab-1\right)^{-1}\left(-a^2b^2\rho^2 + a^2b^2 + a^2\rho^2 - 2ab + b^2\rho^2 - \rho^2 + 1\right)} \tag{10}$$

Equation (10) reveals influence of a, b e ρ in distance D^2.

If $a = b = 0$, namely, $\Phi = 0$ (there is no autocorrelation), the distance D^2 is reduces to:

$$D^2 = \left(x^2 - 2\rho xy + y^2\right) \Big/ \left(1-\rho^2\right) \tag{11}$$

When there is no autocorrelation, that is, data are independent $D^2 \sim \chi^2_{(p;\alpha)}$. To evaluate the autocorrelation effect, it was used in this article the bivariate case and α = 0.01 ($\chi^2_{(p=2;\alpha=0.01)}$), where $D^2 = 10.5966$.

When there is no displacement, the process is in statistical control. The performance of a control chart can be assessed in terms of number of samples that the chart uses to detect a shift in the characteristic to be monitored. It is expected in this case the signal given by the chart to be a false alarm. The value $D^2 = 10.5966$ amounts to a false alarm, on average, for each 200 samples evaluated when using the Hotelling T^2chart [28,29].

In sections 4.1 and 4.2, there was the evaluation of effect autocorrelation of process in control ($\boldsymbol{\delta}$ = 0) and process out of control ($\boldsymbol{\delta} \neq 0$), respectively.At the graphical evaluation of autocorrelation effect, it was considered that the displacement istype $\boldsymbol{\delta} = (\delta_1 = \mu_{11} - \mu_{01}, \delta_2 = \mu_{12} - \mu_{02})$, ie, the occurrence of a special cause shifts the mean vector $\boldsymbol{\mu_0} = \left(\mu_{01}=0; \mu_{02}=0\right)$ to a new level $\boldsymbol{\mu_1} = \left(\mu_{01} + \delta_{1\mu}; \mu_{02} + \delta_{2\mu}\right)$.

4.1 Graphical evaluation of autocorrelation effect with process in control

In a process free of autocorrelation, $a = b = 0$ and ρ = 0.7, it follows that $D^2 = 1.9608x^2 - 2.7451xy + 1.9608y^2$. The ellipse representing the distribution contour line for $D^2 =$ 10.5966 is illustrated in Figure 1. Figure 2 illustrates the contour line for $a = b = 0.5$ and ρ = 0.7.

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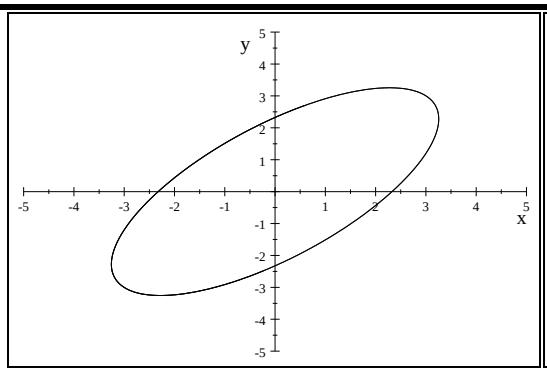

Fig.1: Ellipse: $a = b = 0$ *e* $\rho = 0.7$.
Source: The authors.

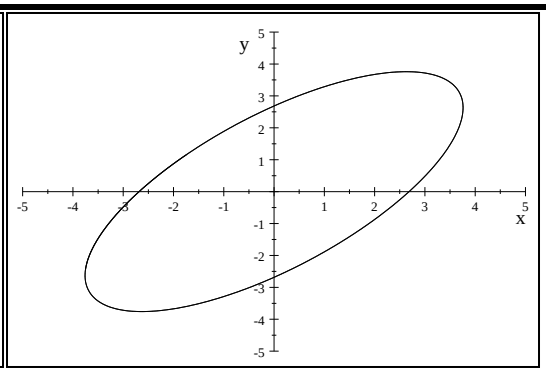

Figure2. Ellipse: $a = b = 0.5$ *e* $\rho = 0.7$.
Source: The authors.

For a and $b \in \{0.0; 0.1; 0.2; 0.3; 0.4; 0.5; 0.6; 0.7; 0.8; 0.9\}$, it can be observed in Figure 3 a graphic demonstration in which the greater the autocorrelation, the greater the elliptical area, that is, if the process is in control and there is autocorrelation in variables, it is necessary to adjust the graphical control limit otherwise, many false alarms will occur.

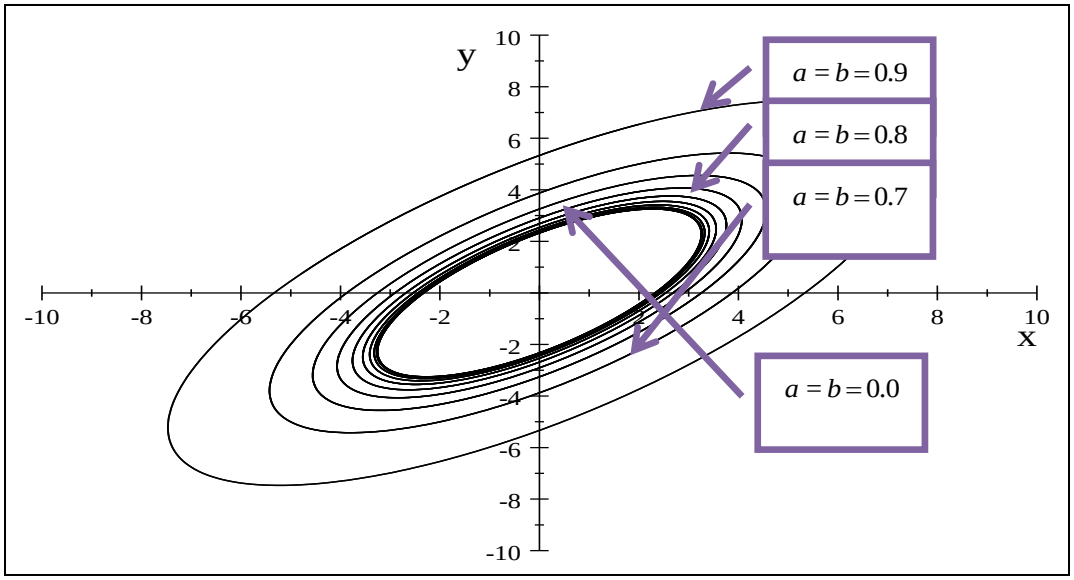

Fig.3: Ellipses: a and $b \in \{0.0; 0.1; 0.2; 0.3; 0.4; 0.5; 0.6; 0.7; 0.8 \;\; ; 0.9\}$ *and* $\rho = 0.7$.

Source: The authors.

Ellipses in Figure 3 represent all equidistant points, in Mahalanobis distance, from the origin, if the data are normally distributed,. This suggests that all these points are equally likely to be governed by a multivariate normal distribution centered at (0,0), for $\boldsymbol{\mu_0} = 0$. In T^2 Hotelling chart, the control limit (CL) equal to $D^2 =$ 10.5966, generates, generally, a false alarm every 200 samples collected when $a = b = 0$. Not so when $a = b \neq 0.0$, that is, the average false alarm rate does not correspond to an alarm every 200 samples collected, even if it is used as the CL value 10.5966. This means in practice that, when one uses the Hotelling T^2 chart, to consider the chart CL with chi-square distribution with *p* degrees of independence $\left(\chi^2_{(p)}\right)$ in autocorrelation presence will provide with a false alarms rate different than the desired.

4.2 Graphical evaluation of autocorrelation effect with the process out of control

In Figure 4, it is illustrated a zero-autocorrelation process with $a = b = 0$ and ρ = 0.7. The dashed ellipse with center (0,0) is a process in control and its equation is $D^2 = 1.9608x^2 - 2.7451xy + 1.9608y^2 = 10.5966$. The other ellipses represent the occurrence of a special cause that moves the mean vector towards a new baseline:

a) Displacement 1 → $\boldsymbol{\mu_1} = (\mu_{01} + 1; \mu_{02} + 1)$; and:

$$D^2 = 1,9608x^2 - 2.7451xy - 1.1765x + 1.9608y^2$$

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Displacement 2 $\rightarrow \boldsymbol{\mu}_1 = (\mu_{01}+2; \mu_{02}+2)$; and:

$$D^2 = 1.9608x^2 - 2.7451xy - 2.3529x + 1.9608y^2 - 2.3529y + 4.7059 = 10.5966$$

b) Displacement 3 $\rightarrow \boldsymbol{\mu}_1 = (\mu_{01}+3; \mu_{02}+3)$; and:

$$D^2 = 1.9608x^2 - 2.7451xy - 3.5294x + 1.9608y^2 - 3.5294y + 10.588 = 10.5966$$

In Figure 5, it is displayd a process with autocorrelation with $a = b = 0.7$ and ρ = 0.7. The dashed ellipse with center in (0,0) is a process control and its equation is: $D^2 = x^2 - 1.4xy + y^2 = 10.06$. The value of 10.06 was used in order to make a fair comparison that, in autocorrelation presence, maintains the average false alarm rate equal to an alarm every 200 samples.As demais elipses representam a ocorrência de uma causa especial que desloca o vetor de médias para um novo patamar: The other ellipses represent the occurrence of a special cause that moves the mean vector towards a new level.

a) Displacement 1 $\rightarrow \boldsymbol{\mu}_1 = (\mu_{01}+1; \mu_{02}+1)$; and:

$$D^2 = x^2 - 1.4xy - 0.18x + y^2 - 0.18y + 0.054 = 1$$

b) Displacement 2 $\rightarrow \boldsymbol{\mu}_1 = (\mu_{01}+2; \mu_{02}+2)$; and:

$$D^2 = x^2 - 1.4xy - 0.36x + y^2 - 0.36y + 0.216 = 1$$

c) Displacement 3 $\rightarrow \boldsymbol{\mu}_1 = (\mu_{01}+3; \mu_{02}+3)$; and:

$$D^2 = x^2 - 1.4xy - 0.54x + y^2 - 0.54y + 0.486 = 1$$

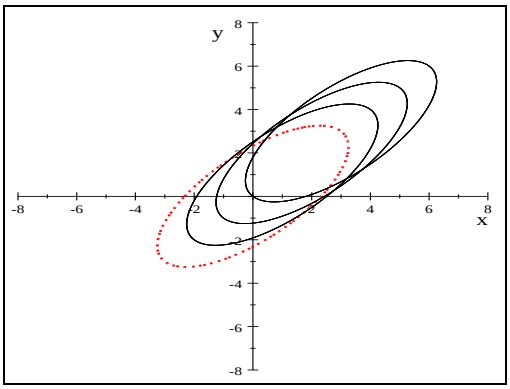

Fig.4: Ellipses: $a = b = 0$ *and* ρ *= 0.7.*

Source: The authors.

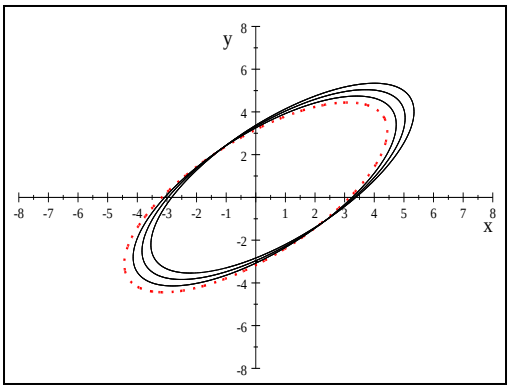

Figure5- Ellipses: $a = b = 0.7$ *and* ρ *= 0.7.*

Source: The authors.

One can note, in Figure 4, that in processes without autocorrelation the displacement in mean vector caused by a special question is represented by ellipses which depart from the center (0,0), indicating that the T^2 chart, in this case, presents superior performance in relation to the case where autocorrelation is present. In Figure 5, the ellipses have a higher resistance to remain close to the center (0,0) when occur displacements that disturb the mean vector, meaning that the T^2 chat performance is lower when the autocorrelation is present.

4.3 Example

It was simulated two types of bivariate processes and T^2 chart applied to control the variables of these processes. In the first case: $\boldsymbol{\mu}_0 = (0;0)$; a=b = 0.0; = 0.7 and CL=10.5966 (ARL_0=200). In the second case: $\boldsymbol{\mu}_0 = (0;0)$; a=b=0.7; =0.7 e CL=10.06 (ARL_0=200). Three kinds of displacements were performed at the mean vector: $\boldsymbol{\delta} = (1.0;1.0)$, $\boldsymbol{\delta} = (2.0;2.0)$ and $\boldsymbol{\delta} = (3.0;3.0)$.Variables observations of the first and second processes were generated with the models of equation (1) and equation (2), respectively. Figures 6, 7 and 8 show the results. In each T^2 chart, the process has displacements in the mean vector from the sample 50. The results show that autocorrelation decreases the chart power to detect a special cause which operates in the mean vector of the process. Similar results were illustrated in Figures 4 and 5.

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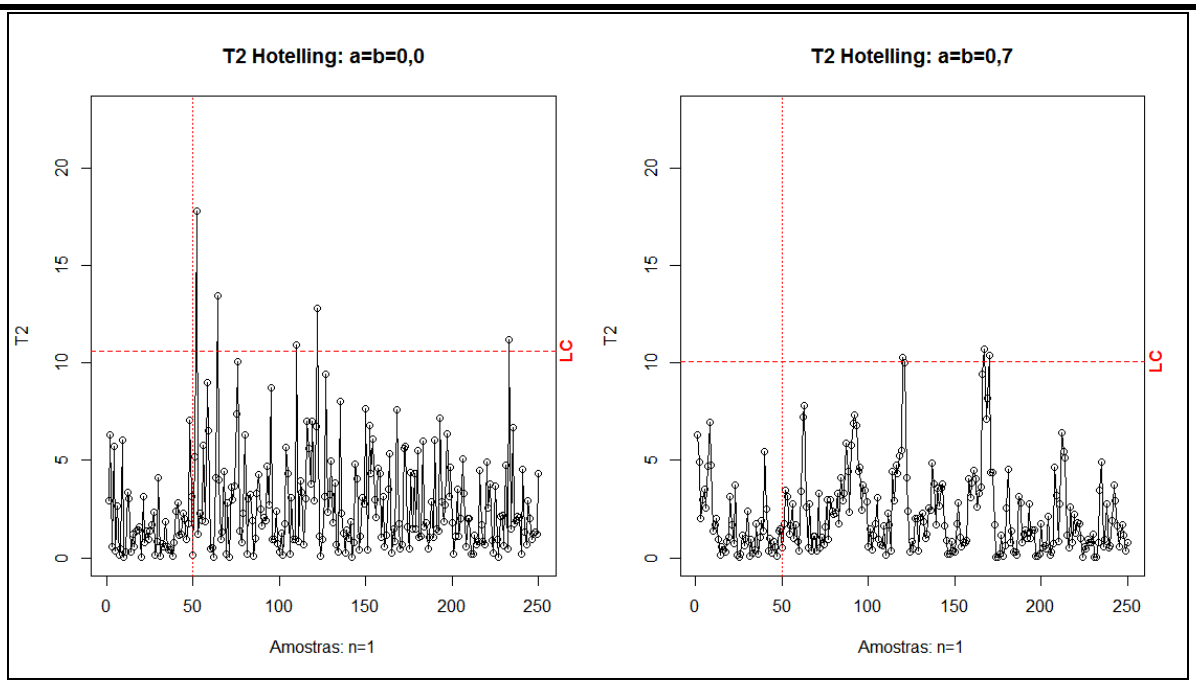

Fig.5 –Hotelling T^2 charts; $\boldsymbol{\delta} = (\delta_1 = 1.0\ ; \delta_2 = 1.0)$.

Source: The authors.

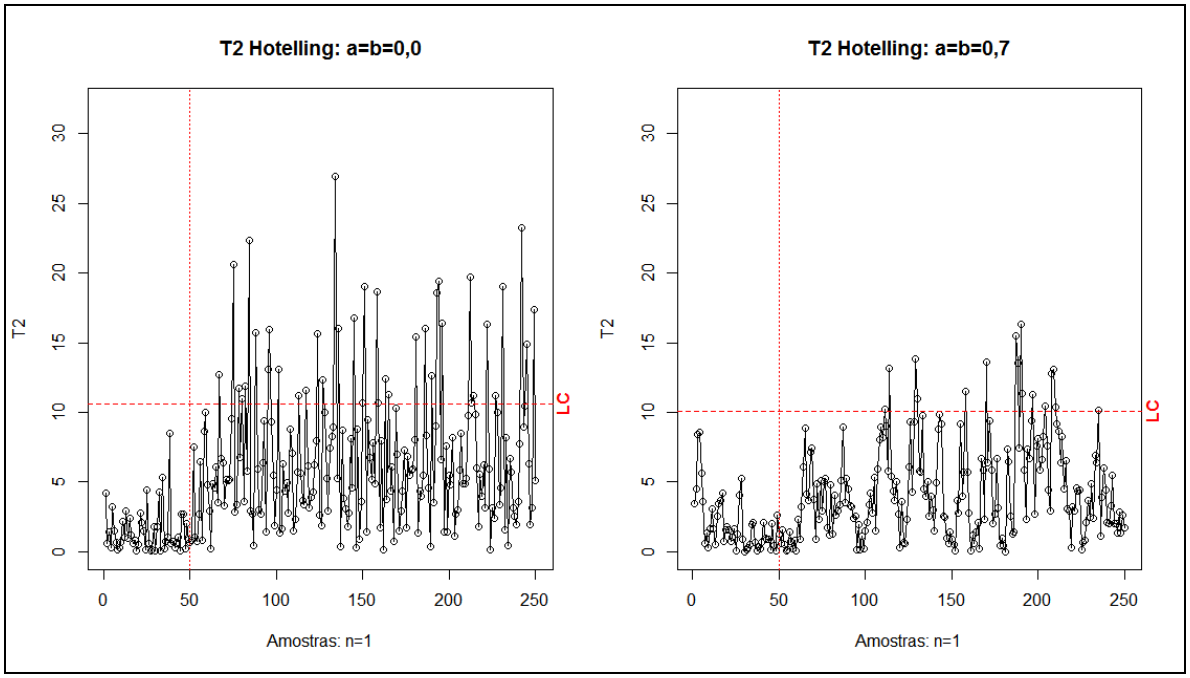

Fig.6 –Hotelling T^2 charts; $\boldsymbol{\delta} = (\delta_1 = 2.0\ ; \delta_2 = 2.0)$.

Source: The authors.

https://dx.doi.org/10.22161/ijaers.6.2.16 *ISSN: 2349-6495(P) | 2456-1908(O)*

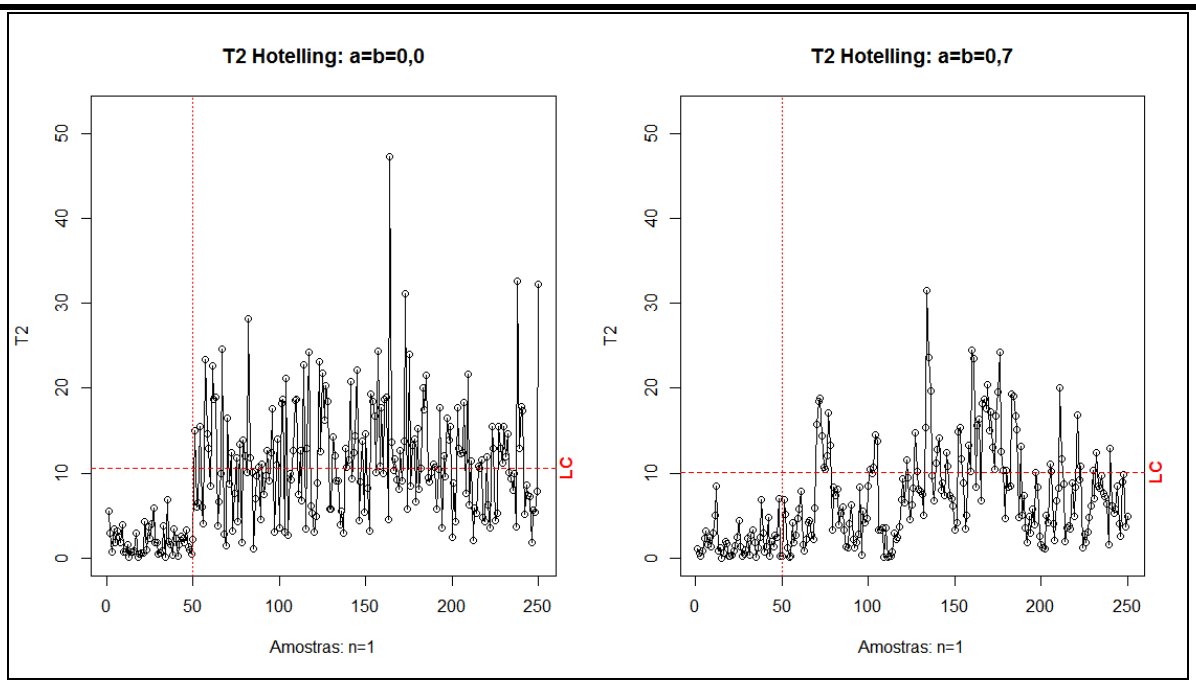

Fig.7 –HotellingT²charts; $\boldsymbol{\delta} = (\delta_1 = 3.0\ ; \delta_2 = 3.0)$.

Source: The authors.

V. CONCLUSION

It has been evaluated, in this article ,the autocorrelation effect in a T^2 control chart since it is one of the most popular tools in academia and industry. The Mahalanobis distance, the same statistic used in the T^2 chart, was used to represent geometrically a process behavior in presence and absence of special causes that affect the average value of the monitored variables.

The T^2 chart performance is affected by the autocorrelation hypothesis violation, reducing the ability to detect deviations in the mean vector. The use of ellipses illustrated how the data of a process behave in presence of autocorrelation, that is, the masking displacement effect in the mean vector of variables. The displayed examples illustrated reduction that occurs in power T^2 chart to detect the presence of a special cause that shifts in the process mean vector. It is suggested, in future works, presentation of statistics or techniques that improve control chart in presence of autocorrelation.

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Technological productivity on control of *Boophilus Microplus* tick: A Patentometric Study

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***Abstract*—** *The Boophilus Microplus tick is responsible for causing large losses in cattle, its control is based on the use of chemical products and this species has presented an increasingly resistance to the products used. The objective of this article is to evaluate the technological profile for the control of the Boophilus Microplus tick through a patentometric study. In order to identify the study, we used the patents of Espacenet and Derwent Innovations Index, where 514 patents were found and 245 were analyzed. The Vantage Point® software was used to identify the temporal evolution, the collaborative network between the researchers and the geographical distribution. It was concluded that the studies identified are of great relevance for the control of ticks, considering that technological publications are important markers of production activity and development of the field of knowledge*

***Keywords*— control, patentometry, patents, technological production, ticks.**

I. INTRODUCTION

One of the global problems are parasitic diseases, being considered a huge hindrance both in health as in the performance of the animals. Whereas the group of ectoparasites, ticks are the biggest responsible for numerous losses. The ticks directly affect the cattle, causing skin problems, wounds, weakening the animal to secondary infection, causing toxicosis and sometimes paralysis (Schroder and Reilly, 2013). Indirectly they act as vectors of fatal diseases (babesiosis and theileriosis), as well as the high cost to fight and control it (Jongejan and Uilenberg, 2004).

Given this assumption, it is critical to leveraging information on the subject, through the promotion and dissemination of the intellectual structure of their technological productions related to the control of Boophilus Microplus tick, through a patentometric study. This is used to track technological trends in several emerging fields of technology; it allows transferring data contained in patent documents in systematic and valuable information (Chang; Wu; Leu, 2010). For Macias-Chapula (1998, p. 137), "the patent number reflects the trends of technical changes over time and assesses the results of the resources invested in research and development (P&D)". The author adds that the patent indicators determine the approximate degree of the technological innovation of a country and that the number of citations of patents measure the impact of technology (Macias-Chapula, 1998).

The tracking of new technologies is extremely important, as well as the protection of intellectual property through patent document. Companies should carefully track technological innovations in this scenario that is characterized by the steady release of new products and the planned obsolescence (Hertz and Parikka, 2012).

The present article sought to assess the technological publications related to the control of Boophilus Microplus tick aiming to use patentometric techniques, seeking to highlight the researchers, companies, the geographical distribution of technological production, as well as build a network of collaboration among researchers.

II. THEORETICAL REVIEW

2.1 *Boophilus microplus*

The Rhipicephalus (Boophilus) microplus is one of the most widely distributed ticks in the world, is the main cattle ticks, being responsible for major losses in Brazilian cattle (Seixas et al., 2012), causing direct and indirect damage to animal health, limiting considerably the productivity (Cruz et al., 2014).

The parasite control relies mainly on the use of chemical acaricides that are produced from a limited set of molecules. These drugs induce the selection of ticks resistant to acaricides and are an important source of

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environmental pollution (Seixas et al., 2012). Taking into account the reports of resistance, many studies have been conducted to try to control the cattle tick through alternative methods (Santos et al., 2012).

The use of acaricides is the primary method of control in Brazil, which are not always used appropriately (Rocha et al., 2006). It is known that resistance is one of the main contributing factors in the selection of individuals due to failures in conservation, dilution and application of the products with time interval and methods that lead to non-lethal concentrations used on ticks (Furlong et al., 2007).

Currently, the are several strategies to coontrol the tick. One is the application of diferente formulations of acaricides. Another is a vaccine and also the rotations between catlle and crops. (Fao, 2004). Among these, the chemicals tickcides offer a quick and economic mitigation, constituting the basis of control to eradication. Prolonged use associated with the misuse has a downside to make these species more resistant, reducing the ability to control the infestations (Khajuria et al., 2014; Singh et al., 2014).

Therefore, it becomes necessary to seek alternatives that are adaptable and less expensive, especially for farmers who has limited means and who make up the bulk of animal breeders in developing countries, including Brazil. Several studies have been conducted to develop environmentally safe control measures against ectoparasites (Abdel-Ghaffar and Semmler, 2007; Rawani et al., 2010; Abdel-Shafy et al., 2009; Godara et al., 2014; Singh et al., 2014).

2.2 Patentometry

The patentometry enables the analysis of large volumes of information and the creation of a useful outcome for companies. Is a tool that provides greater technological orientation, and whose versatility has allowed its use to raise the state of art of variables that can illustrate the behavior of sciences in certain sectors (Romero and Weffer, 2010). In relation to the patentometry, the meaning of this notion is twofold. On the one hand, scores of patents and patent citations are used as indicators. On the other hand, patent-based indicators are used to show the production of technology and innovative activities (Sung et al., 2014).

Patents are evaluated as an index of both industrial development and as countries research, composed of relevant indicators that assess the country's capacity to transform scientific knowledge into technological innovations or products (Pavanelli and Oliveira, 2012). The analysis of patents encourage the development of several studies, both in the academic sector, research, business or industry. Within which are: identify partners; technological trends and obtainable; understand the stage of technology; protect the results in the research and development of the organization and/or of the country; seek solutions to innovative and technological problems; develop technological and business profiles; support and guide P&D programs; etc. (Sánchez, et al., 2007).

As Valdes et al. (2003) the patent documents are one of the most complete, accessible, reliable and up-to-date technological information sources covering a large number of sectors.

According to Leydesdorf (2001), the patent may be used to demonstrate the targeting and technological trends of industry sectors and the economy as a tool for analysis of potential markets, technological trends and the market and competition movements. The use of information contained in patent documents also allows you to identify relevant technologies, assist in the choice of potential partners, showing niche markets, incremental and radical innovation.

III. MATERIAL AND METHOD

For the construction of this analysis a methodological approach was adopted, which is characterized as descriptive and exploratory, with a quantitative approach and makes use of patentometric techniques. The sources of information used for the recovery of patents related to the control of *Boophilus Microplus* tick, were to Espacenet databases and Derwent Innovations Index from the Capes Portal of journals on day March 26 of 2018.

To carry out the searches, the terms "*Boophilus Microplus* and Control", "*Boophilus Microplus*" and "*Boophilus Microplus* and control and method"were used in the fields of the database Espacenet ("title" and "title and summary") and for the database Derwent Innovations Index ("title" and "topic"). The recovered patents has been consolidated and redundant patents were excluded.

First, the 245 documents were used for analysis of annual trends, and countries. Thereupon were selected the 4 International Patent Classifications (IPC) and the 15 years with the highest number of deposit, after this, the co-occurrence matrix between the classes and the inventors who have excelled was made. Soon after, the co-occurrence matrix between the IPC and year was made. The diagram of the countries and inventors was used to verify the collaboration in the development of technologies. The patemt depositors were selected by countries to check their profile to make the correlation between inventors; the chosen ones were those who obtained the 10 highest correlations.

During this research, it was used: - deposit period: date that the patent was deposited; - country: name of the country or Regional or International Organization that published the patent document; - holder: author of the invention will be ensured the right to obtain the patent that ensures the property; - depositors: any person or

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entity, that has legitimacy to obtain the patent (who applied for the patent); - International Classification: is the international rating system, created from the Strasbourg Agreement (1971), whose technology areas are divided in classes A to H. In each class, there are classes, major groups and groups, through a hierarchical system (Macedo, 2000).

The data were analyzed by using Tech Mining methodology (import data, clean data, analyze data, visualize data plots) by means the software Vantage Point ®, which is an important mining and analysis tool that allows exploration and treatment of large amount of scientific and technological information. The documents are processed with advanced bibliometric techniques and that allows to view the data in different ways through grouping of countries, authors, institutions, among others (Vantage Point ®, 2012).

IV. RESULTS AND DISCUSSION

The Table 1 presents the number of documents recovered from searches on patents using the keywords defined in the methodology.

Table.1: Number of patents found in databases

Database	Keywords	Title	Title and summary	Result
Espacenet	Boophilus Microplus and Control	1	6	7
	Boophilus Microplus	5	32	37
	Boophilus Microplus and control and method	0	0	0
Derwent Innovations Index	Boophilus Microplus and Control*	9	157	166
	Boophilus Microplus*	25	240	265
	Boophilus Microplus and control and method*	0	39	39
Total		40	474	514

Source: Table drafted by authors.

After patentometric search in the databases, the 514 documents identified were exported to Microsoft Excel, and later, the 260 repeated documents were deleted after the search. Out of these 254, 9 did not have the name of the inventor and were excluded from the research, therefore, 245 remained for analysis.

Figure 1 presents the annual evolution of 245 documents analyzed. With the results, it might be noted that the patents deposited on the subject come oscilating over the period since the first patent was in the year 1961. The invention comprises carbamic acid esters of general formula. Esters are prepared to induce a reaction a halogen-carbon acid ester (cyclopentyl or phenyl cyclopentenyl) with a mono- or dialkylamines, or induce a Cyclopentyl or phenyl cyclopentenyl to react with an acid halide mono-or dialkylcarbamic. Some examples describe the preparation of o-phenyl-cyclopentyl-N-metilcarbamate and o-phenyl-cyclopentenyl-N-metilcarbamate and its use with a diluent as insecticides and pesticides to plants and animals, deposited by the company Bayer AG in United Kingdom, the international classification used was C07C (acyclic compounds or carbocyclic).

It can be noted that there was an evolution in the accumulated growth for patents deposited over time, the most representative growth happened between the years of 1999 with 14 patent deposits and 2003 with 13 patent deposits, followed by the years of 2013 and 2017 with 12. Representing an increase in the interest of researchers on the theme. During this period, there was an average of 5.212 documents per year.

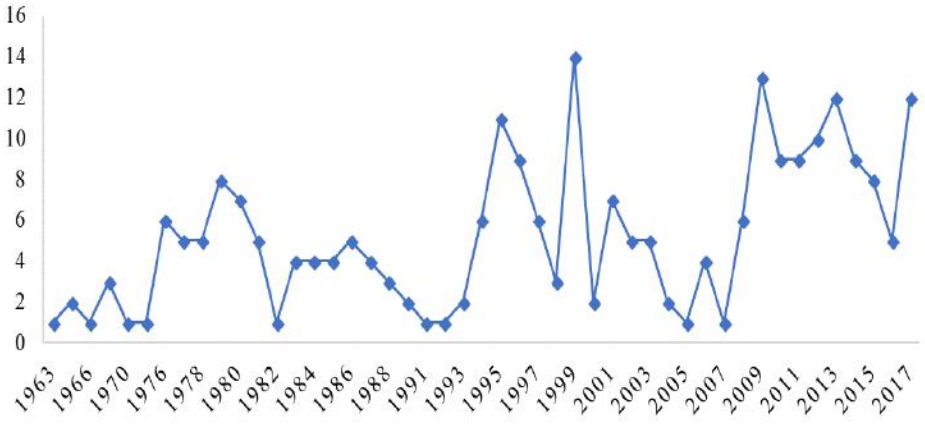

Fig.1: Number of patents deposits per year.
Source: Graphic drafted by authors

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In Figure 2, the online platform 'map in seconds' was used (CHEN, 2018), where the map of the countries of the patents found was made.

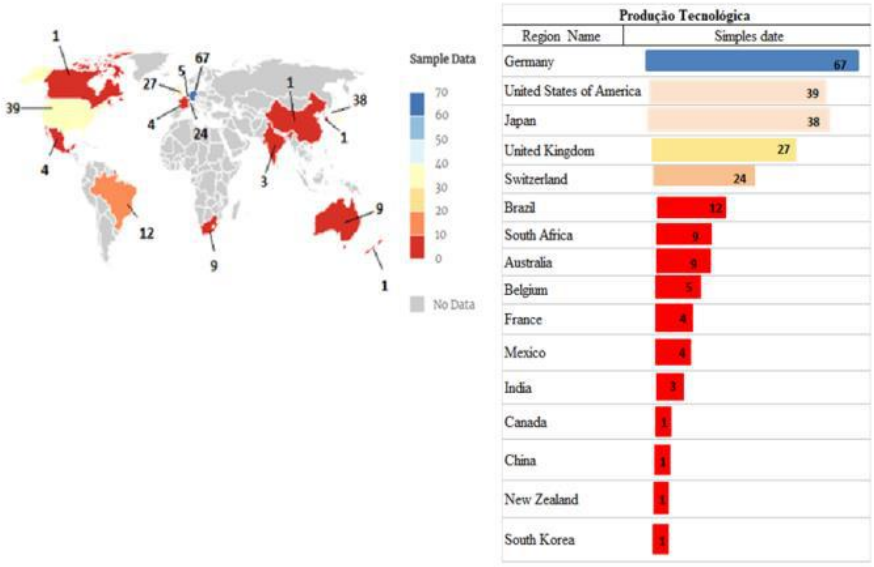

Fig. 2: Number of patents deposits per country
Source: Drafted by authors using 'map in seconds' tool.

It is observed that the most outstanding countries were: Germany with 67 patent deposits, out of these, 32 are represented by the international classification A01N (preservation of humans, animals, plants or parts of it; biocides; attractants or repellents of pests; plant growth regulators), 23 represented by C07D (heterocyclic compounds), 8 classified as C07C (acyclic compounds or carbocyclic), 2 as A61K (preparations for medical, dental or hygienic purposes) and 2 as CO7K (peptides).

Out of the 39 patents filed in the United States of America, 31 are classified as A01N; of the 38 patents deposited in Japan, 32 represents the class A01N; in the United Kingdom, from 27 deposits, 19 are represented by the subclass A01N; in Switzerland, from the 24 deposits, 19 are represented by A07N. In Brazil, it was found 12 patent deposits, being 6 represented by the classification A61K and 4 by A01N.

It is observed in Figure 3, the distribution of IPC per year, where were selected 15 years and the 4 classes that have stood out. The most representative class is represented in A01N, other classes that we can highlight are the A61K, C07C and C07D.

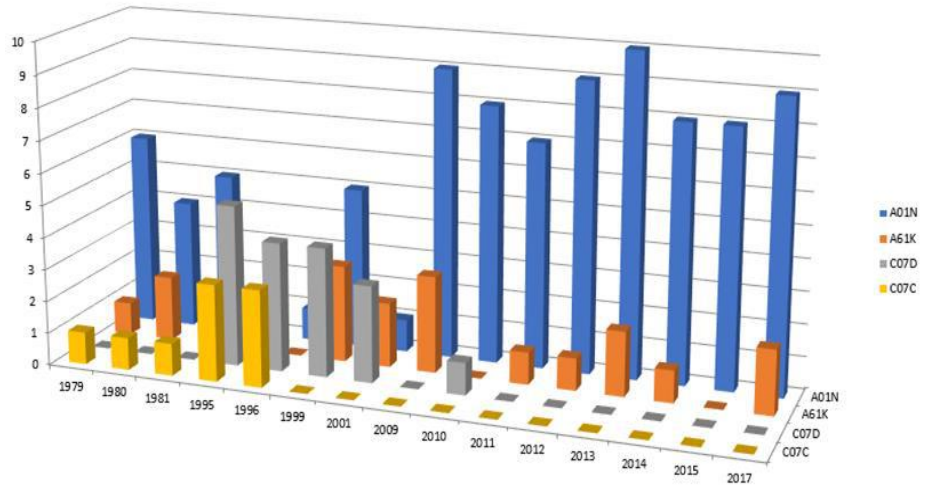

Fig. 3: International classification per year.
Source: Graphic drafted by the authors.

It is observed that the patents are most often classified in section A, which refers to human needs, followed by section C, chemistry and metallurgy.

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In table 2, the 4 classes that have stood out of 245 patents and their descriptions are represented, resulting in 234 patents for analysis.

Table 2: Description of the classes of the IPC

IPC Classes	Description	Total
A01N	A01N - Preservation of humans, animals, plants or parts of it; biocides; Attractants or repellents of pests; plant growth regulators	141
A61K	A61K - Preparations for medical, dental or hygienic purposes.	36
C07D	Heterocyclic compounds	36
C07C	Acyclic compounds or carbocyclic.	21
Total		234

Source: Drafted by the authors.

It can be observed that out of the main IPC, 60% are represented by code A01N- Preservation of humans, animal, plants or parts of it; biocides; attractants or repellents of pest; plant growth regulators.

In table 3 a more specific analysis of the description area was made, describing the 141 documents found in classes A01N, including 23 patents deposits that did not have a sub-group.

Table.3: Description of the subclass A01N of IPC

IPC Class	Subgroup	Description	Quantity
A01N	A01N	Preservation of humans, animals, plants or parts of it; biocides; attractants or repellents of pests; plant growth regulators	23
	A01N 25	Biocides, repellants or attractors of pests, or plant growth regulators, characterized by their forms, or by their non-active ingredients or by their methods of application, for example, seed treatment or sequential application; (apparatus for the destruction of noxious animals or noxious plants)	7
	A01N 27	Biocides, repellants or attractors of pests, or plant growth regulators containing hydrocarbonates	1
	A01N 29	Biocides, repellants or attractors of pests, or plant growth regulators containing halogenated hydrocarbonates	3
	A01N 31	Biocides, repellants or attractors of pests, or plant growth regulators containing organic compounds of oxygen or sulfur	6
	A01N 33	Biocides, repellants or attractors of pests, or plant growth regulators of nitrogen green plants	1
	A01N 35	Biocides, repellants or attractors of pests or plant growth regulators based in a halogen, e.g., radical aldehyde.	3
	A01N 37	Biocides, repellants or attractors of pests, or plant growth regulators of plants that is related to the carbon atom, 3 times per heteroatom and up to 2 connections with a halogen, e.g. carboxylic cyclopropane fruits	10
	A01N 43	Biocides, repellants or attractors of pests, or regulators of the beginning of set of heterogenic plants	70
	A01N 47	Biocides, repellants or attractors of pests, or regulators of the carbon atom without bond to a nitrogen atom	5
	A01N 53	Biocides, repellants or attractors of pests, or regulators of the life level of particular carboxylic cyclopropane or results of these	7
	A01N 57	Biocides, repellants or attractors of pests or regulators of plants market associated with the organic ingredients of phosphor.	6
	A01N 65	Biocides, repellants or attractors of pests, or regulators of growth of material collected from algae, lichens, bryophytes, plants or fungi multicellular or associated models.	3
Total			**141**

Source: Drafted by the authors.

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It is observed that the Group A01N 43 - Biocides, repellants or attractants of pest or regulators from the beginning of the set of heterogeneous plants was what came of the 141 A01N classes.

In Figure 4, we see the matrix of international patent classification (IPC) for allowing inventors to analyze their connection with the tech sector. The yellow node represents the IPC and inventors by the blue node, the 4 highlighted IPCs and the 15 inventors with largest number of deposits were used. The amount of each patent inventor is represented by the line width.

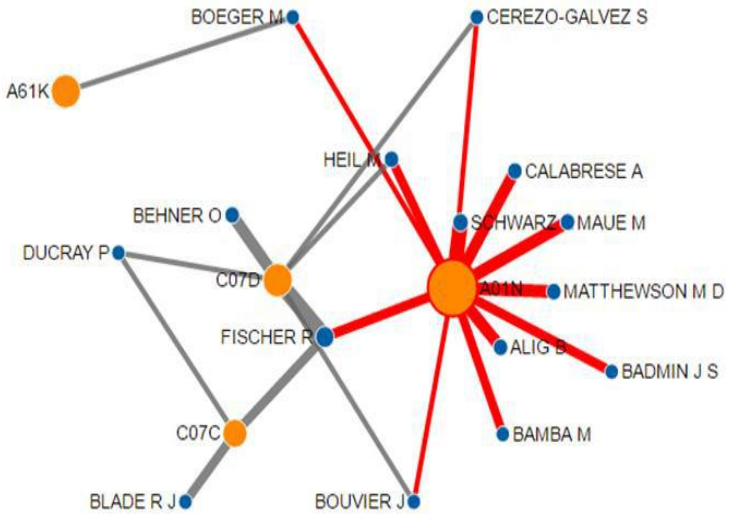

Fig. 4: Matrix of occurrence of the international classification of patents for inventors.
Source: Drafted by the authors using the software Vantage Point®.

In this case, we see that from the 15 inventors, 12 are linked to the subclass A01N (preservation of humans, animals, plants or parts of it; biocides; repellents or attractants of pest; plant growth regulators).

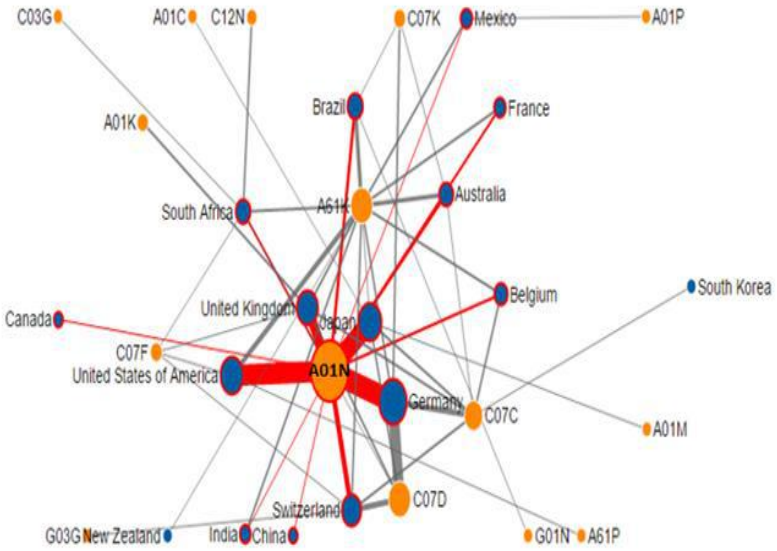

Fig. 5: Matrix of occurrence of the international classification of patents by country.
Source: Image drafted by the authors using the software Vantage Point®.

Note in Figure 5 the matrix between the 15 classifications used by inventors represented by the yellow nodes and the 16 countries found represented by the blue nodes. It turns out that the subclass A01N and A61K were used by several countries.

It is noticed that from the 16 countries, 14 are connected to A01N and 13 are connected to A61K, the two classes are in section A (Human Necessities) of IPC.

The diagram in Figure 6 represents the interaction between countries and inventors of 245 patents, thus allowing the identification of the network and the

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important links between these networks. The size of the circles represents the importance from the viewpoint of quantity of patents in each country and cooperation. Germany stands out with 05 inventors, Fischer has 06 patent deposits, Maue 03, Schwarz 03, Benhner 03, Cerezo 02. The thickness of the lines refers to the intensity of the link, i.e., the thicker the line, the greater the amount of patents that the country has. From this viewpoint, Germany, United States of America, Switzerland, United Kingdom, Belgium, Australia, South Africa, Mexico and Canada presents a link of less than (0.25) on inventors collaboration.

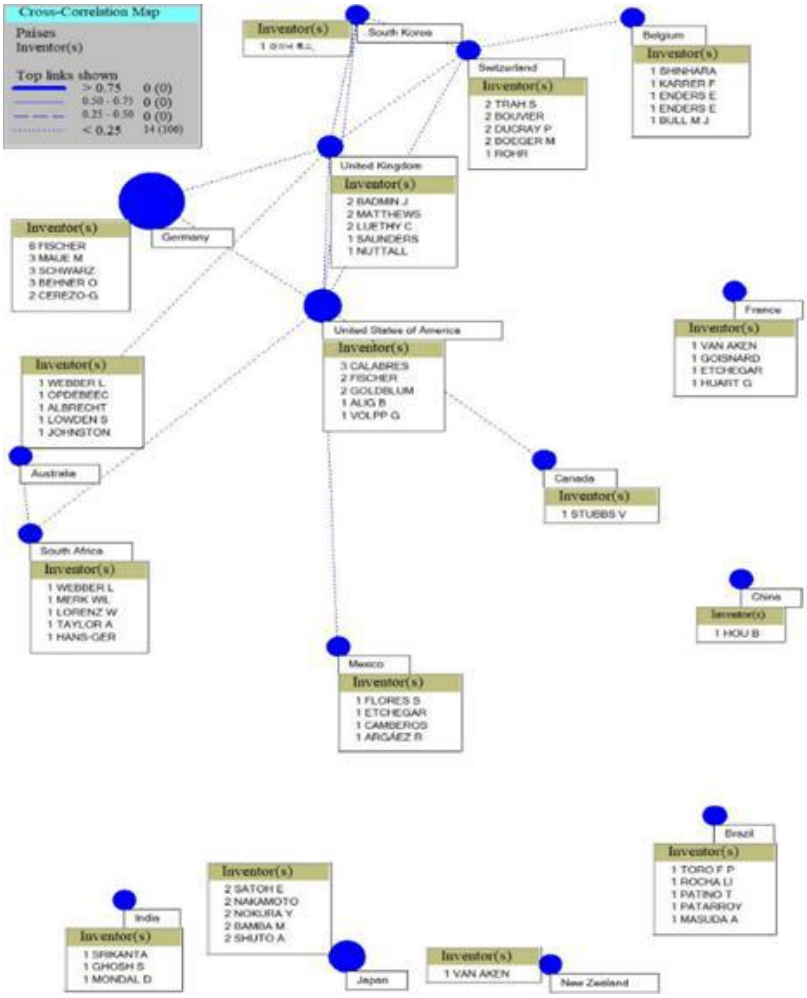

Fig. 6: Diagram of the countries and inventors and their contributions in the development of technologies.
Source: Image drafted by the authors using the software Vantage Point®.

Figure 7 shows that companies lead the ranking in deposits. We analyzed the 86 depositors found; it was checked the source of 18 countries and identified the companies, Research Institutes, independent inventors and the Universities. According to the data, the countries Australia (AU), Belgium (BE), Brazil (BR), Switzerland (CH), Germany (DE), France (FR), Great Britain (GB), India (IN), Japan (JP), South Korea (KR), United States of America (US) and Uruguay (UY) presented depositors companies. However, it is important to highlight the companies from Germany (DE), United States of America (US), United Kingdom (GB) and Japan (US) that have obtained the largest numbers of deposits.

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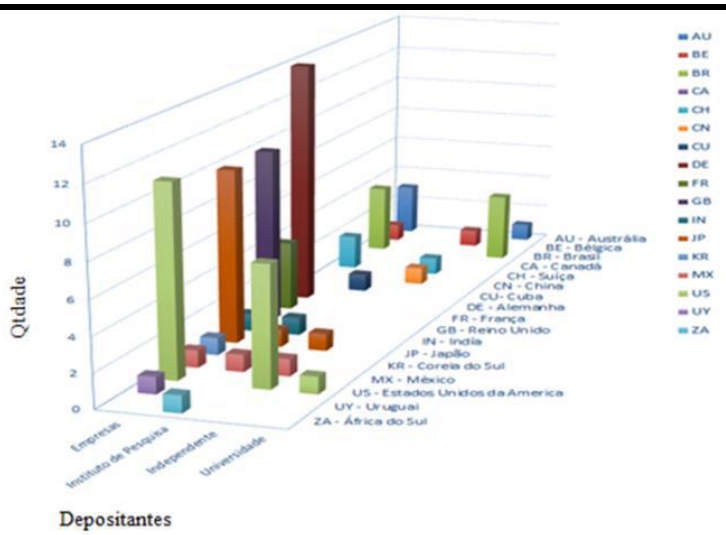

Fig. 7: Profile of depositors in several countries.

It should be noted the presence of Brazilian universities in patent deposit, although little participation, it demonstrates the importance of universities in the development of new technologies.

Table 1 shows that the 10 greatest depositors of 245 patent documents identified are made from companies. The company that comes up with the greatest number of deposits is BAYER AG, followed by BAYER CROPSCIENCE.

Table.1: Top ten depositors

Depositants	**Countries**	**Total**
BAYER AG	Germany	28
BAYER CROPSCIENCE AG	Germany	23
CIBA GEIGY AG	Germany	17
SYNGENTA PARTICIPATIONS AG	Great Britain	13
SUMITOMO CHEM CO LTD	Japan	11
NISSAN CHEM IND LTD	Japan	8
NOVARTIS AG	Switzerland	8
ICI AUSTRALIA LTD	USA	7
WELLCOME FOUND LTD	Germany	6
FARBENFAB BAYER AG	Germany	5

Source: Table drafted by the authors.

Bayer is a global company that operates in the areas of health and Agriculture (BAYER, 2015). Bayer CropScience is the Division of the company specialized in agriculture, being the third largest company of innovative agricultural commodities in the world (CROPSCIENCE, 2018).

In table 2, it was verified the eight greatest depositors of patents by profile, showing the highlight of records between companies and universities and independent inventors of 141 patent documents A01N class, listed in Table 2.

Table.2 - Eight major depositors of patents by profile.

Empresas	**Nº**	**Universidades e Institutos de Pesquisas**	**Nº**	**Inventores Independentes**	**Nº**
Bayer Cropscience Ag	23	Indian Council Agric Res	1	Bretschneider N T	2
Syngenta Participations Ag	13	Kitasato Inst	1	Mizuno H	2
Syngenta Crop Protection Inc	9	Sagami Chem Res Cent	1	Nokura Y	2
Bayer Ag	8	Univ Federal Juiz De Fora	1	Shimizu C	2

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Sumitomo Chem Co Ltd	8	Univ Queensland	1	Angst M	1
Bayer Intellectual Property Gmbh	7	Univ Sao Paulo USP	1	Boeger F	1
Ici Australia Ltd	7	Us Sec Of Agric	1	Boeckh A	1
Merial Ltd	7			Boeger F	1

Source: Table drafted by the authors.

Note that the Bayer Ag showed only 8 patent documents with this international patent classification A01N.

On a thorough search, it is verified that the publications are for combining these data to A01N class, combining with the fact that 82.9% of deposits are made by companies, 3.54% from Universities and Research Institutes, 2.8% by independent inventors and 10.6% are from joint holders.

It should be noted in table 3 the total profile of depositors found on the 141 patent documents.

Table.3-Profile of depositors of patents by profile

Companies	Universities and Research Institutes	Independent Inventors	Joint holders
117	5	4	15

Source: Table drafted by the authors.

In the academic sphere, regarding independent inventors, the proportion of patent applications is quite small, as demonstrated by the information presented in table 3.

One can understand that it is the industry that is encouraging this type of technological innovation.

V. CONCLUSION

In General, the control of *Boophilus Microplus* tick remains an important area of research, since it was reported a large resistance to chemicals. This article proposes to assess the technological productions, through the related patentometry on the subject. With the results obtained in the research, it was found a higher number of deposits from 1999 with 14 deposits, having a growing number in 2003 with 13 documents, followed by the year 2013 and 2017 with 12 patents deposited this result indicates a growing trend showing a great interest in the area.

The leading country on this type of research was Germany with 67 patent deposits, followed by the United States of America, Japan, United Kingdom, Switzerland and Brazil, with an underrepresented number of patent applications compared to other countries. The international classification by year is represented by A01N (preservation of humans, animals, plants or parts of it; biocides; Attractants or repellents of pests; plant growth regulators). It was noted that the network of collaboration among countries and inventors is greater among the inventors of Germany. The company that has the greater number of deposits is the Bayer Ag and the Bayer Cropscience, the profile of deposits found were made by companies.

It is concluded that the analyzes of this research have great relevance for the control of ticks considering that technological publications are important markers of the activity of production and development of the field of knowledge. It is hoped that the results presented in this research may be useful to the researchers and that they collaborate to the extension and expansion of the patent studies on the subject, especially in the Brazilian scope of the 12 patents represents 4.89% a small number of deposits.

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Comparative Study of the Efficiency of Sodium Hydroxide, Sodium Hypochlorite and Sodium Chloride as Extractors of Residual Silver From X-Ray Plates and Graphical Effluents by the Volhard Method

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Abstract— Purpose: *to compare the efficiency of sodium hydroxide, sodium hypochlorite and sodium chloride as extractors of residual silver from x - ray plates and graphical effluents used in the development of photolites by the Volhard method. Methodology: this is an applied and quantitative research using the Volhard method. Results: in relation to recovery of silver-containing metal from solid x-ray sheet residues, the results were 0.51g for NaCl, 0.205 for NaOH and 0.00g for NaClO respectively. The results obtained in the recovery of metal containing residual silver in photolite fixative in the presence of NaCl, NaOH and NaClO were 0.895, 0.835 and 1.330g respectively. Conclusions: NaClO was the best option for the extraction of silver-containing metal in fixation of photolites, being this 37,21% more efficient than NaOH and 32,70% more efficient in relation to NaCl. In relation to the recovery of this metal from x-ray film the results indicated NaCl as the best option for the extraction of silver contained in x-ray plates, which is 58.80% more efficient than NaOH.*

Keywords— Silver Pullers, Residual Silver, Volhard Method.

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I. INTRODUCTION

The silver (Argentum) is represented by the chemical symbol Ag, has atomic number 47, is considered a noble metal, having characteristics as white, bright, dense (density 10,5g / cm3), malleable and ductile used in many precious alloys [1]. Historical accounts show that the first metals to be manipulated and used by man were those that could be found in nature as a pure element, silver was one of them. Silver is believed to have been number three metal to be found and manipulated by man, with gold and copper preceding its discovery [2].

Research indicates that the oldest silver utensils date back to 5000 BC from India. Objects of this metal were also found 3500 BC, in the tombs of the province of Ur in India. There is also a reference to silver in the Bible, in Genesis 44: 2: "And my cup, the silver cup ...", which is a discovery about the time of Egyptian civilizations 3000 BC before Christ, [3].

The practice of natural extraction of silver is done through mining with methods of opening holes and grinding ores. Unlike gold, silver is present in many natural occurrences of minerals. The greatest abundance is represented by the silver sulfide - Ag2S (Argentite), in addition to the occurrence of deposits of native silver (not combined). It also states that because a great majority of the ores contain silver, the most important is the combination of three lead metals, copper and zinc, or each individually [4].

Among the various applications, silver is widely used in the photographic, radiographic, electro-electronic, coin minting and jewelery industries. It is also used in welding, mainly along with copper, zinc and cadmium, in the pharmaceutical industry, in the manufacture of evaporation tanks, tubes and coils. It has wide use together with mercury in the production of mirrors [1].

Like any other residue, those caused by the inadequate disposal of the silver metal and its abandonment in the environment, can generate serious environmental problems, favoring the incorporation of contaminating agents in the trophic chain, interacting in natural physicochemical processes, giving rise to its dispersion and , therefore, to the increase of the problem. Although nature is able to renew itself in its natural course, the accumulation of waste generated by man's action, particularly chemical substances, if they exceed the limits of natural recycling of the environment there will be an imbalance in biological systems [5]. Toxic chemicals and wastes released into the soil, sea and rivers, streams, lakes and ponds cause irrecoverable damage to the life of the fauna and flora, reaching human beings sooner or later [6].

The production of solid waste is a factor of concern for the environment, the demand for the generation of this waste increases daily and among the waste produced are the solid waste generated in health and graphics, which have a significant residual silver concentration.

Silver is widely employed in the photography and imaging industries as well as in general consumer electronics and its residues may pose a risk to aquatic and terrestrial organisms [7]. The inadequate disposal of silver waste generates concern regarding environmental pollution, because it has high toxic potential [1].

The high concentration of silver is harmful to humans and can be toxic to various organisms [8]. It is assimilated by the body through ingestion, inhalation, use of medical equipment and also by direct contact with the skin. It is difficult to identify the amount of silver that is absorbed or retained by the circulation of the gastrointestinal tract, lung or absorption through the skin, however in urine and feces, these quantities can be identified [9]; [10].

In large quantities in the environment, the waste of silver in its ionic form causes toxicity and for this reason, official bodies regulate the disposal of this metal [11]. Standards established by the National Environmental Council (CONAMA), by Resolution No. 357 of 2005, establish the maximum limit of silver in liquid effluent of 0.1 mg / L [12].

Most of the silver found in soil and surface water originates from natural leaching, this metal at high concentrations is usually associated with anthropogenic activities, such as the photographic processing industry and mining [13].

Pollution of rivers, lakes, coastal areas and bays has resulted in environmental degradation due to the dumping of increasing volumes of industrial, agricultural and domestic waste, which leads to the need to adopt government policies [14].

The disposal of silver waste can generate financial loss, since it has significant added value. It should also be mentioned that silver is one of the examples of metals with risk of scarcity [15]; [16]. However, little has been done to minimize the environmental impacts caused by films, revealing solutions, radiographic fixers and residual water [17]. On the other hand, the proper treatment of the developer and fixative solutions can generate inputs, metal and the developer itself, which strengthens the economy with the possibility of reuse [18]; [10].

Liporini et al. [19] state that the recycling of radiographic waste from hospitals and clinics as well as from the photographic industry can become a major undertaking, with possibility of financial return, from the construction of a silver extraction plant of radiographs and photographic films. The generation of waste that is sent to landfills or dumps causes damage to health and the environment and the recycling of a material that is commonly destined for waste has a great significance not only to recover material, but to make it better between man and the environment.

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Waste and man-made waste are unavoidable, but reducing the negative effects of litter on the environment is critical. In the recycling of radiographic film can be done in addition to the reuse of silver, the use of plastic that can be processed into boxes and packaging can benefit micro-packaging companies that offer a quality and affordable recycled product. Thus, a simple radiological examination that could be thrown in the garbage or stored for years is an example of 100% recycled material [19].

In this perspective, in Ariquemes, a city in the Brazilian Amazon, there are several hospitals, diagnostic centers, dental offices, radiology centers, machines for the development of graphic films (photolithography) and photographic development studios, which produce ray sheets -x, in the scope of health and residual water in the process of developing graphic and photographic films, which justifies the elaboration of this proposal of recovery of residual silver, in order to minimize the effects of the disposal of these materials in sanitary landfills, taking into account as these cause contamination of soils and groundwater, among other factors.

The present study had as objective to compare the efficiency of sodium hydroxide, sodium hypochlorite and sodium chloride as extractors of residual silver from x-ray plates and graphical effluents used in the development of photolites using the Volhard Method.

II. METHODOLOGY

This is an applied and quantitative research, insofar as the objective was to compare the efficiency of sodium hydroxide, sodium hypochlorite and sodium chloride as extractors of residual silver from x-ray plates and graphical effluents used in the development of photolites using the Volhard method, quantifying the silver present in x-ray film and in fixation of photoliths used in graphic printing.

The x-ray plates were collected in a private hospital and the fixator of the process of revelation of photolithographs, both in the city of Ariquemes, in Rondônia, in the Brazilian Amazon.

The material containing residual silver was sent to the Chemistry laboratory of the Faculty of Education and Environment – FAEMA in Ariquemes, Rondônia, Brazil, to carry out the analyzes.

The analyzes were performed using the Volhard Method with adaptations, according to the following subitems.

2.1 Removal of silver contained in x-ray plates

For the quantification of silver contained in x-ray plates, three different solutions were used, as shown in the sequence, namely:

- The x-ray plates were cut into squares of approximately 1x1cm, weighed into three 200g portions and placed in different beakers (1000 mL). As shown in figure 01.

Fig.1: Cut sheets

- NaClO sodium hypochlorite (2.0%), sodium hydroxide NaOH (1 mol/L) and NaCl sodium chloride (1 mol/L) respectively were placed in each beaker until the 800 mL mark, placed on the shaker for 90 minutes and allowed to stand for 24 hours.
- In the case of the solution containing sodium hydroxide (NaOH) precipitates the silver hydroxide (AgOH) in the solution of the solution, and the others silver chloride (AgCl).

Fig.2: Filtration of AgCl and AgOH

- After the filter paper containing precipitate was removed from the funnel and placed in porcelain crucibles, which were weighed in GEHAKA brand AG-200 model and counted with pencils for identification, as shown in Figure 03.

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Fig.3: Filtering accommodated in porcelain crucible

- To finish the silver extraction process, samples were taken to the muffle, Quimis brand, model Q-318M25T at a temperature of 1000ºC for 120 minutes, according to figure 04.

Fig.4: Muffle

- Subsequently they were cooled in a desiccator containing silica. Finally, the sample was weighed and the metal content was calculated according to Equation 1:

$$\%\,(m/v)=\frac{100\,x\,N}{P}\qquad \%\,(m/v)=\frac{100\,x\,N}{P}$$

(Equation 1)

At where:
N = mass of ash (g) and
P = initial sample mass (g)

2.2 Removal of the silver contained in fixer of graphic photoliths

For the quantification of the silver contained in fixador of graphic photolites three different solutions were used, as it shows the sequence, to wit:

- A 200 mL sample of graphite photolyte fixative developer solution was placed in three 600 mL beakers, in beaker 01 200 mL of 2% sodium hypochlorite was added to beaker 02, 200 mL of sodium hydroxide was added to 1 mol/L and in the beaker 3, 200 ml of 1 mol/L sodium chloride. The solutions were then shaken for 1 hour and then allowed to stand for 24 hours, as shown in Figure 05.

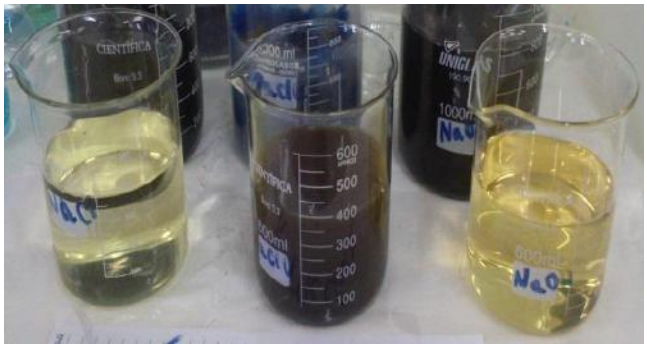

Fig.5: Solutions containing sample at rest

- The precipitate obtained in the decantation process was filtered by a simple method, as shown in Figure 02.
- The filter paper containing precipitate was removed from the funnel and placed in porcelain crucibles, which were weighed in an AG-200 model GEHAKA analytical balance and enumerated with pencils for identification.
- To finish the silver extraction process, the samples were taken to the muffle, Quimis brand, model Q-318M25T at a temperature of 1000ºC for 120 minutes, according to Figure 04.
- Subsequently they were cooled in a desiccator containing silica. Finally, the sample was weighed and the metal content was calculated according to Equation 1. And the other steps were performed analogously to the first case.
- The calculations to quantify the residual silver contained in the samples were made using Rule of Three, and the titration made from x-ray plate residues indicated the presence of 0.453 g for each 100 mL of sample and for the fixative sample of photolites, 0.444 g was obtained for each 100 mL of the sample.

2.3. Titration of samples

For the titration of the samples, the Volhard Method was used with modifications, according to the sequences indicated below.

2.3.1. Titration of the solution obtained from x-ray plate

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- An aliquot (05 mL) of sample 01 containing silver to be analyzed was transferred to a 250 mL Erlenmeyer flask. 1mL of a saturated (~ 40m / v) solution of ammonium ferric sulfate was added.
- The medium was acidified with 5mL of 6 mol / L nitric acid and titrated with standard 0.1 mol / L potassium thiocyanate solution.
- The volume of potassium thiocyanate spent on the first sample was 2.1 mL.

2.3.2. Titration of the photolyte fixative solution

- An aliquot (05 mL) of sample 01 containing silver to be analyzed was transferred to a 250 mL Erlenmeyer flask. 1 ml of a saturated (~ 40 m / v) solution of ammonium ferric sulfate was added.
- The medium was acidified with 5mL of 6 mol / L nitric acid and titrated with standard 0.1 mol / L potassium thiocyanate solution.
- The volume of potassium thiocyanate in the first sample was 2.2 mL.

III. RESULTS AND DISCUSSION

3.1. Metal recovery data containing silver from x-ray sheets with different extractors

The results contained in Table 01 were obtained from 200g of sample x-ray plates with different extractors. NaCl, NaOH and NaClO, respectively.

Table.1: - Results obtained for x-ray plates after use of Volhard Method and muffle purification.

Sample Used	Extraction Solution	Sample mass	Metal obtained containing Ag	g/100g
X-Ray Plates	NaCl	200g	1,02g	0,51
X-Ray Plates	NaOH	200g	0,41g	0,205
X-Ray Plates	NaClO	200g	0,00g	0,00

In relation to the recovery of silver-containing metal from solid x-ray sheet residues, the results were 0.51g for NaCl, 0.205 for NaOH and 0.00g for NaClO respectively, with NaCl being the best option for the extraction of Ag contained in the plates of x-ray, being that 58,80% more efficient than NaOH and in relation to the NaClO it was not possible to establish comparison for not having extracted metal of the sample.

3.2. Silver metal recovery data obtained from different phototractor fixators

The results contained in Table 02 were obtained from 200 mL of photolite fixative sample with different extractors. NaCl, NaOH and NaClO, respectively.

Table.2:- Results obtained for the graphite fixator after using the Volhard method with adaptation and purification in muffle.

Sample Used	Extraction Solution	Sample mass	Metal obtained containing Ag	g/100g
Photolithographic Fixer	NaCl	200mL	1,79g	0,895
Photolithographic Fixer	NaOH	200mL	1,67g	0,835
Photolithographic Fixer	NaClO	200mL	2,66g	1,330

The results obtained in the recovery of metal containing residual silver in photolite fixer in the presence of NaCl, NaOH and NaClO were 0.895, 0.835 and 1.330g respectively, which evidenced NaClO as the best option for the extraction of metal containing silver in residues of photolyte fixative. In quantitative terms, it is worth noting that NaClO was 37.21% more efficient than NaOH and 32.70% more efficient than NaCl.

When comparing the results obtained from the titration, which was 0.474 g of silver per 100 mL of solution, with NaCl extractors of 0.895 g per 100 mL, NaOH of 0.835 g NaClO of 1.330 g per 100 mL of sample, it was observed that the titration showed smaller values than those recovered with the extractors from photopolymer fixative residues. This difference could be related to sample storage time, formation of silver precipitate and titration errors.

With respect to the data quantified by titration of the x-ray plate sample, 0.453 g of silver per 100 mL of the sample were obtained, and the NaCl extractor recovered 56.29% of silver in relation to titration data. NaOH 22.73% and 0% NaClO. The results are the same as those found by Faria [20].

The results obtained by Bortoletto et al., [21] for silver recovery, using NaOH, NaCl and Activated Carbon as precipitating agents, demonstrated that NaOH as precipitating agent provided low silver removal, there was the appearance of undesired substance besides increase of the pH of the solution in the course of the process. The NaOH solution presented precipitation results when its concentration was changed to 1.5 mol/L, removing only

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10.3% of the silver present in the fixative, when its concentration was increased to 1.8 mol/L promoted a significant increase of 40, 1% in silver removal, however, the pH of the medium increased to 13.0. In the same study, it was observed that babassu coconut coal showed higher affinity with silver thiosulphate, adsorbing around 0.42 mg Ag g-1 of coal. Coals of the coconut shell and 119 (charcoal type) showed almost equal adsorption capacity [21]; [22].

Silva et al., [23] obtained a yield of 13.95% using NaClO and 12.39% using NaCl as precipitating agents, but considered as a non-viable process, as their yield is low compared to the recovery of silver from electrolytic bath, for example. Several authors have stood out with studies on treatment of silver residue, recovery of silver and in broader terms of health waste in general. Among these researchers are, Maciel; Liu; Cardoso [24]; Melo [25]; Bampi; Sechi; Gonçalves [26]. Carvalheiro; Mion; Liporini; Libardi [27]; Grigoletto; Santos; Albertini; Takayanagui [28]; Hoceva; Rodriguez [29]; Camargo; Motta; Lunelli; Severe [30]; Gunther [31]; Navarro, et al., [32]; Garcia; Zanetti-Ramos [33]; ANVISA [34]; Tramontini et al., [35]; Antunes [36]; Lippel; Baasch [37].

IV. CONCLUSIONS

With the results obtained it was possible to conclude that in the silver recovery process from x-ray plates and graphite fixator with the NaCl, NaOH and NaClO extractors, NaClO was the best option for the extraction of silver containing metal in fixator, being this 37,21% more efficient than NaOH and 32,70% more efficient in relation to NaCl. In relation to the recovery of this metal from x-ray film the results indicated NaCl as the best option for the silver extraction contained in the x-ray plates, being this 58.80% more efficient than NaOH and in relation to NaClO it was not possible to establish a comparison because it did not extract metal from the sample, which suggests the performance of new tests with this extractor. It is worth noting that the tests carried out indicated that it is feasible to recover residual silver from x-ray plates and fixator of photolithography, which may contribute to minimize the environmental contamination generated by inappropriate disposal of these materials.

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Arsenic-Contaminated Soils in the Urban Area of Ouro Preto, Minas Gerais, Southeastern Brazil

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Abstract— *Arsenic (As) is a toxic and carcinogenic element. Numerous As compounds are present in the environment and in biological systems. The most common exposure routes of humans to As are consumption of polluted water, gas inhalation or ingestion of soil dust, causing toxic and acute effects in tens of millions of victims all over the planet. In the Brazilian city of Ouro Preto, in the urban districts Piedade, Antônio Dias, Padre Faria, Taquaral and Alto da Cruz, 21 soil samples were collected at sites spaced about 200 m apart, in a 2 km^2 area, to analyze the physical properties, chemical constitution, mineralogy and presence of As. Of all samples, 15 had a predominantly clayey texture, and in 12 of these, As levels of > 250 mg.kg^{-1} were detected. In general, the As levels ranged from 6 to 925 mg.kg^{-1}. No primary or secondary As minerals were found, suggesting that As had been retained and adsorbed by Fe, Al and oxides and hydroxides and by clay minerals. The* predominant minerals were quartz, muscovite, kaolinite, goethite, hematite, illite and gibbsite.

Keywords—Arsenic, Contaminated Soil, Ouro Preto.

I. INTRODUCTION

The movement and mixture of different terrains as a result of anthropogenic activities may induce the development of new materials (soils, tailings, weathering rocks), which reflect characteristics of the underlying rock, but may lead to the formation of new compounds and substances in the environment, which can affect humans who get in touch with these materials.

In former, now abandoned, mining areas, tailing dumps were formed as a result of the extraction processes. They have the inherent characteristics of the ore and surrounding rock and are carriers of potentially hazardous chemical elements, at high concentrations. They may come to be a source of dispersion of these elements and, consequently, of environmental contamination, in particular in the case of trace elements such as heavy metals and metalloids. According to Kabata-Pendias et al. (2004), the transfer of chemical elements between the various constituent soil phases can be considered the main process governing their solubility, mobility and availability in surface water, groundwater and living organisms.

The availability of heavy metals in soils depends on the presence of the elements in the soil solution, defined by the composition and reaction of the systems, oxidation conditions and reaction kinetics. These in turn depend on the soil properties and the tendency to form insoluble compounds, which are precipitated and coprecipitated with other minerals and form complexes with organic matter and adsorb other minerals.

Mining areas in particular are drastically altered zones and, in this context, the assessment of soil contamination is the first step in the characterization of degraded areas.

In Brazil, specifically in the region of the Quadrilátero Ferrífero (QF), previous studies report As-contamination of stream sediments in some rivers, surface waters and groundwater. In stream sediments of the Rio do Carmo, Eleutério (1997) reported As contents of 620.0 µg.g^{-1} in the summer and 1.268 µg.g^{-1} in the winter. In the counties of Nova Lima and Santa Bárbara, in the QF, Mattschullat et al. (2000) analyzed As concentrations in urine of 7 to 12-year-old children. These authors confirmed human As contamination at concentrations between 2 and 106 µg.L^{-1}, and concentrations of > 40 µg.g^{-1} in 22% of the children. In Ouro Preto, Pimentel (2001) analyzed water from abandoned gold mines and springs and detected As contents between 0.07 and 2.30 mg.L^{-1}. In studies in the former gold-mining districts, Borba et al. (2002) analyzed the As concentrations of sediments in the hydrographic basins of the rivers do Carmo, Conceição and das Velhas. These authors reported As concentrations in sediments of up to 4000 mg.kg^{-1} and of 350 µg.L^{-1} in surface waters, while in the groundwater of mines in Ouro Preto and Mariana they found As concentrations of up to 2,800 µg.L^{-1}. In groundwater consumed by the population of Ouro Preto, Gonçalves et al. (2007) detected As levels of 224 µg.L^{-1}.

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In this context, the objective of this study was to characterize the physical, chemical and mineralogical properties of the soils of five urban sectors of Ouro Preto, to deepen the understanding of the influence of the matrix rock on the genesis, evolution processes and soil properties, as well as to understand and evaluate the As concentrations they contain.

General characteristics of the study area

The studied area lies in the southeastern part of the QF. This region covers an area of 7.200 km^2 in the center-south part of the state of Minas Gerais.

The geology of Ouro Preto consists of a set of metasedimentary and metavolcanic rocks derived from the Supergroups Minas and Rio das Velhas (Figure 1). The Supergroup Minas consists of a Paleoproterozoic metasedimentary sequence grouped, from base to top, in: Caraça, Itabira and Piracicaba (Derby 1906; Harder & Chamberlin 1915; Dorr 1969; Ladeira 1980; Alkmim & Marshak 1998).

The Supergroup Rio das Velhas consists of a volcanic-sedimentary sequence corresponding to a greenstone belt, divided by Dorr et al. (1957), from base to top, in the groups Nova Lima and Maquiné. The Group Nova Lima is divided into three units: metavolcanic (basal); chemical metassedimentary (intermediate) and chemical metastatic (at the top). The Group Maquiné is divided, from base to top, in the formations Palmital and Casa Forte. The stratigraphic section of the study area consists of the following units, from base to top: metapelitic sericitic; quartzitic; carbonaceous metapelitic, banded iron-rich and dolomitic carbonate sequences. These units correspond, respectively, to the Group Nova Lima, Moeda formation, Batatal formation, Cauê and Gandarela formation, Cercadinho formation, Group Sabará and lateritic covers (Dorr 1969). These units are distributed in continuous layers with vertical variations.

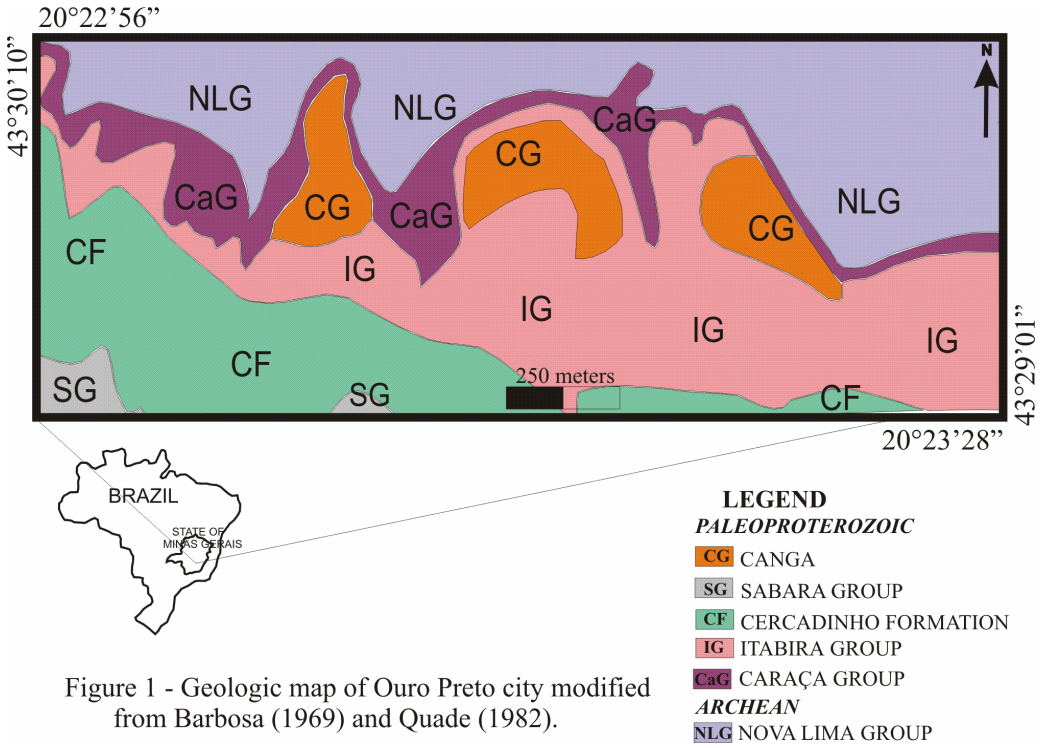

Figure 1 - Geologic map of Ouro Preto city modified from Barbosa (1969) and Quade (1982).

II. MATERIALS AND METHODS

Twenty-one soil samples were collected in the county of Ouro Preto, specifically in the urban districts Padre Faria, Piedade, Antônio Dias, Morro Santana and Taquaral (Figure 2).

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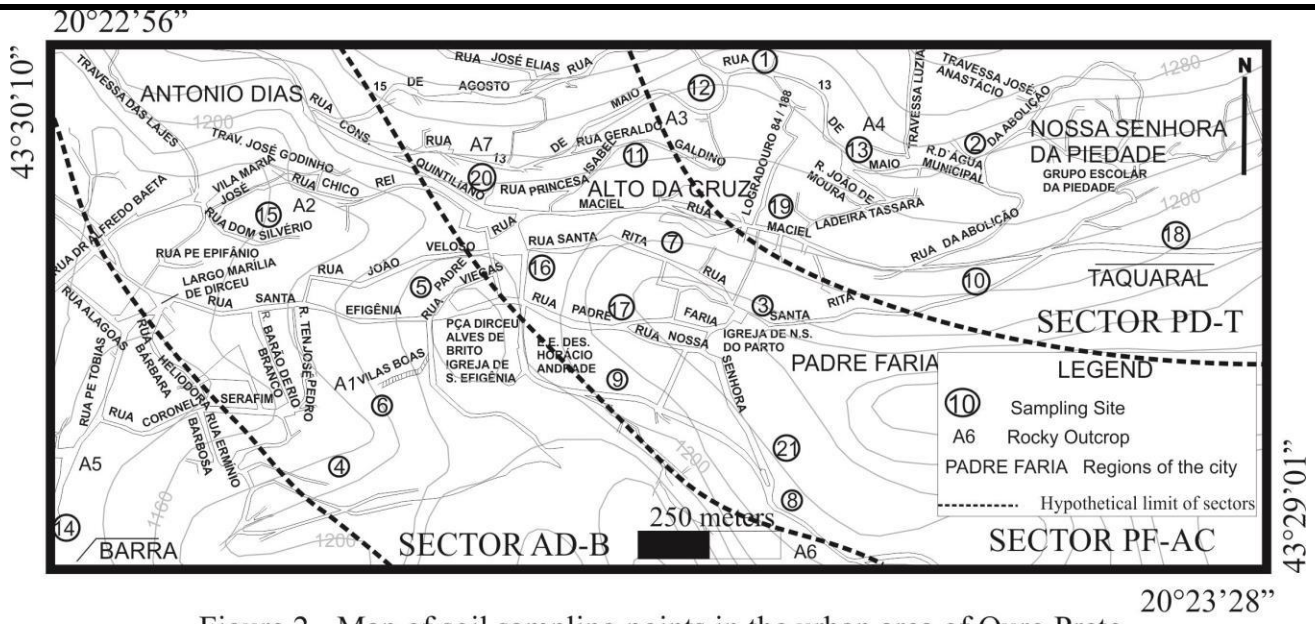

Figure 2 - Map of soil sampling points in the urban area of Ouro Preto

The soil was sampled systematically, at predetermined regular intervals. The distance between the sampling points was not more than 150 m. The points were localized by UTM coordinates and identified by the address of the nearest residences.

Each sample consisted of four sub-samples collected within a 5 m - diameter circle at each sampling point, using a stainless steel core, inserted to a depth of 10 cm. The composite samples (approximately 2.0 kg) were quartered, and sub-aliquots of approximately 100 g of each quarter were filled into labelled sample vials. The soil samples were air-dried, crumbled and sieved (2 mm plastic mesh). The particle size of the resulting air-dried fine soil (ADFS) was analyzed for the fractions sand (2-0.05 mm), silt (0.05-0.002 mm) and clay (<0.002 mm).

In the Laboratory of Mineralogy, of the Department of Soils of the Universidade Federal de Viçosa (UFV), the mineralogical composition was analyzed by X-ray diffraction using a Rigaku D-Max diffractometer equipped with a cobalt tube (Co-Kα radiation, λ = 1,79026 Å), operated at 40 kV and 30 mA. The scanning range was between 4 and 50Â ° 2θ, with a step size of 0.05Â ° and 1 s per step. The chemical composition was determined by X-ray fluorescence (XRF79C - Lithium tetraborate fusion) and the total As content by the method of hydride generation (AAS/HAS14B). All chemical analyses were carried out in the laboratories of the company SGS - Geosol, in Belo Horizonte - MG.

III. RESULTS AND DISCUSSION

In the study area, covering five completely urbanized districts of the city of Ouro Preto, the observation of and access to exposed rocks were impaired. Table 1 shows the lithology of outcrops close to the sampling sites and Figure 2 their locations. Table 2 shows the results of the particle-size analysis of the clay, silt, and coarse and fine sand fractions. The mean and median values of all studied variables are close to each other and symmetrically distributed, which can be confirmed by the asymmetry and kurtosis values close to zero. For being field data, the fitting of the theoretical distribution was only approximate (Warrick & Nielsen 1980).

Table.1: Lithography of outcrops in the study area

Outcrop	Lithology
A1	Quartzite, iron-rich quartzite, and phyllite
A2	Iron-rich quartzite, sericitic and with coarser quartz grains
A3	Quartzite, metagrawacke and chlorite, phyllite
A4	Canga, quartzite, iron-rich quartzite, phyllite, dolomite, chlorite schist
A5	Canga, iron-rich quartzite, conglomerate, phyllite, dolomite, chlorite schist
A6	Canga, quartzite, iron-rich quartzite
A7	Conglomerate, phyllite, dolomite, chlorite schist

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Table 2 - Descriptive statistics for the particle-size properties of 21 soil samples

Particle-size properties	Values					Coefficients	
	Mean	Median	Minimum	Maximum	SD	Variation	Kurtosis
Clay (g kg^{-1})	404.36	370.00	5.80	710.20	186.81	46.20	-0.52
Silt (g kg^{-1})	155.56	155.60	108.30	212.80	34.73	22.33	-1.38
Fine sand (g kg^{-1})	301.02	299.50	73.70	610.00	136.72	45.42	0.01
Coarse sand (g kg^{-1})	139.05	163.00	30.20	236.70	75.11	54.02	-1.35

Data normality is not a requirement, whereas it is relevant that the sample distribution does not have very long tails in these cases (Cressie 1991). Thus, based on the results of Table 2, it was assumed that the sample distributions of the particle-size properties were sufficiently symmetrical.

In different parts of the world, studies reported the natural presence of arsenic or As contents as a result of some anthropogenic activity in soils. In Brazil, Curi and Franzmeir (1987) found As levels in Latossolo Vermelho férrico between 6 and 10 mg.kg^{-1}, whereas in Latossolo ferrífero, the concentration was 36 mg.kg^{-1}. In the Quadrilátero Ferrífero, Matschullat et al. (2000) found soil As concentrations between 200 and 860 mg.kg^{-1}, in the sub-basin of the Córrego do Manso, Andrade et al. (2009) detected As contents between 46.5 and 238.7 mg kg^{-1}, and in Latossolos of the Cerrado,

Marques (2000) found As concentrations of the order of 38 mg.kg^{-1}. In 43 soil samples of the state of Paraná, Licht et al. (2005) found peak As concentrations of 29.40 mg.kg^{-1} and an average value of 7.5 mg.kg^{-1}. In this study, soil As concentrations from 6 mg.kg^{-1} to 925 mg.kg^{-1} were found in the urban area of Ouro Preto (Table 3).

In the analyzed soils, a strong relation was observed between samples with predominantly clayey texture and high As levels (Table 4). Regarding the 10 major oxides, the results of the soil chemical analysis (Table 5) indicated a similar behavior of the samples 10, 11, 12, 13 and 20, as well as of 1 to 9, 14 to 19 and 21. This is a characteristic of tropical soils under high incidence of rainfall. The concentrations of water-soluble forms of the elements, such as [$Si(OH)_4$], Ca^{2+}, Mg^{2+}, Na^{+}, K^{+}, Mn^{2+}, H_2PO^{4-} decrease from rock to soil, whereas insoluble elements such as $Al(OH)_3$, Fe_2O_3 and FeOOH increase from rock to soil. The SiO2 concentration in soils is higher, because a part of the silica released from rocks by weathering is fixed in the soil as a clay component or in the form of quartz, while another part is washed away by the water.

Table.3: Location of sampled points, As contents and textural classification of the 21 soil samples.

Samples	Longitude	Latitude	Texture	Total As (mg kg^{-1}) **D.L. (1)
SOL 01	657496	7745330	Sandy clay loam	660
SOL 02	657878	7745156	Clayey loam	725
SOL 03	657510	7744899	Sandy clay loam	353
SOL 04	656764	7744758	Sandy loam	46
SOL 05	656897	7744955	Sandy loam	130
SOL 06	656832	7744824	Sand	6
SOL 07	657302	7745025	Clay	386
SOL 08	657523	7744640	Sandy clay loam	17
SOL 09	657300	7744790	Sandy loam	34
SOL 10	657856	7744943	Very fine clayey	22
SOL 11	657281	7745216	Clay	610
SOL 12	657468	7745281	Very fine clayey	925
SOL 13	657650	7745160	Very fine clayey	515
SOL 14	656451	7744678	Sandy loam	245
SOL 15	656639	7745085	Clay	910
SOL 16	657110	7744990	Sandy clay	686
SOL 17	657305	7744890	Sandy clay loam	61
SOL 18	658154	7745011	Clay	905
SOL 19	657458	7745064	Sandy clay loam	840

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SOL 20	657022	7745165	Clay	925
SOL 21	657534	7744717	Sandy loam	186

Table.4: Arsenic contents and predominant textures of the soil samples.

As concentrations mg kg^{-1}	Sandy soil texture	Clayey soil texture	Total
<50	3	2	5
50 – 150	1	1	2
151 -250	2	0	2
>250	0	12	12
Total	6	15	

Table.5: Results of semiquantitative analysis, by X-ray fluorescence.

	SiO_2	Al_2O_3	Fe_2O_3	CaO	MgO	TiO_2	P_2O_5	Na_2O	K_2O	MnO
Samples	%	%	%	%	%	%	%	%	%	%
****D.L.**	0.10	0.10	0.01	0.01	0.10	0.01	0.010	0.10	0.01	0.01
SOL 01	57.70	14.60	17.60	0.23	0.65	0.47	0.127	0.28	2.24	0.11
SOL 02	47.30	9.02	32.80	1.01	0.56	0.71	0.166	<0.10	0.9	0.07
SOL 03	55.20	9.11	19.70	1.97	1.16	0.54	0.404	<0.10	0.98	0.18
SOL 04	76.20	6.53	11.10	0.68	0.51	0.46	0.091	0.14	1.05	0.25
SOL 05	66.50	7.38	17.60	1.06	0.94	0.45	0.106	0.13	1.45	0.54
SOL 06	97.90	0.47	1.50	0.04	0.11	0.03	0.013	<0.10	0.11	0.03
SOL 07	36.00	6.01	49.60	0.04	0.28	2.00	0.149	<0.10	0.42	0.12
SOL 08	62.40	9.82	18.10	0.11	0.31	0.98	0.086	0.16	1.08	0.50
SOL 09	60.70	14.40	11.60	1.48	1.16	0.76	0.068	0.20	2.17	0.05
SOL 10	24.90	1.05	70.80	0.87	0.34	0.09	0.164	<0.10	0.06	0.08
SOL 11	29.20	3.02	54.40	2.38	1.64	0.09	0.299	0.23	0.33	0.24
SOL 12	25.30	0.94	70.70	0.10	0.28	0.03	0.191	0.21	0.17	0.10
SOL 13	22.80	1.38	71.90	0.28	0.33	0.09	0.321	<0.10	0.04	0.07
SOL 14	67.40	6.89	12.60	2.50	1.80	0.90	0.172	0.24	1.14	0.54
SOL 15	43.00	1.77	49.50	0.12	1.12	0.09	0.179	<0.10	0.22	0.19
SOL 16	39.70	23.00	20.90	0.20	0.51	0.83	0.228	0.25	1.45	0.11
SOL 17	61.70	14.00	12.10	1.30	0.92	0.67	0.117	0.17	2.19	0.10
SOL 18	44.10	3.96	44.00	0.43	0.40	0.30	0.220	<0.10	0.52	0.09
SOL 19	44.50	3.47	33.80	3.95	2.08	0.26	0.165	<0.10	0.43	0.21
SOL 20	28.50	4.13	58.10	0.15	0.44	0.40	0.375	<0.10	0.31	0.82
SOL 21	62.00	12.10	14.40	0.42	0.53	0.83	0.113	0.18	1.85	0.17

The oxides CaO, MgO, Na_2O and K_2O are easily leached by the water, which explains the lower levels in the soil. The mobility of Al_2O_3, MnO and P_2O_5 is low, although they usually remain in the soil after release from the rocks. In oxidizing environments (as in the studied soils), the mobility of hematite (Fe_2O_3) is low, and it remains in the soil, which also contains Fe_3O_4, found in opaque minerals such as magnetite. Titanium oxide (TiO_2), once released from the rock, remains in the soil as ilmenite and rutile (Piccirilo & Melfi 1988). The arsenic enrichment in surface soils, compared to the concentrations of the parent rock, seems to reflect the influence of external sources (Kabata - Pendias 1992). As and P are chemically similar. In soils, both form insoluble compounds with Al and Fe. Arsenic forms are dominant in most soils, although As has less affinity with Al oxides than phosphates.

The As in the soil can behave similarly to phosphorus, being strongly adsorbed by the oxides, although its chemistry is far more complex, due to the different oxidation states (O'neill 1990). In the studied soils, As can bind to total Fe oxides (crystalline and non-crystalline oxides), manganese oxides and organic matter. Iron

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oxides are rather effective in immobilizing this metalloid (As), in particular non-crystalline As (El Khatib et al. 1984; Carbonell-Barrachina et al., 2004). The soil mineralogical analysis showed that the sand fraction consists mostly of quartz and hematite (Table 6). The mineralogy of the silt and clay fractions is practically the same, containing mainly goethite,gibbsite, mica, kaolinite and talc. In general, the mineralogical analysis showed the disappearance of the less weathering-resistant minerals from altered rock samples, which may also be the result of the predominance of iron compounds in these samples. Little weathered soils, as in this case, tend to reflect the mineralogical composition of the parent material.

Table.6: Results of X-Ray Diffraction analysis

SAMPLES	CLAY	SILT	SAND
SOL 1	Il, Ct, Gt, Gb	Mu, Ct	Qz, Mu, Ct, Hm
SOL 2	Il, Ct, Gb	Mu, Ct, Gb	Qz
SOL 3	Il, Ct, Gb	Mu, Ct, Gb	Qz, Ct, Hm
SOL 4	Il, Ct, Gb	Mu, Ct, Gb	Qz, Um
Solo 5	Il, Ct, Gt, Gb, Ta	Mu, Ct, Gb, Ta	Qz, Mu, Ct, Hm
SOL 6	Il, Ct, Gt, Gb, Ta	Mu, Ct, Qz, Gt	Qz
SOL 7	Il, Ct, Gt, Gb, Ta	Mu, Gt, Ta	Qz, Mu, Hm
SOL 8	Il, Ct, Gt, Gb	Mu, Gt, Ta	Qz, Mu, Gb, Hm
SOL 9	Il, Ct, Gt, Gb, Ta	Mu, Gt, Gb, Ta	Qz, Hm
SOL 10	Gt	Mu, Gt, Gb, Ta	Qz, Gb, Hm
SOL 11	Gt	Mu, Gt, Qz	Qz, Mu, Gt, Hm
SOL 12	Il, Ct, Gt, Mh	Qz, Gt, Hm, Mh	Qz, Mu, Gt, Hm
SOL 13	Ct, Gt, Ru	Mu, Ct, Gt, Hm	Qz, Gt, Hm
SOL 14	Il, Ct, Gt	Mu, Ct, Gt, Gb, Ta	Qz
SOL 15	Il, Ct, Gt, Ta	Mu, Ct, Gt, Ta	Qz, Mu, Ta
SOL 16	Il, Ct, Gt	Mu, Ct, Gb, Gt	Mu, Ct, Gb, Gt
SOL 17	Ct, Il, Gt, Gb	Mu, Ct, Gb	Qz
SOL 18	Ct, Gt	Mu, Ct, Gt, Ta	Qz
SOL 19	Ct, Il	Mu, Ct, Gt, Ta	Qz
SOL 20	Ct, Gb	Mu, Ct, Gt, Ta	Qz, Hm
SOL 21	Il, Ct	Mu, Ct, Ta	Qz

The mineralogy of the soils selected for having maximum As contents is shown in Figure 3. Quartz was found in all studied soils, highlighting the marked presence of talc in sample SOL 15 and of iron oxides such as hematite and maghemite in sample SOL 12. Arsenic-containing primary minerals, e.g. arsenopyrite, scorodite, kolfanite or kraunite, were not detected. Talc and iron oxides may be As carriers, according to the ionic radius and valence (V) of As, facilitating the incorporation

in the tetrahedra as a substitute for the Si^{4+} of the talc mineral. The same dos not apply to quartz, which does not assimilate As in its structure. The results of the mineralogical characterization of the silt fraction were similar to those of the sand fraction, with high proportions of quartz and of the talc and hematite/maghemite minerals in the samples SOL 15 and SOL 12, respectively.

High As contents were found in talc-type minerals by Moen et al. (2010), which was attributed to the presence of these mineral in the crystalline structure, characterizing them as possible primary minerals containing As. Arsenic (III) can participate in the crystalline structure of Fe oxides due to the ease of As incorporation in this oxidation state into the crystalline structure of maghemite and hematite, the main As-containing minerals in mineralized former mining areas (Walker & Jamieson 2005). Arsenates coprecipitated with amorphous iron oxides can be stabilized and crystallized during the transformation of amorphous into crystalline oxides (Ford 2002).

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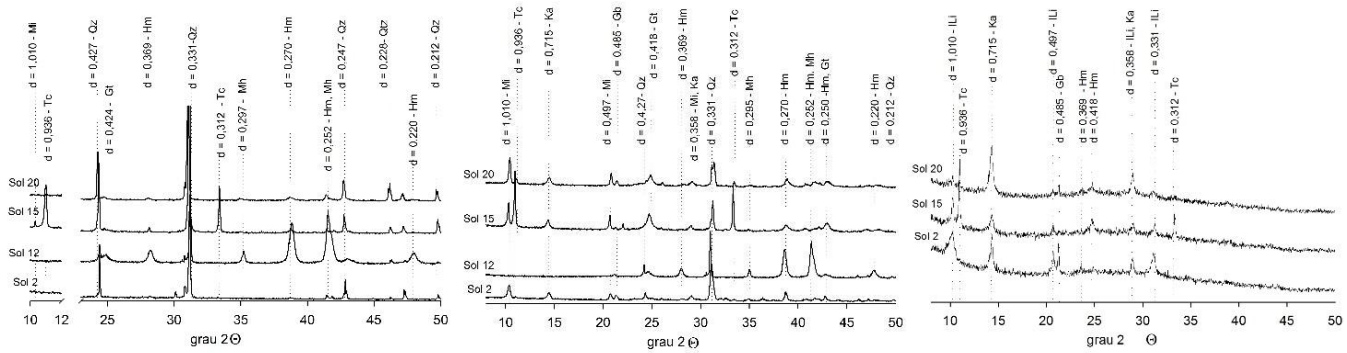

Fig3: Diffractograms of the sand, silt and clay fractions in the samples SOL 12,15,20.

In this study, Fe and clay contents were highest in sample SOL 12, suggesting hematite in the clay fraction as controllers of As availability. On the other hand, sample 2 contained high SiO_2 and lower clay contents, suggesting clay minerals (minerals 1:1 and 2:1) as possible controllers of As in soil. In this context, As availability can be higher under low oxide conditions and poor adsorption capacity of kaolinite. In the clay fraction, the minerals kaolinite, gibbsite and iron oxides were identified. Among these, the most efficient in terms of As adsorption in the soil solution are the Fe and Al (Pierce & Moore, 1982) and Mn oxides Oscarson et al. (1981).

These Al, Fe and Mn oxides and hydroxides are amphoteric minerals that occur as discrete phases and/or associated with other minerals in the form of coatings (Ax and Trivedi 2002). Importantly, these minerals have a large specific surface (>400 m^2 g^{-1}) and contain micropores and different adsorption sites, which makes them influential with regard to the mobility, distribution and attenuation of heavy metals (Axe & Trivedi 2002).

In cases of densely populated urban areas of Brazil and some other countries, it is relevant to reconsider the legislation with regard to the maximum admissible value for any type of land use. In Germany, the reference values of As in soils, for intervention established by environmental agencies for playgrounds, residential areas, parks/leisure areas, commercial and industrial areas are 25, 50, 125 and 140 $mg.kg^{-1}$, respectively .

In the state of Pernambuco, studies for the determination of soil As thresholds found mean As levels of 0.43 mg kg^{-1}, 0.36 mg kg^{-1} and 0.52 mg kg^{-1} in the surface horizons of the regions Zona da Mata, Agreste (sub-humid woodland) and Sertão (semi-arid region), respectively. A mean content close to that of the surface was found in the subsurface horizons of the Agreste, with a mean of 0.39 mg kg^{-1}, and lower values in the regions of Zona da Mata and Sertão (0.26 and 0.25 mg kg^{-1}) (Biondi 2010). For the soils of the state of Minas Gerais, the As reference values found ranged from 3.8 to 50.6 mg kg^{-1} Caires (2009). In the state of São Paulo, the reference soil As value was established at 3.5 mg kg^{-1}, the alert value is 15 $mg.kg^{-1}$, whereas the levels for intervention in agricultural, residential and industrial areas are 25, 50 and 100 $mg.kg^{-1}$, respectively CETESB (2005).

IV. CONCLUSIONS

1 - In the city of Ouro Preto, the soils of the urban sectors Santana, Padre Faria, Piedade, Antônio Dias contain high total As levels, which exceed the maximum admissible value for any type of use by far. Dust from contaminated soil may have toxic effects if inhaled or ingested by humans, particularly by children, who are most susceptible to this type of contamination as a result of their habits. Soil ingestion has been recognized as the most relevant source of heavy metal contamination.

2 – Among the criteria and guiding values of soil quality for the presence of chemical substances established by CONAMA, Resolution No. 420 (2009) determined a soil As content of 15 $mg.kg^{-1}$ for a given area as a situation requiring prevention and a content of 55 $mg.kg^{-1}$ in a residential area as requiring investigation. Averaged across the 21 soil samples studied, the mean As concentration was 437.47 $mg.kg^{-1}$.

3 -Soils with a clayey texture accounted for 71% of all samples, and of these, 80% contained As levels of > 250 $mg.kg^{-1}$.

4 - The mineralogical analyses identified silicates, predominantly in quartz, muscovite and kaolinite. A high proportion of a variety of iron and aluminum oxides and/or oxides-hydroxides, represented by goethite, hematite and gibbsite, was also found.

5 - The distribution of As in the soil throughout the study area varied according to the intrinsic characteristics of the parent material.

6 - No autigenic or secondary As minerals were detected in the studied soils. The absence of these minerals in the analyzed soils means that a greater amount of As is retained in the crystalline and noncrystalline iron oxides

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(amorphous materials) formed during the meteorization processes of the bedrock.

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Synthesis, characterization and photocatalytic activity of activated charcoal prepared from vegetable sponge for photocatalytic degradation of Rhodamine B dye

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Abstract— *An alternative for the correct treatment and final disposal of these wastes are the Advanced Oxidative Processes, in particular heterogeneous photocatalysis. Thus, the vegetable sponge (Luffa cylindrica) was used for the synthesis of activated carbon and photocatalysts doped with TiO_2, for application in heterogeneous photocatalysis. The samples were characterized by diffuse reflectance spectroscopy (DRS-UV), nitrogen porosimetry, zeta potential (ZP) and scanning electron microscopy (SEM). To evaluate the photocatalytic activity, experiments were carried out in a stirred batch reactor, with the photocatalyst in suspension, under ultraviolet and visible radiation and as the target molecule was used the rhodamine B dye. The doped photocatalyst with Ti^{+4} synthesized from the activated carbon prepared with sucrose and glycine showed the best photocatalytic activity in the degradation of the RhB dye of 66 % ($k = 0.0088\ min^{-1}$, under ultraviolet radiation) and 49.8 % ($k = 0.0059\ min^{-1}$, under visible radiation) after 120 minutes of the reaction, while, under the same conditions, the commercial catalyst P25 showed a degradation of 53.92 % and 40.44 %, respectively.*

Keywords— ***Dyes; Heterogeneous photocatalysis; Titanium doping; Vegetable sponge; Degradation.***

I. INTRODUCTION

The growing urbanization and industrialization of society have reflected an increase in the generation of wastes, whether domestic or industrial, and its inadequate disposal has caused a serie of serious environmental damages (Dunn, 2012). Thus, considering that there is a fine line between the human development and water quality, it is indispensable to maintenance of good quality of the water sources to there is a full economic development and ensure health care of the population.

In addition, wastes from industrial and agricultural activities constitute a large part of the amount of toxic or rich residues in microbial activity that are currently generated(Mourão and De Mendonça, 2009). Moreover, despite the fact that Brazil is the pioneer in the development of regulatory standards for the disposal of liquid effluents, these wastes still constitute a major public health problem (Almeida *et al*., 2012).

At the same time, due to its physicochemical and biochemical characteristics, which may be biologically constituted, industrial wastes are destined to a receiving body, directly or indirectly, and can not be used economically or technically. Before this discharge, the constituents of these wastes must be treated according to sanitary, environmental and legal standards previously established in environmental legislation.

The treatment of effluents and industrial wastes is aimed at the preservation and integrity of the environment and receiving waters, as well as complying with norms and legislation on effluent emission standards. In this case, seeks to minimize and/ or avoid through different treatment technologies. Among these, stands out the Advanced Oxidative Processes (AOPs), technologies with the potential to oxidize a large variety of complex organic compounds (Ma *et al*., 2014), which are not removed by conventional sewage treatment processes.

In parallel, these methods are based on the action of a highly oxidizing species (the hydroxyl radical, •OH),

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which reacts with the various organic compounds, mineralizing them in non-toxic forms such as CO_2 and H_2O (Pereira *et al.*, 2010). Thus, the great advantage of AOPs is that, during the treatment of the organic compounds, they are destroyed and not only transferred from one phase to another, as in some conventional treatment processes. Among the AOPs, stands out the heterogeneous photocatalysis, a process that involves redox reactions induced by radiation on the surface of semiconductors (photocatalysts).

The ideal photocatalyst to heterogeneous photocatalysis should to have unique electronic and optical properties, high physical and chemical stability, low cost and non-toxicity (Liu *et al.*, 2011). However, some drawbacks of photocatalysts such as wide band gap energy and high rate of electron–hole recombination restricts its range of practical applications only under UV irradiation ($\lambda < 388$ nm) (Xu *et al.*, 2010; Lin *et al.*, 2011). Therefore, many research works have focused to extend its optical absorption edge from UV to the visible-light region and to decrease the electron–hole recombination rate. The prominent way to encounter these limitations is to alter the band gap energy via doping of some metals (e.g., Cu, Fe, Zn, Co, Mg, Al) and non-metals (e.g., N and Cl) (Zhang *et al.*, 2012; Wu *et al.*, 2011; Abed *et al.*, 2015).

Therefore, the present work aims to evaluate the potential of heterogeneous photocatalysts prepared from a vegetable sponge (*Luffa cylindrica*) in the form of activated carbon, evaluating the effect of doping with TiO_2 (Ti^{+4}) on the degradation of Rhodamine B dye (RhB) in aqueous solution under ultraviolet and visible radiation. For comparative reasons, commercial titania (Evonik Aeroxide P25) was also employed.

II. MATERIALS AND METHODS

2.1 Materials

Three combustible reagents were used to prepare the activated charcoal from vegetable sponge, such as glycine ($C_2H_5NO_2$, Vetec, 98,5%), sucrose ($C_{12}H_{22}O_{11}$, Labsytih, 99,95%) and urea (CH_4N_2O, CAQ, 99%). Rhodamine B ($C_{28}H_{31}ClN_2O_3$, Próton Química, P.A.) was used as the dye probe for the degradation tests. TiO_2 (Evonik Aeroxide P25). All other chemicals and reagents, being of analytical grade, were purchased from Merck (Germany) and used without further purification. Double-distilled deionized water was used for the preparation of the solutions used in the catalytic tests.

2.2 Synthesis of activated charcoal

Initially, the vegetable sponge was prepared, where it was manually cut, washed and dried (DeLeo 4400 W, Brazil) at 80 ºC for 12 hours. Afterwards, the combustion process occurred, where heat was generated through the heating elements, which was transferred to the surface of the sample. Finally, three different fuels (glycine, sucrose and urea) were used. Thus, three samples with different compositions of the fuels were prepared.

The combustion process was performed in muffle (Quimis Q318M, Brazil), where after carbonization, the material was macerated in order to obtain a fine and uniform texture. In addition, the method of synthesis of activated charcoal by combustion is characterized by being simple, producing high purity powders with high specific area and small particle size (Barros *et al.*, 2005).The labels that were employed are described in Table 1, which have been designated as x-A.C., where x refers to the fuels used in the synthesis.

Table.1: Compositions of activated charcoal (A.C.) in proportions

A.C.	vegetable sponge	sucrose	urea	glycine
SucGly-A.C.	0,422 g	0,900 g	0	0,200 g
Suc-A.C.	0,455 g	1,370 g	0	0
UreGly-A.C.	0,450 g	0	0,700 g	0,700 g

2.3 Synthesis of photocatalysts

The photocatalysts were synthesized by the doping of the activated charcoal with the photoactive metal precursor, in this case the TiO_2. Thus, for doping with Ti^{+4}, aqueous solutions were prepared using the activated charcoal (xA.C.) with titanium in the concentration of 25% w/w (Ti^{+4}/ xA.C.). Each solution was placed under continuous stirring at room temperature for 90 minutes and calcined at 450 ° C (heating rate 10 °C min^{-1}) for 4 hours. Photocatalysts doped with Ti^{+4} were labeled as xTi-A.C., where x refers to the different fuels, according to Table 2.

Table.2: Photocatalysts doped with Ti^{+4}

Sample	Label
A.C. + sucrose + glycine + TiO_2 (25 % w/w)	SucGlyTi-A.C.
A.C. + sucrose + TiO_2 (25 % w/w)	SucTi-A.C.
A.C. + urea + glycine + TiO_2 (25 % w/w)	UreGlyTi-A.C.

2.4 Characterization of photocatalyst

The specific surface area, pore diameter and pore volume of the samples were calculated from nitrogen measurements performed on a Micromeritics Gemini 2375 instrument. The energy band gap was determined by

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diffuse reflectance spectroscopy (DRS-UV) in a UV-visible spectrophotometer (Cary 100 Scan Spectrophotometers) equipped with an integrating sphere with a diameter of 60 mm using $BaSO_4$ as a standard. The scanning electron microscopy (SEM) was used to characterize the morphology of the photocatalysts using a scanning electron microscope-energy dispersive spectrometer X-ray JEOL model JSM 5800 operating between 5 and 20 and the samples were coated with a thin layer of conductive carbon by a sputtering technique. The zeta potential (ZP) was measured on a Malvern Zetasizer® nanoZS-style instrument.

2.5 Photocatalytic activity

Photocatalytic studies were performed in a 50 mL slurry reactor. In a typical reaction, 25 mL of the rhodamine B aqueous solution (9.58 M, pH ≅ 4.3) was introduced into the stirred tank reactor (STR) along with 0.0175 g of catalyst. The mixture was then stirred and illuminated with UV–visible light using a 125WHg vapor lamp (General Electric). The visible light source was a 125W mercury vapor lamp associated with a polycarbonate filter that excludes wavelengths below 385 nm. For the ultraviolet configuration, a similar lamp with a modified bulb was used. The radiation was adjusted to 202 W m^{-2} for the visible range (Pyranometer Type SL 100, Skilltech Instruments) and 61.8 W m^{-2} (Radiometer Series 9811, Cole-Parmer Instrument Company) for the UV range. The reaction temperature was maintained at 30 ± 2 ºC through continuous water circulation in the outer jacket of the STR. A blank phenol solution (without catalyst) was used as a control test. Then, the lamp was turned on, and an aliquot of the sample solution was withdrawn from the reactor at regular intervals (0, 5, 15, 30, 60, 75, 90 and 120 min). The photocatalyst was separated from the solution by centrifugation (Cientec CT-5000R) for 20 min at 5,000 rpm. The absorbance of the remaining dye in the solution was measured using a Varian Cary 100 UV-vis spectrophotometer (at a wavelength of 553 nm). The absorbance was correlated to the concentration of dye through a calibration curve where Abs = 0.0168 C (mg L^{-1}) (R^2 = 0.9911; n = 7). All of the photocatalytic tests were performedin duplicate (with error values less than 5%).

2.6 Photodegradation kinetics

Kinetics interpretations were conducted as a function of the remaining concentration of phenol in solution over time. Data were fitted as kinetic model of Langmuir-Hinshelwood (L-M)(Konstantinou and Albanis, 2004; Gaya and Abdullah, 2008; Herrmann, 2005), according to equation (1):

$$-r_i = -\frac{dC_i}{dt} = \frac{\kappa_S . K . C_i}{1 + K . C_i} \quad (1)$$

where κ_s is the true photodegradation rate of the organic compound, C_i the concentration of the compound, t the illumination time, and K the adsorption coefficient of the compound to be degraded. κ_s is related to several parameters such as mass of catalyst, efficient photon flow and layer of oxygen. The L–Hmodel can be simplified to a pseudo-first-order kinetic equation and κ is the apparent rate of the pseudo-first-order reaction, according to equations (2) and (3) (Konstantinou and Albanis, 2004):

$$-r_i = -\frac{dC_i}{dt} = \kappa_S . K . C_i \quad (2)$$

$$\ln\left(\frac{C_{io}}{C_i}\right) = \kappa_S . K . t = \kappa . t \text{ or } C_i = C_{io} . e^{-\kappa t} \quad (3)$$

Pseudo first-order reaction rate constant was determined from the slope of the linear regression of ln(Co Ci^{-1}) *versus* time.

2.7 Statistical analysis

The SPSS Statistical System (SPSS for Windows, version 19,IBM®) was used to analyze the relationships among thedata. All statistical tests were performed at the $p<0.05$level of significance. The Spearman correlation coefficient(r_p) was used as a non-parametric measure of statisticaldependence between two variables, without making anyassumptions about the frequency distribution of thevariables.

III. RESULTS AND DISCUSSION

3.1 Catalyst characterization

xA.C. and the photocatalysts doped with titanium (xTi-A.C.) were characterized by scanning electron microscopy (SEM), diffuse reflectance spectroscopy in the ultraviolet (DRS-UV), nitrogen porosimetry and zeta potential (ZP) measurements. SEM was used for morphological analysis. For textural analysis of the catalyst, nitrogen porosimetry and zeta potential measurements were used. DRS-UV was used to evaluate the structural properties of the catalysts. Table 3 shows the results of analysis for the characterization of the photocatalysts. For comparative, the results of the commercial catalyst P25 were also determined.

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*Table.3: Results of the surface area (S_{BET}), pore diameter (Dp), pore volume (Vp), band gap energy (Eg), absorption wavelength (λ) and zeta potential (ZP) of the Evonik Aeroxide P25, activated charcoal prepared from vegetable sponge a*nd doped with Ti^{+4}

Sample	P25	SucGly-A.C.	Suc-A.C.	UreGly-A.C.	SucGlyTi-A.C.	SucTi-A.C.	UreGlyTi-A.C.
S_{BET} (m^2 g^{-1})	56	138.42	17.81	70.80	634.51	174.23	326.56
Dp (nm)	4.8	16.36	3.2	2.40	19.95	3.51	5.23
Vp (cm^3 g^{-1})	0.07	0.057	0.0014	0.042	0.32	0.002	0.078
λ (nm)	371.25	220.64	150.67	184.25	441.28	375.76	410.60
Eg (eV)	3.34	5.62	8.23	6.73	2.81	3.30	3.02
ZP (mV)	-24.0	-26.48	-6.66	-24.75	-35.30	-12.20	-33.00

According to Table 3, the samples xA.C. and xTi-A.C. showed higher specific surface area if compared to commercial P25. Furthermore, the samples SucGlyTi-A.C. and UreGlyTi-A.C.had energy gap (Eg) values lower than that of P25 and a higher zeta potential (in module) than the commercial catalyst. For photocatalysis, crystal structure, surface area and porosity are some of the factors that influence the photocatalytic performance. These factors are crucial in the production of electron/hole pairs, adsorption processes and also in the processes of oxidation-reduction (Cheng *et al.*, 2016). A high surface area to promote adsorption of the pollutant to be degraded on the catalyst/support surface, and a significant pore volume to allow diffusion of the pollutant to the catalyst center (Bet-Moushoul *et al.*, 2016).

The energy band gap (Eg) is a relevant parameter for the photocatalytic process, since the smaller the Eg, the less radiation energy is required to the activation of the process, which in turn may reach the visible light region and the values were calculated by using the formula E = hc/λ, where h is Plank's constant, c is the velocity of light and λ is the wavelength. The band gap of xA.C. and xTi–A.C. were found between 2.81 and 8.23 eV. The band gap of Ti^{+4} doped xA.C. was shifted slightly towards longer wavelength region. This is possibly due to the fact that, with titanium doping (Ti^{+4}), the concentration of the electron acceptor/donor species (e_{BC}^- and h_{BV}^+) increases, followed by a decrease in the polarization of the O^{2-} ion in the conduction band. Thus, it promotes a change in conduction bands and valence band levels, promoting a reduction in the energy band range of photocatalysts (Vadivel and Rajarajan, 2015).

Measurement of the zeta potential (ZP) is also an important tool for evaluating the surface charge distribution and stability of photocatalysts because compatibility between the surface potential and the charge of the molecule to be degraded may improve the photocatalytic activity (Gaya and Abdullah, 2008). According to Table 3, the samples xA.C and xTi-A.C. exhibited a negative surface potential that ranged from -6.66 to -35.30 mV. However, the samples doped with titanium showed a greater potential (in module), confirming that the surface doped with $TiO_2$is beneficialto the surface charge, according the Figure 1. Moreover, RhB is characterized by their cationicnature, and the compatibility between the surface potential of the photocatalyst and the charge of the molecule to bedegraded can improve the photocatalytic activity (Debrassi*et al.*, 2011; Salleh*et al.*, 2011), since the RhB dye tends to adsorb on the catalytic surface of the photocatalysts by attractive forces, thus allowing degradation of the pollutant.

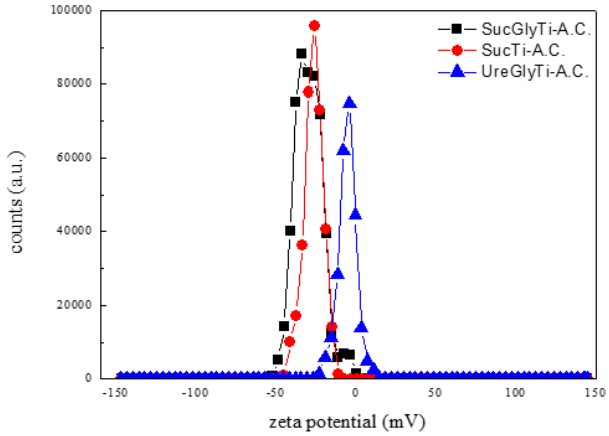

Fig.1: Zeta potential of the photocatalysts doped with Ti^{+4}.

Figure 2 shows some typical isotherms of adsorption/desorption of N_2 at 77 K which provides the indications of the presence of the pore size and structure. The isotherms are type IV sorption with a H3 hysteresis loop, according to IUPAC classification (IUPAC 1972), which indicates the existence of mesoporous in the corresponding materials and the type H4 loop is associated with narrow slit-like pores. The adsorption branch exhibits three distinct regions corresponding to a monolayer-multilayer adsorption, multilayer adsorption on the outer particle surfaces and capillary condensation at relative pressures in the range from 0.6 to 0.9, for all the isotherms. The Ti^{+4} sample showed the highest

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specific surface area and pore volume. Table 3 shows the characteristics of the resulting photocatalysts. For photocatalysis, one relevant strategy to enhance degradation is to guarantee high surface area of the catalyst to promote adsorption of the pollutant to be degraded on the catalyst/support surface, and a significant pore volume to allow diffusion of the pollutant to the catalyst center (Wang*et al.*, 2008). Then, a stable, high surface area with a three-dimensional mesoporous structure can achieve much facile adsorption/desorption equilibrium and mass diffusion of reactants and products and thus enhance the activity and stability of the Ti^{+4} material in the photocatalytic application.

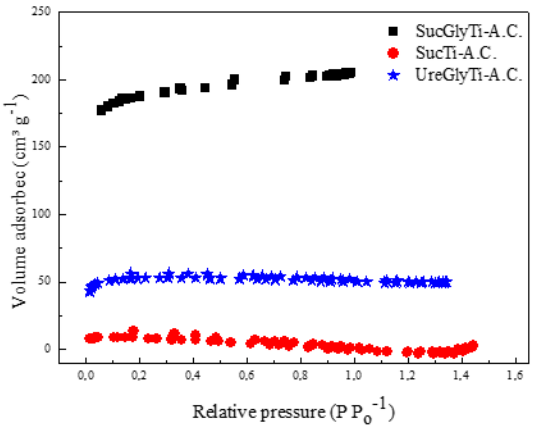

Fig.2: Nitrogen adsorption / desorption isotherms for the samples doped with Ti^{+4}.

According to Table 3, the sample SucGlyTi-A.C. showed higher S_{BET} value (634.51 m^2 g^{-1}) and higher porosity with 19.95 nm and 0.32 cm^3 g^{-1} diameter and pore volume, respectively. Among the doped samples, the presence of Ti^{+4} provided a significant increase in the surface area and porosity of the samples, for example the SucGlyTi-A.C. sample showed an increase of about 358% in its surface area, 22% in Dp and 461% in Vp. In addition, through the pore diameter, it is possible to affirm that they are structures with mesoporous (2-50 nm) (IUPAC, 1972) and, by the distribution of pores, it was possible to verify that SucGlyTi-A.C. showed a larger pore volume, followed by the UreGlyTi-A.C

Figures 3a and 3c show micrographs of the samples SucGlyTi-A.C and UreGlyTi-A.C., where it is possible to visualize a more dispersed distribution of the particles. Meanwhile, Figure 3b shows a micrograph of the SucTi-A.C sample indicating the formation of particle agglomerates (clusters). This can be explained by the surface charge (zeta potential), where the samples prepared with sucrose and glycine have higher repulsive forces between the particles, by the higher value of ZP, so the particles tend to disperse. While using only sucrose, the ZP is smaller between the particles, providing a lower dispersion and, thus, a greater sinterization of the particles, after calcination. In addition, this higher dispersion of the particles provides a higher catalytic surface area and thus a better adsorption of the target molecule and better photocatalytic activity (Kaleji*et al.*, 2011).

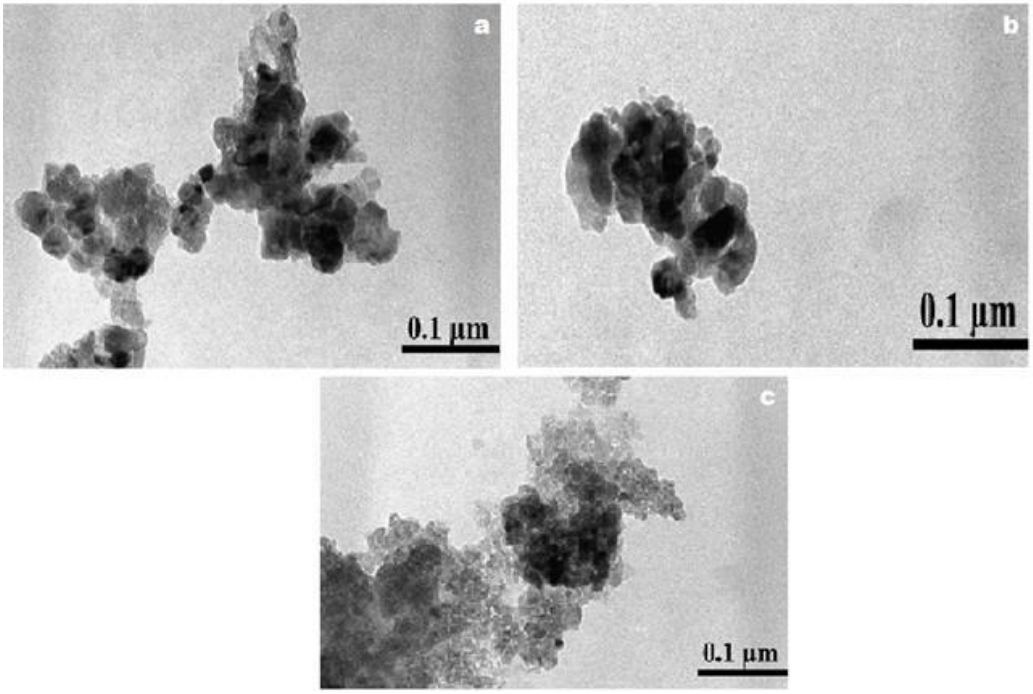

Fig.3: SEM images for the samples: (a) SucGlyTi-A.C., (b) SucTi-A.C., and (c) UreGlyTi-A.C.

3.2 Photocatalytic Activity

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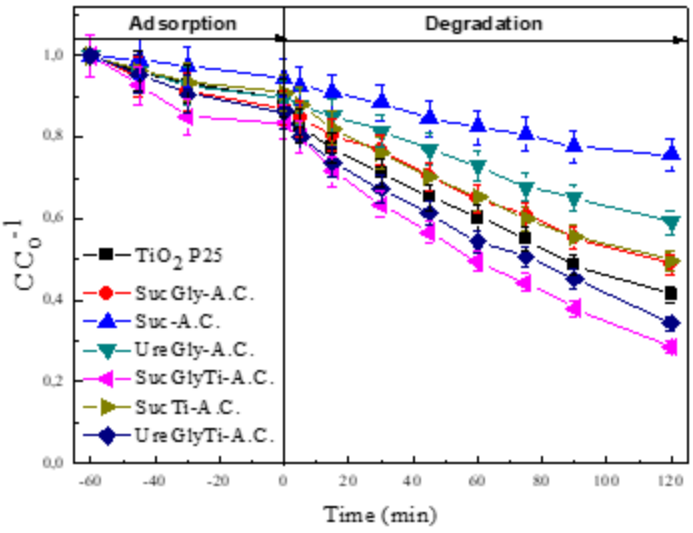
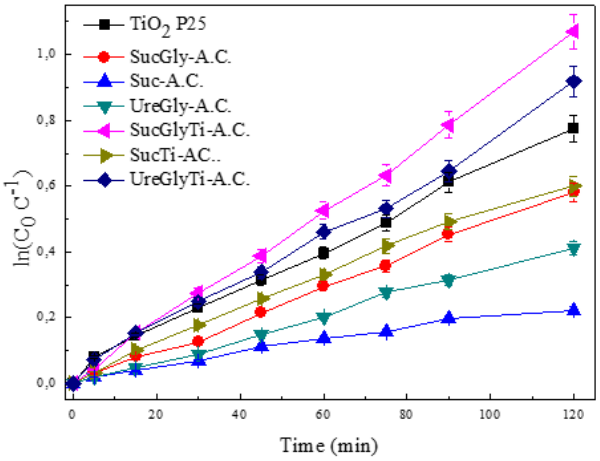
Figure 4 shows the photocatalytic activity and the respective specific rates of reaction (k), under ultraviolet radiation, while Figure 5 under visible radiation, after 120 minutes of reaction of degradation of RhB dye. Moreover, adsorption results were added, indicating an adsorption of about 10% in the synthesized samples.

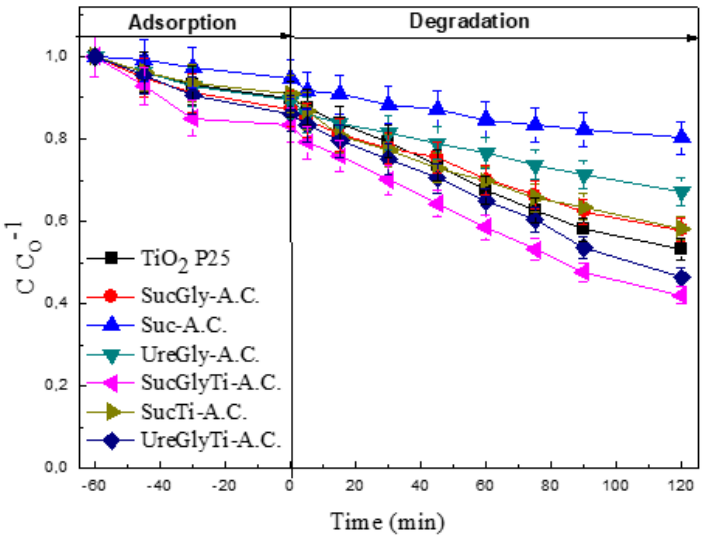


(a)



(b)

Fig.4: (a) Photocatalytic activity and (b) specific rate of the RhB dye degradation reaction of the samples synthesized under UV radiation after 120 minutes($C_{catalyst}$ = 0.7 g L^{-1}, C_{RhB} = 20 mg L^{-1}, T = 30 ° C, natural pH, UV radiation of 61.8 W m^{-2} and error 5%)



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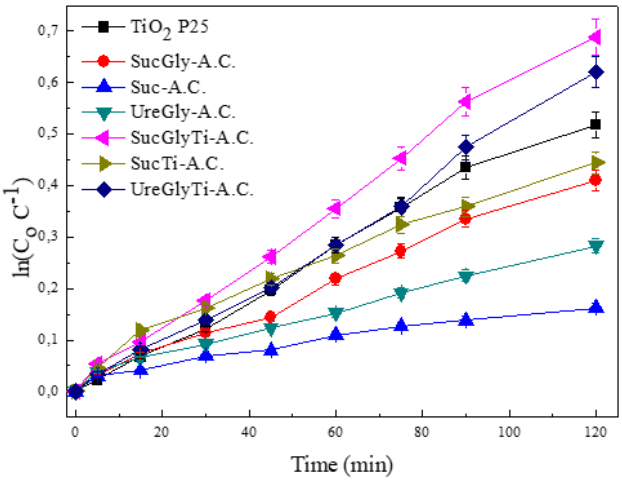
(a)



(b)

Fig.5: (a) Photocatalytic activity and (b) specific rate of the RhB dye degradation reaction of the samples synthesized under visible radiation after 120 minutes ($C_{catalyst}$ = 0.7 g L^{-1}, C_{RhB} = 20 mg L^{-1}, T = 30 ° C, natural pH, visible radiation of 202 W $m^{-2}$and error 5%)

Under ultraviolet radiation (Figure 4), the photolysis of RhB represents about 14% of the degradation and the SucGlyTi-A.C. (66 %) showed the best activity photocatalytic, which can be justified according its structural and structural characteristics, such as higher surface area (S_{BET}) and porosity (Dp and Vp), lower band gap energy (Eg) and higher load (ZP, in module), providing a better mass transfer and diffusion of the RhB molecules and, thus, a better photocatalytic activity. Moreover, all doped samples showed a significant increase in degradation of about 49 %, 127 % and 78 % for the SucGlyTi-A.C. (k = 0.0088 min^{-1}), SucTi-A.C. (k = 0.0053 min^{-1}) and UreGlyTi-A.C. (k = 0.0075 min^{-1}), relative to the non-doped samples, SucGly-A.C. (k = 0.0049 min^{-1}), Suc-A.C. (k = 0.0021 min^{-1}) and UreGly-A.C. (k = 0.0049 min^{-1}). In relation to the commercial catalyst (TiO_2 P25), SucGlyTi-A.C. and UreGly-A.C. obtained a superior catalytic performance under UV radiation, that is, while TiO_2 showed a degradation of 53.92% after 120 minutes of reaction, the same 65.71 % and 60.10 % respectively under the same conditions.

While under visible radiation (Figure 5), photolysis represents 4 % degradation, in addition to the samples SucGlyTi-A.C. (49.8% and k = 0.0059 min^{-1}), SucTi-A.C. (35.9% and k = 0.0041 min^{-1}) and UreGlyTi-A.C. (46.25% e k = 0.0050 min^{-1}) showed an increase in their photocatalytic activity after Ti^{+4} doping (48 %, 139 % and 87 % in relation to SucGly-A.C., Suc-A.C. and UreGly-A.C. , respectively), highlighting for the photocatalyst SucGlyTi-A.C. which, as in ultraviolet radiation, showed a higher photocatalytic activity. In all degradation processes, the reactions followed a pseudo-first order kinetics. Table 4 shows the respective values of the specific reaction rate (k) and photocatalytic degradation.

Table.4: Specific reaction rates (k) of the RhB tests under UV and visible radiation

Catalyst	% degradation (UV)	k_{UV} (min^{-1})	% degradation (vis)	k_{vis} (min^{-1})
TiO_2 P25	53.9	0.0067	40.4	0.0046
SucGly-A.C.	44.1	0.0049	33.6	0.0036
Suc-A.C.	19.9	0.0021	15.0	0.0016
UreGly-A.C.	33.8	0.0035	24.7	0.0025
SucGlyTi-A.C.	66.0	0.0088	49.8	0.0059
SucTi-A.C.	45.1	0.0053	35.9	0.0041
UreGlyTi-A.C.	60.1	0.0075	46.2	0.0050

Some strong Spearman's correlations were observed between some electronic and physical properties, as illustrated in Figures 6, 7 and 8. It was possible to observe a strong direct correlation between the specific surface area (S_{BET}) and specific reaction rates (k) underUV (r_p> 0.941) and visible (r_p> 0.919) radiation (Figure 6), as well as an indirect correlation between band gap energy (Eg) (r_p< - 0.920 to UV radiation and r_p< - 0.952 to visible radiation) and zeta potential (ZP) (r_p< - 0.798 to UV radiation and r_p< - 0.749 to visible radiation) with the specific reaction rates (k), according to Figure 7 and 8, respectively . Thus, the higher the surface area, the greater the amount of RhB adsorbed and thus the greater the degradation and the reaction rate. On the other hand,

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the higher the Eg and ZP, the greater the energy required to activate the catalyst and the larger the surface repulsive forces, so the catalytic efficiency will be lower, affecting the rate of reaction.

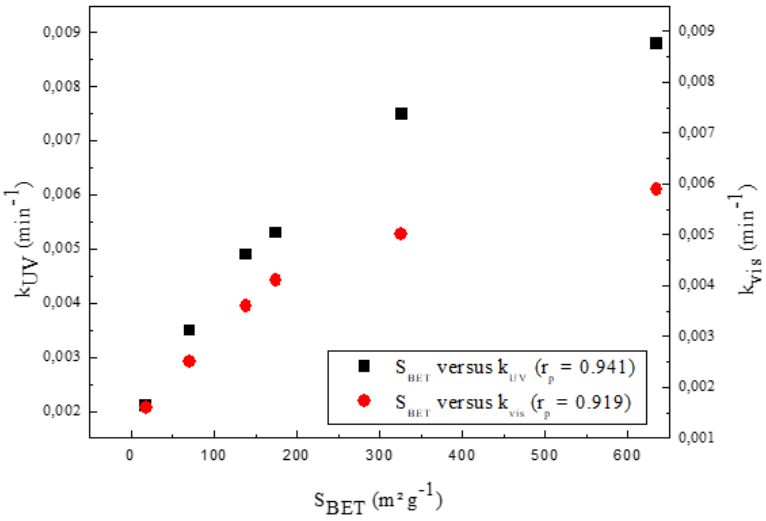

Fig.6: Correlation between specific surface area (S_{BET}) and specific reaction rates (k).

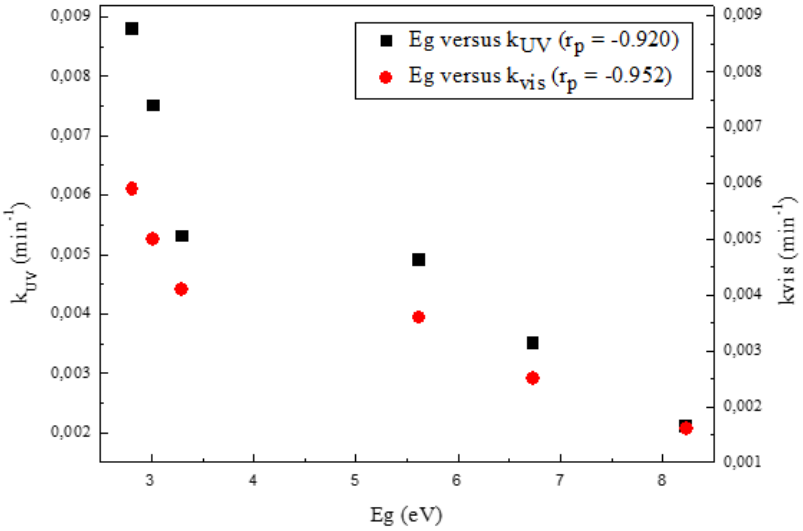

Fig.7: Correlation between band gap energy (Eg) and specific reaction rates (k).

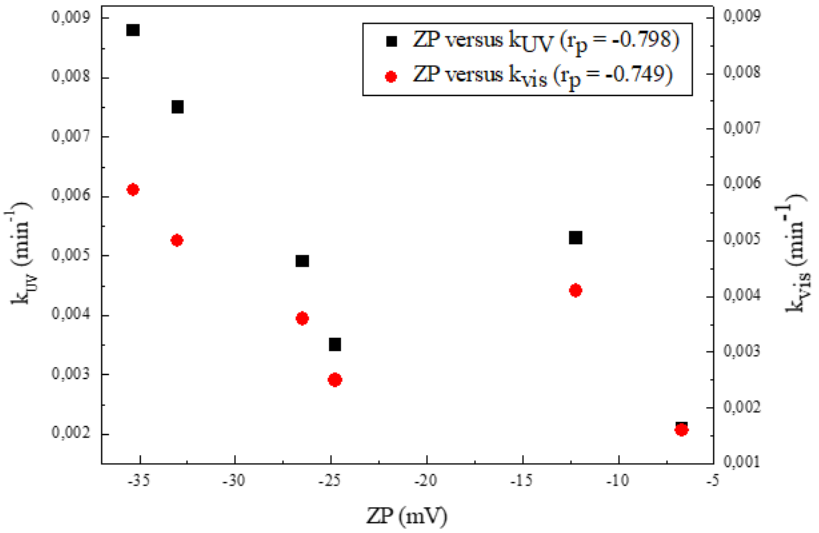

Fig.8: Correlation between zeta potential (ZP) and specific reaction rates (k).

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IV. CONCLUSION

In summary, it can be concluded that the photo degradation kinetics of the Rhoda mine B dye can be approximated to a pseudo-order model and that the doping with Ti^{+4} provided changes in the textural and structural properties, in relation to the non-doped samples, such as band gap energy (Eg), surface area (S_{BET}), porosity (Dp and Vp), zeta potential (ZP), and a better photocatalytic performance in the degradation of RhB dye, under UV and visible radiation. Moreover, these results suggest that the positive effect of titanium as a dopant in the development of photocatalysts, due to the fact that Ti^{+4} is capable of generating an intermediate band gap energy between the conduction and valence bands of the non-doped sample, capable of promoting the absorption of photons and generating more electron / vacancy pairs (e_{BC}^- and h_{BV}^+) and, thus, providing a higher formation of the hydroxyl radical (•OH). Therefore, photocatalysts doped with titanium from activated charcoal prepared with vegetable sponge are promising for use in the degradation of organic pollutants, via heterogeneous photocatalysis.

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FIGURE CAPTIONS

Figure 1. Zeta potential of the photocatalysts doped with Ti^{+4}.

Figure 2. Nitrogen adsorption / desorption isotherms for the samples doped with Ti^{+4}.

Figure 3. SEM images for the samples: (a) SucGlyTi-A.C., (b) SucTi-A.C., and (c) UreGlyTi-A.C.

Figure 4. (a) Photocatalytic activity and (b) specific rate of the RhB dye degradation reaction of the samples synthesized under UV radiation after 120 minutes ($C_{catalyst}$ = 0.7 g L^{-1}, C_{RhB} = 20 mg L^{-1}, T = 30 ° C, natural pH, UV radiation of 61.8 W m^{-2} and error 5%)

Figure 5. (a) Photocatalytic activity and (b) specific rate of the RhB dye degradation reaction of the samples synthesized under visible radiation after 120 minutes ($C_{catalyst}$ = 0.7 g L^{-1}, C_{RhB} = 20 mg L^{-1}, T = 30 ° C, natural pH, visible radiation of 202 W m^{-2} and error 5%)

Figure 6. Correlation between specific surface area (S_{BET}) and specific reaction rates (k)

Figure 7. Correlation between band gap energy (Eg) and specific reaction rates (k)

Figure 8. Correlation between zeta potential (ZP) and specific reaction rates (k)

TABLE CAPTIONS

Table 1. Compositions of activated charcoal (A.C.) in proportions

Table 2. Photocatalysts doped with Ti^{+4}

Table 3. Results of the surface area (S_{BET}), pore diameter (Dp), pore volume (Vp), *band gap* energy (Eg), absorption wavelength (λ) and zeta potential (ZP) of the Evonik Aeroxide P25, activated charcoal prepared from vegetable sponge and doped with Ti^{+4}

Table 4. Specific reaction rates (k) of the RhB tests under UV and visible radiation

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Aquifer Barreiras: Evaluation of ground water reserves in northern Espírito Santo, southeastern Brazil

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Abstract**—** *The aquifer Barreiras is porous, free and semi-confined, with high porosity and permeability. It is composed of alluvial and fluvial sediments of the Barreiras Formation, in a complex association of permeable/impermeable strata. The mean hydrodynamic parameters of the 107 registered and evaluated tubular wells are a depth of 100.81 m, static level of 14.18 m, dynamic level of 51.48 m, drawdown of 37.30 m, a flow rate of 43.52 m, specific flow of 2,3681 m and transmissivity of 175.54 m^2/day. The natural outflow of Barreiras Aquifer is 296.10^6 m^3/year, the Infiltration Rate is 0.82%, the Regulatory Reserve or Recharge Volume 321.10^6 m^3 and the Permanent Reserve volume 1,27.10^{10} m^3. The hydrodynamic characteristics of the Aquifer Barreiras indicate a promising underground source and high heterogeneity throughout the formation.*

Keywords— *Aquifer Barreiras; Groundwater; Rio Doce Basin.*

I. INTRODUCTION

Surface water and groundwater must be considered as the same natural resource, inseparable and in continuous interaction between surface flows and the aquifer, forming the composition of a hydrological cycle. Groundwater plays an important and unique role in the public water supply and agricultural irrigation in northern Espírito Santo. The catchment area of the Rio Doce, with a length of 853 km, covers 82,000 km^2, 14% of which lie in the state of Espírito Santo. The regional climate is classified as tropical hot humid, with annual averages of 1,200 mm rainfall and evaporation from 70 mm in June to 110 mm in January. The study area of 3,568.4 km^2 is founded on the sedimentary basin of Espírito Santo, in the lower course of Rio Doce drainage system, in the region of the river mouth to the sea, between the cities of Linhares, São Mateus, Jaguaré and Nova Venécia. For this study, 107 tubular wells were registered across the region, resulting in a rather high density of 33.4 wells per km^2 (Gonçalves et al. 2005), representing the entire studied terrain (Figure 1), which together exploit relevant flow rates of the ground water. The great productivity of this aquifer has attracted a large number of public and private users. The main objective of this study was to characterize and evaluate the natural physical conditions as well as the hydrodynamic parameters of the Aquifer Barreiras in northern Espírito Santo, with a view to implementing a sustainable exploitation of the groundwater flow.

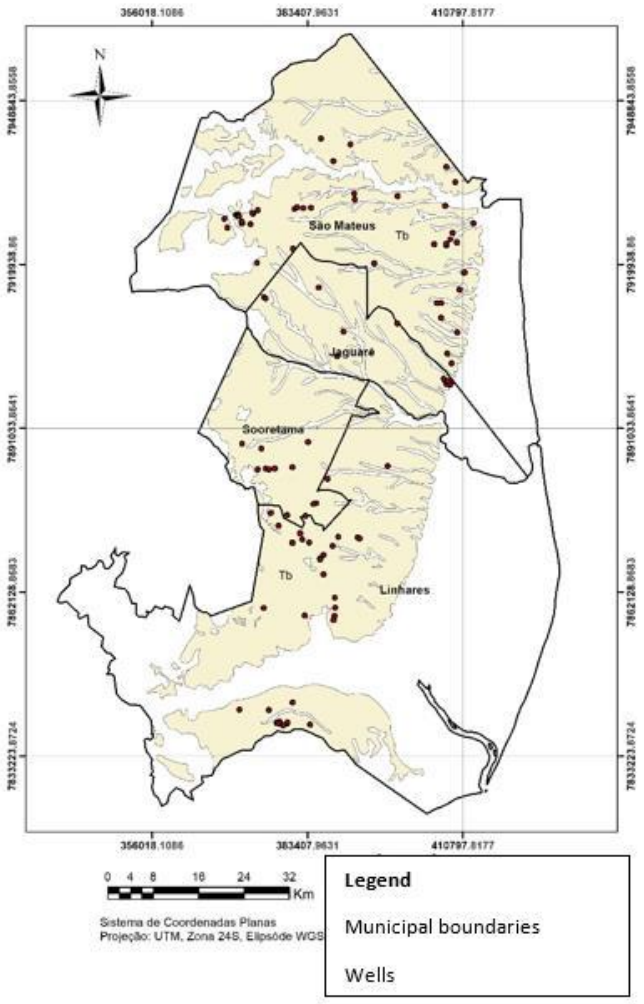

Fig.1: Well location map

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II. GEOLOGY

The Barreiras formation(Vieira & Menezes, 2015) is composed of unconsolidated tertiary detrital sediments of continental origin, covering a narrow strip along the coast, extendingfrom the state of Rio de Janeiro up to Pará. In Espírito Santo, this formation is foundeverywhere in the East and Northeast, with a strip width of approximately 30 km (Costa, 1980) and thickness decreasing westwards. The relief of the Barreiras formation consists of sedimentary layers with typical topographic features of tablelands, with wide shallow valleys, flat surfaces and slopes of 1.2 km/m facing the sea, due to the inclination of the staggered structures along the coast (Nunes et al. 2011). The particle size of the sedimentary composition of the Barreiras formation is regionally extremely heterogeneous, with faciological variations, containing sandstones of medium, fine or coarse particle size, and siltstones and argillites (Martin et al. 1997). The sediments are immature, coarse, poorly classified, with clay lenses and fine quartz sand, from pinkish to red, purplish, yellowish or whitish, and cross-stratified (Costa, 1980). Their composition is regionally varied, but the predominant mineral is quartz, followed by weathering clay minerals and feldspar. The accessory minerals are magnetite, limonite, zirconium, barite, micas, fluorite and tourmaline (Leal, 2007).

III. HIDROGEOLOGY

The aquifer Barreiras is porous, freeand sometimes semi-confined, with enormous spatial distribution and generallyhigh porosity and permeability. It is composed of alluvial and fluvial sediments in a complex association of permeable/impermeable strata. The great heterogeneity is the result of the discontinuity of the aquifers (lenticular geometry), associated with permeability barriers caused by more clayey sedimentary facies. This lithological association affects the permo-porous characteristics of the layers.

Table.1: Hydraulic characteristics and statistics based on 107 registered wells of the aquifer Barreiras.

AQUIFER BARREIRAS	MEDIA	MEDIANA	MAXIMUM	MINIMUM	No. of wells
Depth – D - (m)	100.81	105	190.00	15.00	107
Static Water Level- SWL - (m)	14.18	10.25	80.00	0.00	
Pumping water level- PDL - (m)	51.48	49.77	139.00	5.50	
Drawdown – S - (m)	37.30	32.00	115.2	1.70	
Yield – Q - (m3/h)	43.52	27.46	216.00	0.21	
Specific Capacity - Q/S (m3/h.m)	2.3681	1.0067	21.1752	0.0066	
Saturated thickness (m)	85.86	85.00	179.70	13.00	
Transmissivity – T - (m2/day)	175.54	167.67	302.23	110.00	46

The values listed in Table 1 and analyses of the hydraulic characteristics of the Aquifer Barreiras indicate great heterogeneity of this underground source throughout its wide area of occurrence. The alimentation of the aquifer Barreiras is mainly based on rainfall on its outcrop area. During the flood periods, there is also fluvial contribution.

The thickness of the formation is very variable, since the bed rock out crops at some points, emerging from a few to 150 m high in the coastal region (Mourão, 2002), with on average 60 m, estimated from construction reports of tubular wells. The sediments of the Barreiras formation constitute a major aquifer that transmits water to the common outflows: the sea, rivers, sources and diffuse resurgence zones, as well as vertical infiltrations into the Rio Doce Formation and crystalline bedrock, aside from evapotranspiration, which is an important outflow.

The transmissivity (T) values were calculated bythe high flow rate pumping test, and the recovery values interpreted by the method of Cooper and Jacob (1946) for 46 tubular wells, included in the list of 107 wells evaluated statistically (Table 1). Although this method was created to evaluate confined aquifers, it was used here to estimate transmissivity in from free to confined aquifers (Domenico & Schwartz, 1990), where aquifer tests were not available. The lack of transmissivity data for the wells required the determination of the relationship between these and the specific flow rate capacity (Q/s), showing a clear relationship between these parameters. The T evaluation did not include the necessary corrections for partial penetration of the wells

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in the aquifer, since there were not enough data of the total aquifer depth (Hirata, 2012).

IV. RESULTS

The potentiometric maps showed that the underground flow at the highest points has gradients of the order of 3%, and in the alluvial plain domain the gradients vary from 0.1% to 0.06%. There is a domain of gradients of the order of 0.25%. Based on the potentiometric curves, with data of the dry period, the discharge of the natural underground flow was estimated, so that the calculation of the natural flow of "Q" generated in the aquifer Barreiras domain by the representative formula of Darcy's law,:

Q = TIL (1) where: Q = natural flow rate (m^3/year)

T = coefficient of transmissibility (m^2/s) - 175.54 m^2/day (means of 46 wells)

I = hydraulic gradient of the piezometric surface – $2.5.10^{-3}$ or 0.25%

L = width of the flow front (m) - 185 km or 185.10^3 m (width of the flow front);

Thus:

Q = $296.10^6 m^3$/year, i.e., 26.7 mm in terms of water level.

Usually, this volume Q can be considered the exploitable reserve of an aquifer.

The flow rate of the underground flow was evaluated for the conditionsof anexploited aquifer. Consequently, to compute the total annual flow amount, theannual exploitation by registered wells must be added. In this case however, the available data were insufficient for calculation.

For the calculation of the Infiltration Rate, we used the expression:

IR = Q/VPA (2), where IR = infiltration rate (%)

Q - aquifer outflow volume – $296.10^6 m^3$/year

V –annual rainfall volume – $3.6.\ 10^9 m^3$/year

Infiltration Rate - IR = $296.\ 10^6/3.6.\ 10^9.\ 10^2 = 0.82\%$

For the calculation of the Regulatory Reserves, two methods were used:

1st - calculation based on the annually infiltrated water volume - AIV = A. ANNUAL PPT. IR (3)

AIV = Annual infiltration volume

A - area in m^2 = 3568.10^6 m^2

Annual RF - annual rainfall - 1100 mm

IR - Infiltration rate - 0.82%

AIV = 321.10^6 m^3/year (This volume represents the water resources available for exploitation each year).

2nd - Calculation of the Regulatory Reserve or Recharge Volume (RRV)

Let RRV = A x Δh x μ (4)

Where: RRV = Regulatory Reserve Volume

A - area in m^2 = 3568.4 km^2

Δh - mean annual variation in potentiometric height– 1.80 m

μ - effective porosity - 5%

RRV = $321.10^6 m^3$

The same result was obtainedby both methods.

Considering the free aquifer Barreiras, the permanent reserve represents the cumulative water volume in the rock interstices as a function of the effective porosity, where:

PRV = A. h. μ (5) where: PRV = Permanent Reserve Volume

A = study area - 3568.4 km^2

h = mean saturated thickness - mean static level = 71.68 m

μ = effective porosity - 5%

PRV = $1.27.\ 10^{10}$ m^3

The potential of an aquifer represents the water volume that can be used annually for a given number of years using a portion of the permanent reserve volume.

Potential - PO = (PRV x 0.002) + RRV (6)

Where: PRV - permanent reserve volume – $1.27.\ 10^{10} m^3$

RRV - regulatory reserve volume - $321.\ 10^6 m^3$/year

Maximum percentage of depletion of the permanent reserve in one year ("safe yield") - 0.002.

PO = $346.\ 10^6 m^3$/year

V. CONCLUSIONS

1-The hydrodynamic characteristics of the Aquifer Barreiras indicate a promising underground source.

2-The transmissivity (T) values indicate the heterogeneity of the aquifers.

3–A well depth ofup to 150 m is recommended, below the first 70 m of the surface layers.

4 - All users (public water supply, agriculture/irrigation and industry) who depend on groundwater should periodically evaluate the drawdownof the water level and flows explored.

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Improvement of Surveillance Process Applied to Continuity Indicators of the Energy Distributors

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Abstract**—** *The National Electric Energy Agency (ANEEL), created in 1996, is responsible for regulating and supervising the Brazilian electricity sector. In case of non-compliance with the current regulation, the ANEEL initiates the instruction of the punitive process and may apply a punishment to the regulated agent. In this context, to improve the current regulation, an additional form of penalty is proposed, which takes into account the amount of sanctions applied to continuity indicator inspections in the last four years when defining the new limits of continuity indicators. In this way, the distributors with the highest number of penalties will have their limits reduced, that is, they will be more penalized. To analyze the improvement proposed the electrical assemblies belonging to the concession area of a small distributor was considered.*

Keywords**— Electricity distribution, Surveillance, Continuity indicators, Regulatory agency.**

I. INTRODUCTION

In 1996 the federal government created the National Electric Energy Agency (ANEEL) with the purpose of regulating and supervising the Brazilian Electricity Sector [1].

In this sense, since the characteristics of the Brazilian states are heterogeneous, it became necessary to create state agencies to expand ANEEL's activities, and they act according to local particularities, based on the observation of integrated state policies and performance of distributors [2]. For an efficient process of supervision and regulation of the electric sector, the state agencies depend on the financial independence, the autonomy, the technical capacity and the State participation [3].

In addition, in order for electricity distribution services to be adequately provided, the supervision carried out by the Agency verifies compliance with the concession contract and the legislation in force by the respective concessionaire, observing the evolution of safety, regularity and continuity standards, which translate the quality of the customer service.

Among the items inspected by regulatory agencies and object of this article will be considered the "Individual and Collective Continuity Indicators". From the inspection process, when the agent (distributor) does not follow the current regulation, it may be penalized. On the other hand, this penalty does not always result in the improvement of the continuity indicator.

In this way, it is proposed to improve the current regulation, which takes into account the amount of sanctions applied in the inspections of indicators of continuity in the last four years, at the time of defining the new limits of the indicators of continuity. In this way, distributors with a higher number of sanctions will have their limits reduced.

II. BRAZILIAN ELECTRICITY SECTOR SURVEILLANCE

According to Law 8,987, 1995, the inspection of the service may be done through a technical body of the Granting Authority or by an entity with which it has been contracted, and periodically, as provided for in a regulatory standard, by a commission composed of representatives of the Granting Authority, the concessionaire and the consumers.

Therefore the ANEEL functions are related to the regulation and supervision of the provision of electricity generation, transmission and distribution services and the State Regulatory Agencies have been delegated a regulatory action regarding the provision of electricity distribution services [4].

In a first stage, the federal and state agencies aim to educate and guide the agents of the electricity sector regarding compliance with the legislation in force and the concession contracts. In a second stage, the inspection action, in accordance with the regulatory norms and the respective concession agreements and authorizing acts, may result in penalties for agents of the electric sector, as provided in Article 2 of ANEEL Normative Resolution no. 63/2004. This act also provides for the cumulativeness, aggravation or mitigation of these penalties [5].

Among these actions is the inspection of electric energy services, whose purpose is to verify the compliance of the obligations established to the agents in

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the acts of grants and in regulatory devices, to ensure that the customer service is given in standards of quality, time and security, compatible with the requirements appropriate to the purpose of the services [6].

III. STAGES OF SUPERVISION OF DISTRIBUTION SERVICES

In a context of Responsive Regulation, ANEEL is based on a strategic vision seeking to graduate surveillance actions with a focus on prevention using Analytical Intelligence to verify and validate the data.

According to ANEEL [7], the Inspection of Electricity Services is composed of four stages (Monitoring, Analysis, Monitoring and Supervisory Actions).

Failures are identified in the Monitoring, Analysis and Monitoring stages and if they are not corrected, the notification and monitoring step will start and may result in an eventual punishment [7].

The inspection process within a regulatory agency is presented in the flowchart illustrated by Fig. 1. In the control process, no deadlines are set for each stage, thus being at the discretion of the regulatory agency [8].

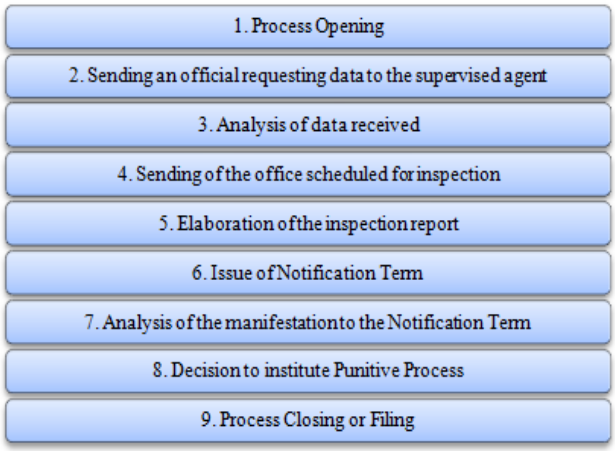

Fig.1: Steps of the inspection process within a regulatory agency. Source: Authors.

IV. TYPES OF SURVEILLANCE

ANEEL together with the State Agencies inspect the following topics in the electricity distribution sector: Technical, Commercial, Low Income, Assets, Universalization, Teleservice, Voltage Level and supervision of continuity indicators [9].

The inspection of the Continuity Indicators aims to determine the continuity of the electric power supply to the consumer units in their aspects of duration and frequency, and can be defined as [10]:

- Collective Indicators: calculated by grouping consumer units served by a distribution substation as shown in Table 1. In this case, the indicators are monitored and are not subject to penalties.

Table.1: Collective Indicators.

DEC - Equivalent Duration of Interruption per Consumer Unit measured in hours
FEC - Equivalent Frequency of Interruptions per Consumer Unit, which measures the number of times of power outages

- Individual Indicators: calculated for each consumer unit, as shown in Table 2. In this case, the determination of the penalty is automatic and the compensation resulting from the transgression is directly reimbursed in the electric energy bill.

Table.2: Individual Indicators.

DIC - Duration of Individual Interruption per Consuming Unit, or by point of connection, expressed in hours and hundredths of hours
FIC - Frequency of Individual Interruption per Consumer Unit, or per connection point, expressed in number of interruptions
DMIC - Maximum Continuous Individual Interruption Duration per Consuming Unit, or per connection point, expressed in hours and hundredths of hours
DICRI - Duration of Individual Interruption occurring on a Critical Day by Consumer Unit, or by point of connection, expressed in hours and hundredths of hours

According to the Electricity Distribution Procedure in the National Electrical System - PRODIST, Module 8, Section 8.2, revision 9, to establish the limits of the continuity indicators, the distributors must send to ANEEL their BDGD (Data Base Geographic Information System) as established in Module 6 (Required Information and Obligations), from which the physical and electrical attributes of its consumer units will be extracted [11].

V. PUNITIVE ADMINISTRATIVE PROCESS

After the inspection process has been completed, if there is evidence of non-compliance, a punitive administrative proceeding is initiated. According to Moreira Pinto [12], "The fine is the main instrument that the State uses to punish and, above all, to prevent new anti-competitive conduct."

The Normative Resolution of ANEEL no. 63/2004 approves procedures to regulate the imposition of penalties on concessionaires, permit holders, authorized agents and other agents of electric power installations and services, as well as on entities responsible for operating the system, for the sale of electric energy and for the management of resources from sectoral charges. According to art. 2 of the Normative Resolution of

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ANEEL no. 63/2004, electric sector agents are subject to the following penalties [13]:

I. Advertence;

II. Fine;

III. Construction interruption;

IV. Installation Interdict;

V. Temporary suspension of participation in bids to obtain new concessions, permits or authorizations, as well as being prevented from contracting with ANEEL and receiving authorization for electric energy services and installations;

VI. Authorization revocation;

VII. Administrative intervention;

VIII. Expiry of the concession or permission.

In the event of the occurrence of more than one infraction, the penalties corresponding to each will be applied simultaneously and cumulatively [13].

VI. THE APPLICATION OF REN Nº 63/2004 IN THE DOSIMETRY OF FINES

ANEEL has sought to establish clear parameters for the application of Resolution No. 63/2004. In this sense, Technical Note No. 39/2010-SFE / ANEEL defined Equation (1) to calculate the amount of fines [13].

$$M=(0,5*G+0,2*D+0,2*V+0,1*S)*A*MaxGrupo*r*Fat \quad (1)$$

Where,

M: fine, in *reais* (R$);

G: Severity (%);

D: Damages to the consumer services (%);

V: Advantages to the Distributor resulted from the infraction (%);

S: Sanctions in the last 4 years (%);

A: Scope (%);

r: reincidence (r = 1 ou r = 1,5);

MaxGrupo: maximum value of the respective group (%);

Fat: company revenues in the last 12 months, in *reais* (R$).

Regarding the parameter "reincidence" (r), ANEEL followed the one described in REN 63/2004. The "scope" (A) is used by the audit agencies to establish the relationship between the quantity of non-conforming items of the inspection sample and the total quantity of items in that sample. The definition of the parameters "severity", "damages" and "advantages" is done case by case subjectively, according to Technical Note 39/2010 [13].

VII. PROPOSED ADJUSTMENT

As previously mentioned, ANEEL is responsible for defining the limits of the indicators of continuity of the Brazilian distributors and uses some criteria to obtain and inspect them. However, the oversight and sanctions currently considered are not achieving the desired outcome with regard to the improvement of continuity indicators [14].

In this sense, in order to present a constant improvement in the continuity indicators, an adjustment is proposed in the process of applying the sanctions used by the regulatory / supervisory body.

In this way, it is proposed that each new process of defining the limits of the DEC and FEC continuity indicators be taken into account the total number of administrative sanctions related to the topic applied in the last 4 years. Thus, the total of sanctions applied will directly impact on the percentage reduction of the values of said indicators, as proposed in Table 3.

Table.3: Percentage of Reduction in the Limit of Continuity Indicator.

Amount of sanctions in the last 4 years	**1**	**2**	**3**	**4 or more**
Indicator reduction percentage	5%	10%	20 %	30%

The values proposed in Table III were defined based on the evaluation of the percentage of reduction in the final result of the continuity indicator, always seeking harmony between the regulatory body and the regulated agent. The Fig. 2 illustrates the steps of proposed adjustment.

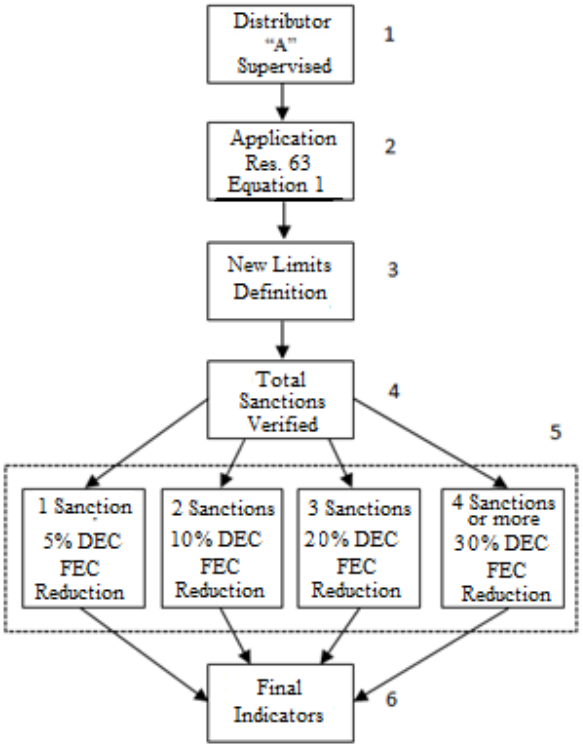

Fig. 2: Diagram of the adjustment proposal for the inspection process. Source: Authors.

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VIII. RESULTS

To exemplify the proposed methodology, a small distributor that has only two electrical assemblies was considered. In this way, Table 4 illustrates the limits of DEC and FEC defined by ANEEL in the period from 2009 to 2012 to this distributor.

For the period from 2009 to 2012, it was considered that the distributor was inspected only once, in 2010, and it was penalized. In this sense, applying the proposed criterion, the distributor will have a 5% reduction in the new values of the DEC and FEC limits of their consumer unit sets.

Table.4: DEC and FEC limits defined by ANEEL to the surveillance period.

GROUPS	DEC (hours)				FEC (number of interruptions)			
	2009	2010	2011	2012	2009	2010	2011	2012
Group 1	13	12	12	11	14	13	12	11
Group 2	16	15	14	13	17	16	15	14

The Table 5 presents the new values of DEC and FEC calculated by ANEEL to the next period (2013 a 2016) without the proposed adjustment.

Table.5: DEC and FEC limits defined by ANEEL to the next period without consider the application of proposed adjustment.

GROUPS	DEC (hours)				FEC (number of interruptions)			
	2013	2014	2015	2016	2013	2014	2015	2016
Group 1	11	10	10	9	11	11	10	9
Group 2	13	12	12	11	14	13	12	11

The Table 6 presents the new values of DEC and FEC calculated by ANEEL to the next period (2013 a 2016) considering the proposed adjustment.

Table.6: DEC and FEC limits defined by ANEEL to the next period considering the application of proposed adjustment.

GROUPS	DEC (hours)				FEC (number of interruptions)			
	2013	2014	2015	2016	2013	2014	2015	2016
Group 1	10.5	9.5	9.5	8.6	10.5	10.5	9.5	8.6
Group 2	12.4	11.4	11.4	10.5	13.3	12.4	11.4	10.5

The test carried out showed that the proposed methodology resulted in the reduction of continuity indicators. This was expected and fundamental to improve the quality of the electricity distribution system.

The reduction of the limits of the indicators of continuity in the set of consumer units is negative to the distributor since it becomes more difficult to meet the goal stipulated by the regulator.

It should be noted that audited distributors that do not present non-conformities will not be punished and consequently will not suffer a reduction in the limits of their consumer units. In this way, the regulated agent is expected to seek continuous improvement and full compliance with the current regulation.

IX. CONCLUSIONS

ANEEL is responsible for regulating and supervising the Brazilian electricity sector. To meet the different characteristics of the Brazilian states, ANEEL decentralized the activities of inspection of the distribution to state agencies. In this sense, the Normative Resolution of ANEEL no. 63/2004 approved the procedures to regulate the imposition of penalties to the distributors, having as main penalties applied the warnings and the fines.

Even with constant monitoring, the indicators of continuity have not presented the expected improvement, showing the need for evolution in the process of applying the sanctions employed by the regulatory agency.

Thus, in order to improve existing regulations, an improvement was made to the current regulations, which take into account the amount of sanctions applied in the monitoring of continuity indicators in the last four years, at the moment of defining the new limits of continuity indicators for consumer units. In this case, distributors with a higher number of sanctions will have their limits reduced, that is, they will be more penalized.

It was analyzed the concession of a small distributor and after the application of the penalty, a reduction in the limits of the continuity indicators, DEC and FEC, of the consumer units was observed.

In this sense, by reducing the limits of continuity indicators, it is expected that the regulated agent will make the necessary efforts to comply with the current regulations.

X. ACKNOWLEDGEMENTS

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Flying Object Detection and Classification using Deep Neural Networks

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Abstract— *Unmanned Arial Vehicles (UAVs) are extensively used everywhere in commercial applications such as delivering goods and medicines, taking photographs, and to monitor crowded areas. Sometimes these drones are used for capturing our private information without our knowledge. To avoid misuse of UAVs, we need to detect them in advance before entering into the protected areas. Detecting the UAV is a complex task because it is supplemented by birds, aircrafts, moving clouds, and swaying trees. To prevent this, we will detect the drones by video camera. In this paper, we compare the existing computer vision methods such as background subtraction, frame differencing, optical flow and edge detection for object detection. In our work, we will use Convolutional Neural Network for both object detection and classification to enhance its performance.*

Keywords— Unmanned Aerial Vehicles, Computer Vision, Background Subtraction, Frame Differencing, Optical Flow, Edge detection, Convolutional Neural Networks.

I. INTRODUCTION

Flying object detection is done by extracting the moving objects from a video sequence. There are various methods have been proposed such as, the background subtraction, the frame differencing, optical flow method, and edge detection.

Background subtraction is a method which is widely used for detecting foreground objects from the background in video sequence. It is calculated by subracting the current frame from the reference frame, called "background image". Its performance always depends on the quality of background modeling.

The advantage of this method is fast and accurate detection and easy to implement. It is not applicable for moving camera because each and every frame will have a different background.

Frame Differencing is used to extract the moving object which is based on calculating the difference between current frame and previous frame in video sequence. The advantages of the frame difference algorithm is quick to implement and highly adaptive to dynamic scene changes. relatively low computational complexity. However, it has some drawbacks, it is generally not an efficient approach for extracting all relevant pixels of moving regions as it is unable to find the internal pixels of enormous size, with uniformly distributed intensity values.

Optical flow method is a common method for objects detection. The optical flow method detects the objects based on the relative velocity of objects in the scene. Although this method adapts to moving objects detection, the complicated calculation makes it not applicabe for real-time detection.

Edge detection method converts the original images into edge images by examinning the changes of intensity values in the image. The edges are extracted from the video based on the features like edge, curve, straight lines and this is able to detect the objects.

II. RELATED WORKS

In paper[1], they discussed UAV detection framework is based on video images and they capture either by static camera or moving camera. Detection by static camera involves background subtraction. Moving camera based detection done by Region Proposal Neural Network. UAV is detected based on confident value of UAV detection. By using RPN, the number of false positive will be reduced which leads to be an early warning detection system. In there future work, they will use temporal information to increase the accuracy.

Paper[2], focuses on detecting moving objects in image sequences produced by stationary camera.An edge tracker is a method which is used to extract edge traces on the drone. It is robust and fast method for detecting moving objects. Moving objects are detected by computing the difference between the edge-trace flows in consecutive frames. Pairs of consecutive images are processed and perceptual edge segments are found piece by piece.

YOLO detection method was discussed in [3] to detect objects. This unified architecture is ultimately fast and YOLO model processes images in real-time at 45 frames per second. Fast YOLO, can process an astonishing 155

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frames per second. When Comparing with other detection systems, YOLO makes more localization errors but is less likely to predict false positives on background.

In paper[4], the authors used convolutional neural networks(CNN) to detect the moving objects. By combining with background subtraction algorithm they have created the artificial dataset which contains the real images. By this approach we can get high precision and recall value at the same time. In future, they will use time domain to improve the performance.

CNN method which are capable of solving the optical flow estimation problem are discussed in [5]. Since existing sets are not sufficiently large to train a CNN, they generated a large synthetic Flying Chairs dataset. The networks trained on this paper is unrealistic data set. When comparing with Deep flow and Epic flow CNN performed well on this data set. In future work, they will try for realistic training data set.

Background subtraction method is handled in [6]. Objects are detected by PTZ camera. By using the data of two consecutive images previous and upcoming rotation new background will be created for the detection of moving objects. This method achieved the object detection for single moving object. In future they will choose a multiple moving object detection.

In[7] authors discussed region shrinking algorithm. The region with high density of motion pixels is approached by region shrinking algorithm to detect the moving objects. An image power transformation is adopted to enhance objects at different position. The method needs no prior knowledge of the number of moving object and it is robust to noise.

Detecting moving objects is achieved by the background subraction algorithm[8]. The current frame is subtracted from the reference frame. They analyzed different background subtraction algorithms like Data Validation, Foreground Detection, Background Modelling and Pre-processing.

[9] focused on CNN method to detect moving object. Zeiler and Fergus (ZF), Visual Geometry Group (VGG16) are CNN architecture. In training data set VGG 16 perform well when comparing with faster R-CNN. The Data set contains both drone and bird images. The results can be improved if the birds are also annotated. By considering bird as a separate class will reduce false positives. Then the trained model will be able to identify birds and drones.

Paper[10] focused on two techniques. Back ground subtraction algorithm to get background model and frame differencing algorithm to update it. Then extracts the moving objects from the fusion of images extracted from these two methods. The moving object used in the video are bees they are very small in size and always fly in high speed. To get more moving information the circle segmentation dynamic threshold is used.

III. COMPARISON OF VARIOUS METHODS

Reference	Methodology	Description	Limitations
[1]	Background Subtraction + Region Proposal Network	Background Subtraction is used to identify moving objects. It is done by finding the difference between the current frame and background key model. Region Proposal Network consists of set of candidate regions that consists of object are produced for every individual frames.	Background Subtraction is only applicable for short sequence length. It is only suitable for static camera.
[2]	Edge Detection	Edge detection reduces the data and filters the useless information present in an image. It is implemented by GCS and CPP algorithm. GCS consists of curve points.	We must have prior knowledge about patterns o implement edge linking which is impossible in every moment.
[3]	YOLO Detection System	YOLO can process an images at the speed of 45 frames per second and Fast YOLO can process an image astonishing 155 frames per second.	YOLO unable to find small objects that appear in group like flocks of birds. It learn to predict bounding box from the data, it is not suitable to identify objects in unusual configuration.
[4]	Deep Networks	YOLOv2 attemp to design regression for object detection. Fully convolutional architecture are trained to extract the high level features in an image. It aims to find bounding boxes of an object in the video sequence directly, replacing the dealing with regions in the video sequence.	It require larger dataset that can include many scenario for high accuracy.

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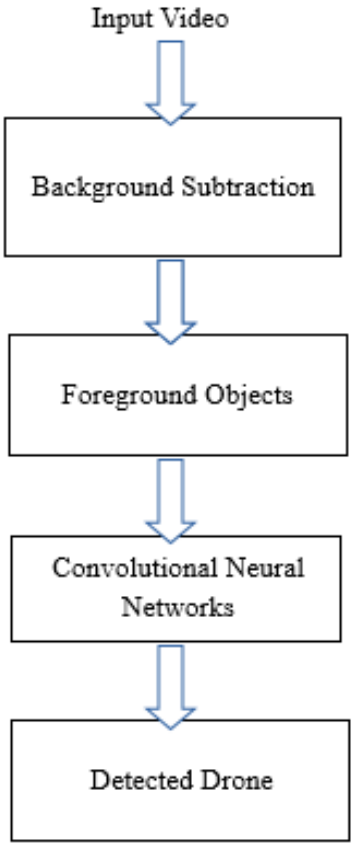
Reference	Methodology	Description	Limitations
[5]	Convolutional Neural Networks	They introduce correlation layer that works by multiplicative patch comparison in between feature maps.	It is only applicable for GPU.
[6]	Background Subtraction	PTZ (Pan, Tilt, Zoom) camera is used to detect the moving object because it provide broad vision and more information. Mean filter algorithm is used to build the initial background model.	It is not applicable for moving cameras due to initialization of background model.
[7]	Region Shrinking Algorithm	They introduced power transformation method before region shrinking to solve limitation of situation that there is a single object in an image.	___
[8]	Background Subtraction	The main role of background modelling is to track the changes in background scene and extract the foreground information.	It is unable to process the moving camera videos due to the background key frames.
[9]	Faster RCNN	In this method Caffe deep learning library is used to detect the objects. These are publically available for most of the models and it requires less amount of data set for deep learning system to train from basic. They have used ZF and VGG16 architecture to train their system.	They have used only drone dataset so there is a possible for false positive.
[10]	Background subtraction + frame differencing Algorithm	For getting background model its uses surendra background algorithm and uses frame differencing algorithm to update it, finally the moving object can be extracted from the images from these two methods.	It depending on The time interval between frames.

IV. BLOCK DIAGRAM



V. SUMMARY

We have analysed the existing methods such as Background Subtraction, Frame Differencing, Optical Flow and Edge Detection algorithms for object detection. Background Subtraction is only suitable for static camera due to initialization of background model. Frame Differencing, Optical Flow and Edge Detection are applicable to both static and moving cameras. YOLO based detection can process an images at the speed of 45 frames per second and Fast YOLO can process an image at the speed of 155 frames per second, but Fast YOLO will not give an accurate result compared to YOLO detection method.

VI. CONCLUSION

The existing object detection methods such as Background Subtraction, Frame Differencing, Optical Flow, and Edge Detection algorithms are suitable for detecting objects flying at a particular distance, either in a clear or in a slightly blurred background. In our proposed UAV detection and classification system, we will use CNN both to detect and to classify the flying objects even at a far away distance and with unclear background. The performance of our system will be improved by training the network with sufficient data set.

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Thin Film of Nickel-Zinc Solar Absorber Deposited on Nanostructured Copper Substrate by Reactive Electron-Beam Evaporation

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Abstract**—** *This article deals with the motivation for development of selective thin film on structured substrate in the field of upgrading solar energy conversion. Some observations on reactive PVD E-beam and structural and optical properties of nickel-zinc solar absorber obtained were briefly discussed. The thin film of nickel-zinc obtained shows optimum optical properties as far as maximum absorptance and minimum emittance, these results verified closed to the Planck black body and the ideal selective film. The nickel-zinc oxides from the thin film obtained allow exceptional stability and semiconductor properties, make practical applications feasible for future photovoltaics designs.*

Keywords**— Nanostructuration, Nickel-zinc thin film, Reactive PVD E-beam, Solar absorber surface, Sol-gel antireflection layer of SiO_2.**

I. INTRODUCTION

The flat plate collectors are based on two important principles: a black base that absorbs the solar radiation better than any other color and a glass lid that is needed to keep the heat in[1,2]. An ideal solar selective (solar absorber) coating must have then high solar absorptance and low emittance [3,4]. Several techniques, such as vacuum techniques (sputtering, electron beam, chemical vapor deposition, etc.), sol-gel, electrochemical and electroless deposition (catalytic reduction process) are currently used to produce solar absorber surfaces, but two types are mainly applied in industry: vacuum and electrochemical techniques [5]. In this work, black nickel-zinc solar absorber layers are deposited on copper C81100 substrates by REACTIVE electron-beam evaporation (PVD E-beam). After nickel-zinc thin film deposition a sol-gel antireflection coating of SiO_2 is applied to each solar absorber surface obtained by the spin coating method. The thicknesses of the layers have to be nanostructured in order to avoid absorption by interference for wavelengths in the middle of the solar spectrum (solar light trapping effects), the substrate nanostructuration. The characteristics of the nickel-zinc absorber film revealed by atomic force microscopy (AFM), X-ray diffraction (XRD) and optical UV-VIS-NIR and MIR spectrophotometry (optical proprieties) shows beneficial effects of the nanostructuration proposed and PVD E-beam technique on their optical characteristics.

II. EXPERIMENTAL PROCEDURE

The proposed nickel-zinc thin film on nanostructured were obtained using the following sequence of operations:

1) Nanometric leveling of metallic substrates: mechanical unidirectional polishing (P1200) of C81100 copper substrates (1 × 1 cm^2); copper electrochemical polishing (electropolished) in 85 %v/v H_3PO_4 a 1750 mV (DC) for 180 seconds (3 × 60 seconds), only for nanostructured sample [6];

2) Deposition of the solar absorber coating:

Reactive PVD E-beam[9]: nickel and ZnO powder particles are used as source materials to deposition by PVD electron beam evaporation, O_2 introduced into the chamber (working pressure: 1.3×10^{-3} Pa). The electron gun voltage applied were of 4kV to7kV and working current were of 300 to 500 mA for 15 minutes. Target composition equivalent to the electrochemical condition or procedure: 3Ni:ZnO [8]. The E-beam solar absorber surface presented a Filmetrics™ F20 estimated thickness of about 1-2 μm on nanometric leveled C81100 copper substrate.

3) Sol-gel antireflection layer of SiO_2 [10]: the antireflection coating, from tetraethylorthosilicate (TEOS), was made by the spin coating method. The antireflection coating of SiO_2 presented a DekTak™ IIA profilometer estimated thickness of 200 nm.

All chemical reactants and solutions were made from Vetec chemicals (Vetec Química Fina Ltda) and Milli-Q™ water.

4) Scanning Electron Microscopy (SEM) and Energy Dispersive X-ray (EDS) spectroscopy of the absorber samples were performed using JEOL JSM-6460 LV and EDX Noran in 200 kV (EDS), respectively. Back scattered

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electron imaging, qualitative X-ray analysis, and cross-section images were obtained.

Ultraviolet-visible- near infrared spectroscopy (UV-VIS-NIR absorption patterns) of the absorber samples were obtained using a Perkin Elmer™ Lambda 950 spectrophotometer with wavelength of 175 nm at 2500 nm, Labsphere's Spectralon® reflectance material was used as standard sample for calibration (reflectance > 95%). FTIR spectra and mid infrared emittance results (MIR or thermal infrared, wavelength of 3 μm to 8 μm) of the absorber surface were analyzed with Perkin Elmer Spectrum GX using as reference a polished nickel plate (with reflectance > 95 %) with wavelength of 2500 nm at 7000 nm.

The thin film thicknesses were evaluated using Filmetrics™ F20 also. To determine film thickness, the Filmetrics™ F20 software calculates a reflectance spectrum that matches as closely as possible to the measured spectrum, the thickness baseline. To determine the anti-reflective layer thickness were only used a DekTak™ IIA profilometer.

AFM images of the absorber samples were recorded using intermittent contact mode operation on a JPK™ atomic force microscope (JPK Instruments- Nanotechnology for Life Science) under ambient condition, relative humidity between 45% and 55%. Micromasch™ rectangular cantilever NSC16/AlBS has been employed to obtain topography and phase contrast images. Magnetic force microscopy (MFM) images of the absorber surface were obtained by using the same tips coated with Co-Cr. Image resolution has been set to 512×512 points.

X-ray diffraction patterns were obtained using a Rigaku MiniFlex™ X-ray Diffraction System adapted to measure non-powder XRD on Back Filled Holder. The goniometer of radiation operating at 30 keV and 15 mA (Cu Kα) with nickel filter produces monochromatic X-rays focused on the sample surface to determine by Bragg Law the interplanar spacing (d-spacing). The analysis range of 2×theta was between 10° and 100° with a 0.05° step. The data was analyzed by XRD analysis software Jade™ (Jade 5.0.37 from Materials Data, Inc).

III. RESULTS AND DISCUSSION

3.1 Optical Analysis – Spectrometry UV, VIS, nIR and mIR

The normal reflectance of prepared samples was measured in the wavelength interval (λ) 0.3 to 2.50 μm by a Perkin-Elmer Lambda 950 spectrophotometer with an integrating sphere. The solar absorptance (α in equation 1) is theoretically defined as a weighted fraction between absorbed radiation and incoming solar radiation. The direct normal solar irradiance (I_{sol}) is defined according to the ISO standard 9845-1 (1992) where an air mass of 1.5 (ASTM E891-1987) is used. Normal thermal emittance (ε in equation 2) is a weighted fraction between emitted radiation and the Planck black body distribution (I_p, equation 4: σ is Stefan Boltzmann constant, 5.67 ×10^{-8} W m^{-2} K^{-4} and T_o is the absolute temperature of heated surface at steady-state) at 100ºC (373 K). Selectivity is the comparative fraction between absorptance and emittance. The ideal selective surface in Figure 1 has zero reflectance (R, □ = 1 – R = 1 or 100 %) to λ between 0.3 and 2.5 □m and unity reflectance (R, □ = 1 –R = 0 or 0 %) in the infrared region, to λ between 2.5 and 25 □m [2,11]. The antireflection sol-gel coating of SiO_2 presented an emittance of about 5 % (smooth glass)[2,10].

$$\alpha_{sol} = \frac{\int_{0.3\mu m}^{2.5\mu m} (1 - R(\lambda)) \cdot I_{sol}(\lambda) \cdot d\lambda}{\int_{0.3\mu m}^{2.5\mu m} I_{sol}(\lambda) \cdot d\lambda} \quad (1)[11]$$

$$\varepsilon_{therm} = \frac{\int_{2.5\mu m}^{20\mu m} (1 - R(\lambda)) \cdot I_p(\lambda) \cdot d\lambda}{\int_{2.5\mu m}^{20\mu m} I_p(\lambda) \cdot d\lambda} \quad (2)[11]$$

$$\varepsilon_\lambda + R_\lambda = \alpha_\lambda + R_\lambda = 1 \quad (3)[11]$$

$$I_p \approx \sigma \cdot \left(T_o^4\right) \quad (4)\ [11]$$

In Figure 1 and 2, the absorptance for both structuration conditions for □ = 300 - 2500 nm shows a statistical optical improvement in α with E-beam with absorptance (99,6 ± 0.1) % of the E-beam condition. The results of solar absorptance indicate that the optical parameters of the absorber samples are improved by the deposition technique and nanostructuration of substrate. The emittance for both structuration conditions for □ = 2500 nm to 25000 nm shows a decreasing s in ε with reactive PVD E-beam, thus the emittance of 8.4 % of the electrochemical condition and 10.4 % or □ = 2500 nm to 25000 nm. The thin film deposited presented a highly selectivity (solar absorptance and thermal/ emittance) value of 11.55 (0.9703/0.084 due a nickel-zinc electrochemical solar absorber on nanostructured copper substrates). This result of selectivity was improved using an antireflection SiO_2 sol-gel coating with emittance values of 0.05 [2,10]. The PVD E-beam film measured by the Filmetrics™ F20 shows a thin film with a thickness from 1μm to 2 μm. Table 1 shows that the thin film behave are close to an ideal selective material, with the absorptance close to Plank black body.

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Table.1. Mid-temperature of some black selective surfaces[2].

Material	Fabrication Method	α	ε (100 °C)	Product
Black nickel NiS-ZnS	Electrodeposition	0.98 - 0.96	0.03 - 0.10	Maxorb
Black copper BlCu-Cu_2O:Cu	Electrodeposition / Sol-gel	0.97 - 0.98	0.02	
Black chrome Cr-Cr_2O_3	Electrodeposition	0.97	0.09	MTI Chrome Coat Energie Solaire
Ni-NiO_x	Reactive sputtering	0.96	0.10	Sunstrip
Ni pigmented Al_2O_3	Anodization	0.85 - 0.97	0.08 - 0.21	TeknoTerm Energi Showa

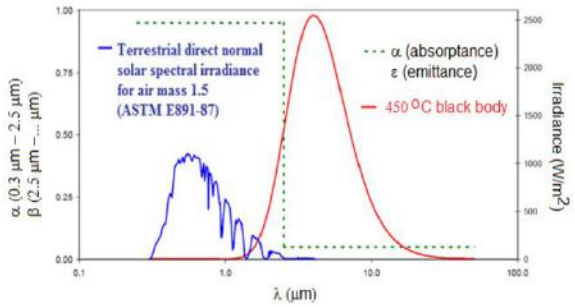

Fig.1: Spectral performance of an ideal selective solar absorber[2].

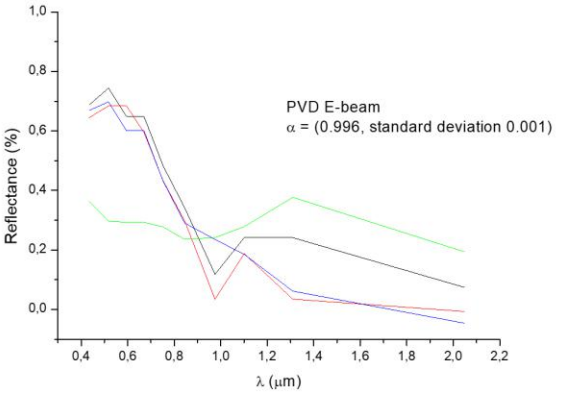

Fig.2: Solar reflectance (λ = 350 nm-2000 nm, 450 K) of thin film with an antireflection sol-gel layer of SiO_2.

3.2 Topography and Physical Analysis: Atomic Force Microscopy

AFM micrometric image of samples - Figure 3(a) and Figure 3(b) - compare the P1200 polished and electropolished samples and show the nanometric leveling effects on the surface of the electropolished copper plates via a multistep method. The JPK™ root mean square roughness (RMS) deviation has decreased from 114.6 nm (submicrometric) in the mechanical polished surface to 24.5 nm in the electropolished surface. Also, the JPK™ maximum peak height is reduced from (504.1± 0.1) nm (mechanical polished surface) to (39.8 ± 0.1) nm (electropolished surface). Furthermore, a better height distribution in the electropolished copper surface was registered. Thus, JPK™ AFM analysis results show that copper bulk is nanometrically leveled.

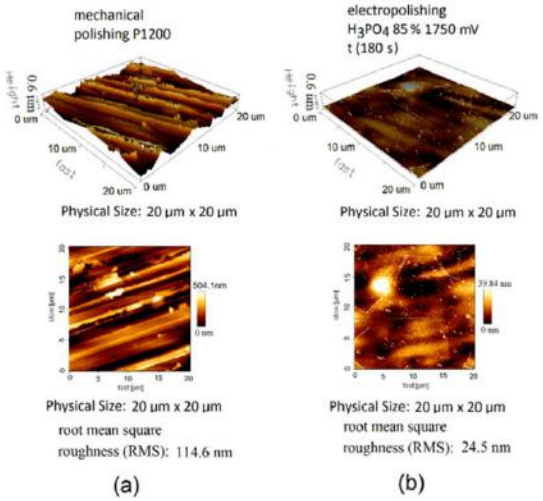

Fig.3: AFM 20 µm × 20 µm images and statistical JPK™ roughness of the surface nanometric leveling of (a) copper mechanical P1200 polished with and (b) copper electropolished at 1750 mV (DC), in H_3PO_4 85 %v/v for 180 s [6].

To confirm the dimensions of the nickel-zinc solar absorber surfaces to both conditions, phase contrast and topography scanning images were performed with SPIP™ image analyses. In Figure 4, AFM SPIP™ parameters of the nickel-zinc thin film indicate the presence of smaller and some periodic nanometric grains with an estimate mode particle size of 20 nm, an average and a maximum height roughness of 71 fm and 21.1 nm (respectively), besides, the thin film presented an AFM JPK™ a roughness deviation of 2.7 nm. AFM JPK™ RMS and maximum height roughness for the thin film is lower than sunlight wavelengths and therefore, the surface texturing or trapping effects related by Kennedy; this consideration means that sunlight absorbing effect is improved using PVD E-beam technique [3].

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Fig.4: AFM of thin film. (a) 4 ×4 µm images of the height (topography profile) and (b) 4 ×4 µm lock-in phase image.

3.3. Morphology: Scanning Electron Microscopy (SEM) and Energy Dispersive X-ray (EDS) spectroscopy

Images of SEM (and EDS), Figure 5 (a) show a smooth and continuous surface for the thin film. Analysis of EDS for the electrochemical condition, Figure 5(b) showed the presence of zinc and nickel for the thin film. The nickel/zinc percentage atomic composition EDS rate found for the electrochemical condition is 80%/20 % in the PVD E-beam deposition.

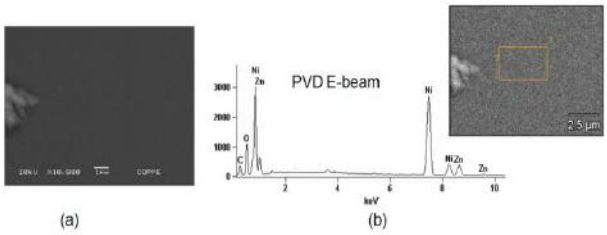

Fig.5: (a) SEM 10,000× image and (b) EDS spectrum of thin film.

3.4. Chemical Analysis: Fourier Transform Infrared (FTIR)

FTIR literature broad bands in table 2 were used to study the chemical composition of the absorber film type nickel-zinc using to the electrochemical and E-beam conditions.

The infrared spectrum of the PVD E-beam condition in Figure 8 exhibits broad bands, centered at zinc oxide and nickel oxide, this result agree with EDS (Figure 7(b)) also. The FTIR results in Figure 6 showed nickel and zinc oxides with indicatives close to Dharmaraj and Ghule for the NiO and ZnO nanoparticles FTIR broad bands [13,16]. The presence of thiocyanate and indicatives of ZnS were detected only in the electrochemical condition. Therefore, were basically produced a black zinc-nickel absorber surfaces by electrochemical and evaporation (PVD E-beam) methods with a chemical composition of zinc and nickel oxides. The results obtained from FTIR are equivalents with those obtained previously by XPS [6,8].

Table 2. FTIR absorption bands of thin film.

Identification	Absorption, broad bands	Intensity (%)
NiO[12]	600-680 cm^{-1}	3
	830-930 cm^{-1}	70
	1000-1130 cm^{-1}	10
NiO[13, 14, 15]	420-440 cm^{-1}, 475-480 cm^{-1}, 445-490 cm^{-1}, 1633 cm^{-1} e 3470 cm^{-1}	-
Zn (2+)[16]	870-900 cm^{-1} e 1047-1050 cm^{-1}	-
ZnO[17,18]	450-460 cm^{-1}, 1486 cm^{-1}, 1600-1630 cm^{-1} e 3410-3420 cm^{-1}	-

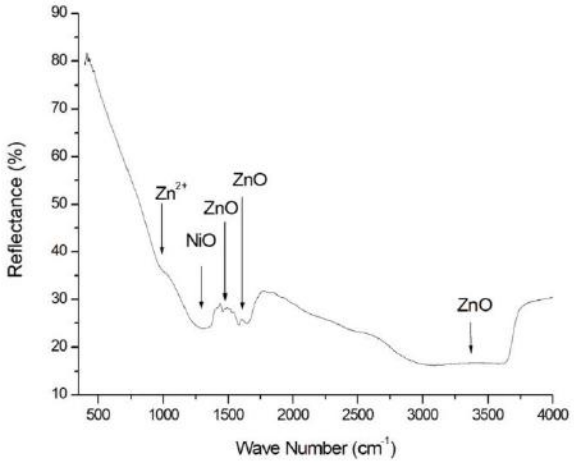

Fig.6: FTIR of thin film.

3.5. X-ray diffraction (XRD)

Figure 7 shows the XRD pattern for ZnO and NiO of thin film on copper substrate. XRD to detect some peaks of NiO (200), NiO(220), ZnO (200) and other Lattice planes NiO beyond copper substrate signals. The peak at about 45° and 43° corresponds to the diffraction from (002) plane of ZnO e (200) NiO, indicating an oriented ZnO and NiO growth along the c-axis perpendicular to the substrate surface [22, 23, 24]. The results obtained from XRD are consistent with those obtained previously by XPS [6,8].

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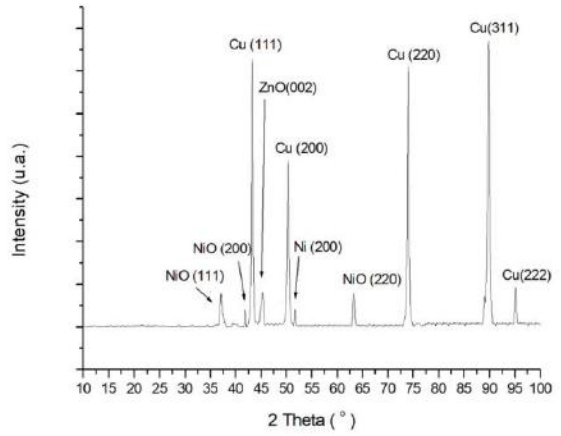

Fig.7: XRD pattern NiO-ZnO of thin film.

IV. CONCLUSIONS

The results of solar absorptance and selectivity indicate that the optical parameters of the absorber samples were improved by the PVD E-beam deposition technique and nanostructuration of substrate when compared with commercial optical selective films. The thin film of nickel-zinc oxide deposited offered a highly selectivity of 11.55 (0.9703/0.084) close to the ideal optical selective film and absorptance close to the Planck black body.

AFM images confirmed the success of the surface nanostructuration of the copper bulk RMS roughness and thin film. The results of solar absorptance indicate that the optical parameters of the absorber samples are improved by nanostructuration of the copper substrate.

The FTIR and XRD results showed a ZnO semiconductor thin film PVD E-beam were deposited on copper substrate making this thin film feasible for future photovoltaics designs in solar power plants.

V. ACKNOWLEDGEMENTS

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Method of Perception of Materials by Users (PERMATUS) for Development of Sacred Imagesin Aparecida, Sao Paulo, Brazil

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Abstract*—This article aims to apply a method of evaluating products in relation to the perception of their materials by users, based on studies performed with sacred images. The religious culture is one of the main characteristics of the city of Aparecida, located in the Paraiba Valley, in the state of São Paulo, Brazil, attracting tourists from various regions of Brazil, moving and expanding the source of income of the residents. The study is based on the user's method of perception of materials - PERMATUS that aims to assist designers in the selection of materials considering the subjective attributes as a way of incorporating identity in product development, valuing the artifact. Users' perception tests were performed with seven types of images in different materials, such as: metallic, polymeric, ceramic and composite with different diatomaceous earth loads in gypsum. The research was conducted at the tourist support center in the city of Aparecida. The results show that the materials influence and affect the sensations by the diversity in the individuals expression in front of the products, finishing, textures with significant impact in the choices and decision making.*

Keywords*— *Material Selection, Product Design, Texture, Sacred Images, PERMATUS Method.

I. INTRODUCTION

The materials were of great importance for the development of human history in which for thousands of years man used basic materials such as wood, stone, bone, horn and skin that were essential for his survival and progress.

"We live in a world of materials. It is the materials that give substance to everything we see and touch." The choice of materials it is an important step for the whole project, since they have a direct connection and influence the shape of objects, as can be seen from historical architectural monuments to simple products developed for our daily life. [1] "Material is the interface between artifacts and man"[3], the designer transforms his ideas, sketches, his designs into tangible objects through materials. In the development of a product the choice of materials is of great importance, because it is necessary to know the main characteristics in the material so that it meets the concepts present in the product.

Despite all the planning adopted for the development of a product (technical aspects, aesthetic attributes, among others) there is still an unexplored step, the relationship and interaction between the user and the product in question.

This article aims to apply the study of the method of evaluation of products in relation to the perception of their materials by users. According to the method Perception of Materials by Users (PERMATUS) was based on several methods, tools and techniques known and applied by professionals and researchers, both in projects for industry and in academic research. The Method aims to assist designers in the selection of materials, considering the subjective attributes of users as

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an essential part to develop a project, valuing and making the final product significant.The PERMATUS has two phases with six steps and stresses the importance of applying several types of tests to obtain the users sensorial and emotional information and convert them into objective information. [4]

The study of the perception of materials is a component of a research that has been developed since 2013 as project through Conselho Nacional de Pesquisa e Desenvolvimento Tecnológico – MCTI-CNPq. The project has interdisciplinary characteristics in the areas of design, materials engineering and social technologies with technological extension of the academic master degree in Development, Technologies and Society at the Federal University of Itajubá (UNIFEI). The research aims to develop a new material using the residue before filtration of beer, Diatomaceous Earth, aiming at improving the quality of the material and the sustainability of the product. This residue is added in small percentages (5%, 10% and 15%) and mixed with gypsum – the main material used in the manufacture of this product – for application in sacred images. One of the prototypes of sacred image with gypsum and diatomaceous earth (with 5% of DE) was one of the objects used in the test on the PERMATUS method with the users in the city of Aparecida.

The religious catholic culture is one of the main characteristics of Brazil, mainly in the city of Aparecida, state of São Paulo. At the study site, the city's economy is made up of the service sector, with several sacred image factories.The micro-enterprise partner to develop this project is administered only by the own relatives and the manufacture of these objects is realized in an empirical way, without having any methodology for production, and also are not found methods that effectively evaluate the application of the materials in sacred images and that allow to know their influences in the choice or rejection of the product by the user, at the time of purchase or use.This type of information can contribute to a better understanding of the relationship between product, material and the emotional of the user in relation to the products.

"the subjective evaluations resulting from the research can be reversed in objective information" such as the definition of the characteristics of the product, the technical specification of the materials, definition of textures and finishes, among others. [4]

II. DESIGN AND SELECTION MATERIALS

The materials are the basis for all technological advances. [2]. The most important aspect of materials is to be facilitative, to make project ideas workable.Materials such as stone, iron and bronze played an important role in the history of civilization and were essential for its development.

We live in a world of materials. They are the materials that give substance to everything we see and touch. Our species - Homo sapiens - is different from others, perhaps more significantly by the ability to project - produce "things" from materials - and by the ability to see more of an object than just its appearance.Objects can have meaning, awaken associations, or be signs of more abstract ideas. Projected objects, both symbolic and utilitarian, precede any recorded language - and give us the earliest evidence of a cultural society and symbolic reasoning. [1]The industrial revolution caused an accelerated multiplication of materials and forms of production, and was responsible for profound economic, social and cultural transformations.[4]

In material selection, the interactive material contact, each sense organ is able to provide different sensations. The tactile modality is an important system in the user-product interaction as a function of factors such as comfort, satisfaction and preferences,the properties of each material induce a unique and particular perception for each user.Therefore, strategic use of materials is one of the most influential means that designers can use to communicate and create emotional connections between products and their users. [4]

III. METHODOLY

3.1 Place of Study

Fig.1: Location of the city of Aparecida, State of São Paulo, Brazil

The economy of some cities stands out for the provision of services. In view of this, the project in question was developed based on the religious economic highlight of the municipality of Aparecida, located in the Vale do Paraíba, state of São Paulo, due to religious and historical tourist, which gathers more than 12 million tourists per year and in 2017 broke the record, receiving 13 million tourists. [18]

With the demand of religious tourism it is necessary to hire new employees in seasons. According to Jornal

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Globo (2013), with the visit of Pope Francisco the city hired 1,500 temporary jobs for the production of sacred image of "Nossa Senhora de Aparecida", being an influential factor in the city's turning of capital.

The study of the perception of materials by the users was carried out at the Tourist Support Center, one of the main centers of religious commerce in Aparecida, since it maintains an intense flow of people since it is located next to the new Basilica of "Nossa Senhora de Aparecida".

3.2 PERMATUS Method

The User Perception of Materials method (PERMATUS) aims to study how users perceive meanings of the materials present in the products of their daily life [3]. The method is composed of six steps as illustrated in figure 2.

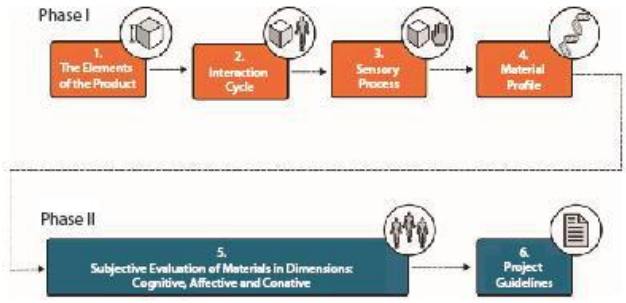

Fig. 2: Summary architecture of the method of perception of materials by users (PERMATUS)

The method is composed of six stages subdivided into two phases. Phase I consists of 4 steps, deals with questions related to the product to be studied (1) the elements of the product, (2) the possible interactions between the user product, (3) the sensory modalities involved in the stimulus (4) the profile of the materials that will be selected [4]. This phase can be considered as the structuring of the fundamental information for the consecutive stages of the evaluation and specification. In this way, it is important that it be carried out in the initial phase of material selection.

Performing steps 1 through 4 is the responsibility of the project team.

The first stage "Product Elements", allows to know the product in detail, defining its elements, its main characteristics and most relevant aesthetic and ergonomic functions.This step it is like a dissection of the product into user-understandable components.

The second stage, "Cycle of Interactions", analyzes the relationship between product and user, the particular product establishes cycles of interactions with its users, from the first contact, which begins before the purchase and extends through the stages of discovery, transportation, unpacking, use, storage and disposal of the product.

The third stage "Sensory Process", has as its tool the five sensations often applied, in this step all the sensations that occur throughout the cycle of interactions between user and product are analyzed.

The fourth stage of the "Material Profile" divides the material into three groups: Family, Class and Member, based on the nature of the atoms of the material and the connection between them, their variations and also in the details of composition. The product is attributed aspects related to aesthetics, practice and symbology. The aesthetic attributes establish direct relationships with the aesthetics of the product, perceived through the senses, the use, handling and experience of the user in relation to the product, configure the factors that establish the practical attributes, and social aspects that are directly related to the status provided by it, is attributed to the symbolic attributes of the material.

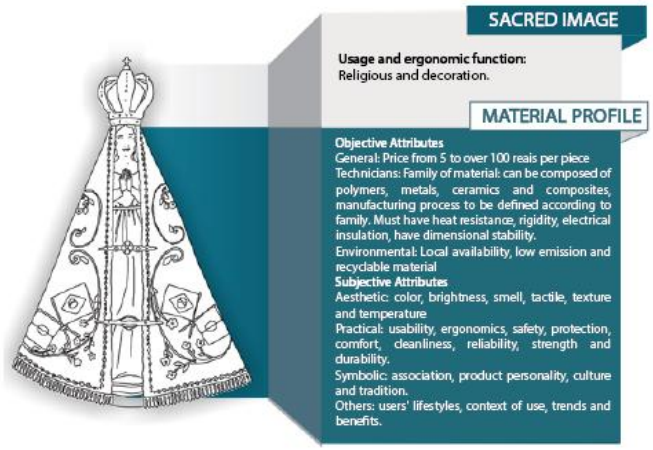

Fig. 3: Material Profile based in PERMATUS Method

Phase II consists of two stages, Subjective Evaluation and Objective Specification.

The fifth stage "Subjective Evaluation" is formed by the evaluation of users in the cognitive, affective and conative areas.In the cognitive sphere the users evaluate the product in practical circumstances of use, in the affective the users evaluate the emotions and pleasures motivated by the product, which defines the preferences of the users, composes the conative sphere, it is evaluated how much the other attributes influence in the definitions and choice of the product.

Finally, the sixth step, "Objective Specification", defines the guidelines to be followed by the project, analyzing all the factors gathered through the previous five steps, it depends on the professional to transform the assessments of subjective character in objective evaluations, at the end of this evaluation are established the profiles of the materials that will be used throughout the development of the product.

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3.3Test with users

The model of perception of the materials by the users (PERMATUS) was applied in a practical circumstance. The test was applied with voluntary participants, using the six steps and had as objective a comparative evaluation of sacred images. The main function of the object chosen for study - sacred image - is of a religious symbolic character.

Table 1 -Test Characteristics

TESTS	FEATURE	POPULATION	TEST LOCATION
1	Apply the Permatus tool to evaluate 7 sacred images of different materials and finishes, based on the users' interaction with the products.	Individual tests with both sexes without any prerequisite required for participation in the test. It was realized with 10 users	Tourist support center in Aparecida, São Paulo, Brazil.

Seven sacred images of four families in different materials were chosen. Figure 4 illustrates which image models were stipulated for application of the test. acquisition.

Fig.4: Sacred images in several materials

(1) Biscuit (cold porcelain); (2) Low carbon steel; (3) Polymer; (4) Polymer PLA (polylactic acid) produced by 3D printing; (5) Resin; (6) Gypsum; (7) Gypsum with addition of 5% of Diatomaceous Earth.

For the accomplishment of the tests two people were required for the application. The functions were divided into: the researcher instructed, interviewed and recorded important data during the test, and the assistant researcher was responsible for video recording the entire interview process and also supported the organization of the environment in which the tests were to be conducted.

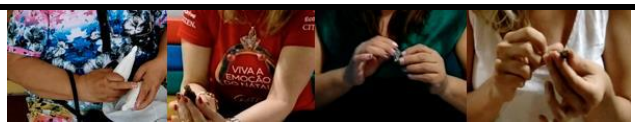

Fig. 5: Users interacting with the objectives

The sampling procedure adopted was accidental non-probabilistic, obtaining a total of 10 individuals, being 2 males and 8 females. The visual evaluation was first carried out only by means of photos of the seven models of sacred images constructed in four families of materials as already mentioned. The interviewee should choose the favorite sacred image and the one he would not choose considering only the visual aspect of the material. After the choices, without being informed about which material possessed each image, users could have contact with the seven objects already presented in photos and should say what material is employed in it. Upon completion, users should indicate which sacred image they would choose and would not choose after knowing what material was used in each object. The profile of the interviewed users was quite broad since there was no prerequisite for participation in the research.

IV. RESULTS AND DISCUSSION

4.1 Application of the PERMATUS Method

First the product was explored with respect to the elements that compose it, its relevant characteristics, main and secondary functions. Being an object of religious character the main function is symbolic, since for many people the image of “Nossa Senhora de Aparecida”, symbolizes the own guarding by their homes. Each element of the image, besides having its aesthetic and functional function for the product, also has a symbology. The size of the image varies and also the materials that can include polymers, woods, plaster, resins, among others. Dimensions and materials are important factors as the manufacturing process influences the price of these images.

4.1.1 Phase 1 - Cycle of interactions

First contact: usually occurs in trades where the consumer can see images in various sizes and materials. These images are usually sold at local fairs, stores in some cases can be purchased online. At the physical points of sale, the sacred images do not have any packaging, they are displayed packed in transparent or unshielded with polyvinyl chloride (PVC) film wrappers.

Transport: These images are usually not heavy, for transportation the sacred image is wrapped in newspaper and a bag is provided, some may still be wrapped in PVC film.

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Unpacking: consists of removing the sacred image from the bag, removing the newspaper and removing the case if you have one. This type of product does not accompany recommendations manual.

Use and rest: consists of accommodating the image in some room of the house or other environment and perform the cleaning periodically.

Disposal: This product does not have an exact life expectancy, however, its mechanical resistance is low, making it susceptible to fails. At the time of disposal, people generally do not know how to discard it, so much of it ends up playing in rivers, burying or putting in places known as "cruises", few people put in garbage cans because of the symbolic value.

4.1.2 Phase 2 - Sensory Process

Visual sensations: Refers to the quality of the visual elements of the image, the finishing, painting and so on.

Haptic sensations: Feel the weight of the image, the texture of its visual elements and the quality of the material used by its texture.

Olfactory sensations: The materials used may have aroma, but it is almost imperceptible.

Thermal Sensations: Feel the temperature of the material used as the gypsum for example.

Functional sensations: The product should be handled with care since the material is fragile and sensitive to falling, so it should be accommodated in one place and rarely removed.

4.1.3 Phase I – Material Profile

As already mentioned, seven types of sacred images were used, totaling four types of family of materials (Ceramic, metallic, polymers and composites) throughout the study, however to demonstrate the applicability of the method, we will continue using the example of the sacred image produced in gypsum.

4.1.4 Phase II - Subjective Evaluation of Material

Cognitive: presents the image as context of use based on the materials that compose it and how the user reacts to this interaction.

Affective: directly linked to the emotional relationship of the user with the image. Especially in the religious sphere.

Conative: the way in which a certain image differs from other influences directly in the choice of the user, although dominated by a religious feeling, portrays a purely aesthetic element in order to elevate to a certain spiritual plane.

4.1.5 Phase II - Project Guidelines

After the application of all phases and stages of the method by the researchers, a questionnaire was designed for the volunteers of the research, to obtain sociotechnical information of the same for the test of application of the PERMATUS method in sacred images executed in the city of Aparecida, State of São Paulo, Brazil.

4.1.6User Profile

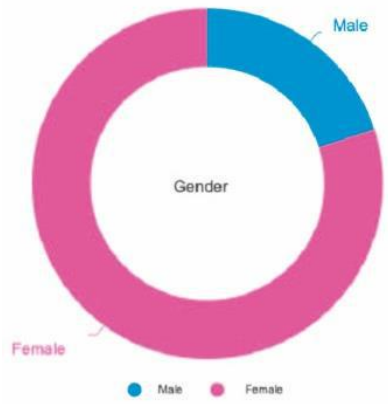

Fig.6: Gender of the research participants

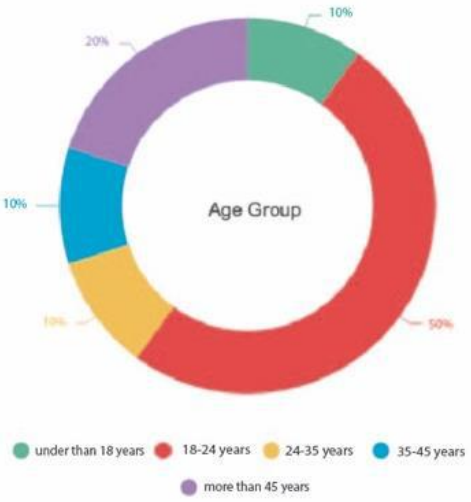

Fig.7: Percentage of age participants

Of the total number of participating users, 20% were men and 80% were women, predominating the female gender. The age range of the participants varies from under 18 years to over 45 years of age as shown in figure 6. Users aged 18 to 24 represent 50% of the total research, followed by over 45 years (20%), 24 to 35 years (10%), 35 to 45 years (10%) and under than 18 years (10%). In addition, information on the marital status of the users was collected. Being composed as follows: 70% of them are single, 30% married, 0% Widowed, divorced or with stable union.

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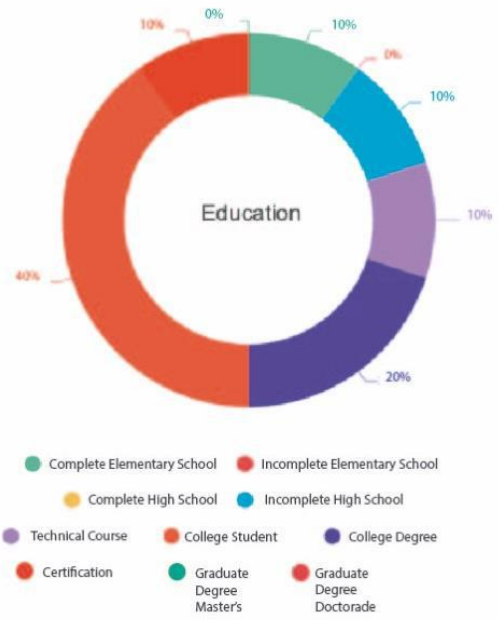

Fig.8: Academic Profile of the users

The academic profile of the users is quite varied and represents in its totality college students (40%), followed by graduates (20%), Certification (10%), Technical Course (10%) and complete elementary school (10%).

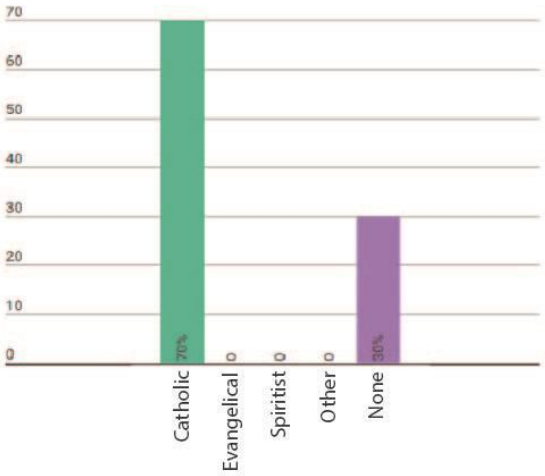

Fig.9: Religions of the users

The religion of the users was considered an essential factor to consolidate the profile of the consumer of sacred images. The Catholic religion predominates (70%), followed by users who have no religion (30%). The predominance of Catholicism in the sampling is due to the research place, Aparecida is the city characterized as the largest religious pilgrimage center in Latin America, receiving annually more than 13 million visitors, which make the city one of the main tourist centers of Brazil.

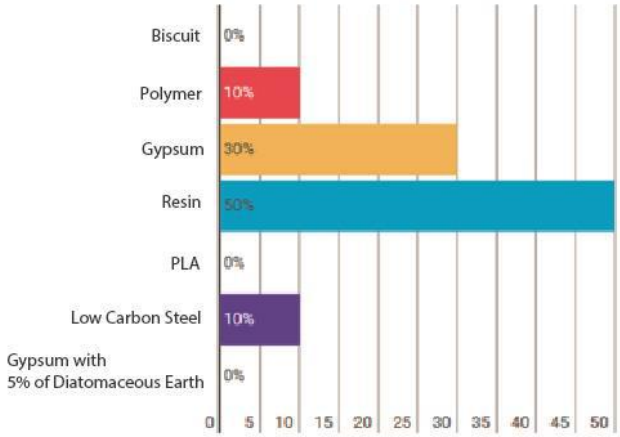

Fig.10: Percentage of choice of sacred images through photo viewing

The preferred religious image among the interviewees was mostly Resin (50%), followed by gypsum (30%), polymer (10%) and low carbon steel (10%).

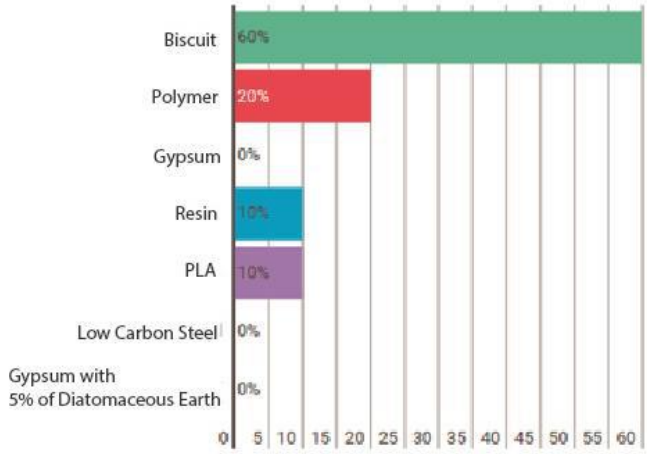

Fig.11: Which sacred image would not buy by choosing by viewing photos

The sacred image that they would not choose to acquire was mostly biscuit (60%), Plastic (20%), Resin (10%) and PLA (Polylactic Acid) - 3D printing (10%).

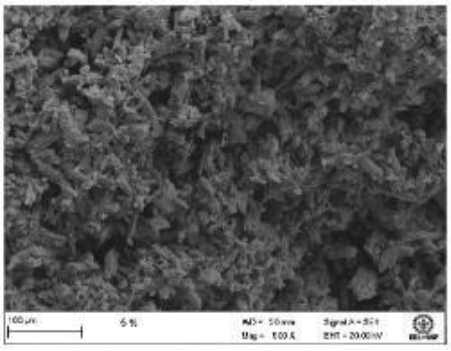

Fig.12: Scanning electron microscopy (SEM), gypsum with 5% of Diatomaceous Earth

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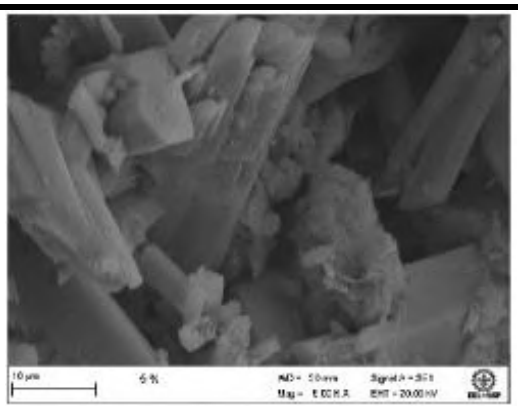

Fig.13: Scanning electron microscopy (SEM), gypsum with 5% of Diatomaceous Earth, possible formation of fungi

It was observed that the finishing of surface of the product is of extreme importance for the choice. In the user test the prototype of the material in development, gypsum with 5% of Diatomaceous Earth, was used, as the object had no surface finish and was not chosen by any user. It was observed that the research volunteers looked at familiarity with the sacred image of gypsum, but surface pores due to the material were a relevant factor for non-choice of the product.

The scanning electron microscopy session was performed at the Lorena Engineering School at University of São Paulo, using a Leo type VP1450 microscope. It was observed that the morphology of the material visually represents the formation of crystals coming from calcium in the shape of needles in disordered senses, samples loaded with diatomaceous earth at the concentration of 5% promote a change in the one-dimensional morphology of the crystals in the angular shape and the possible formation of fungi according to Figure 13.Because the ceramic material is very porous, gypsum with a 5% addition of diatomaceous earth has this surface feature, more pores forming on the surface than the material only pure gypsum.

Fig.14: How users identified the material of each object

The Word Cloud of Figure 14 demonstrates what the main words cited by users after interaction with products are. The research volunteers mainly cited the senses as a basis for identifying the materials. The main word cited was Tact (10 times), followed by Vision (9 times), Hearing (6 times) and Smelling (3 times).

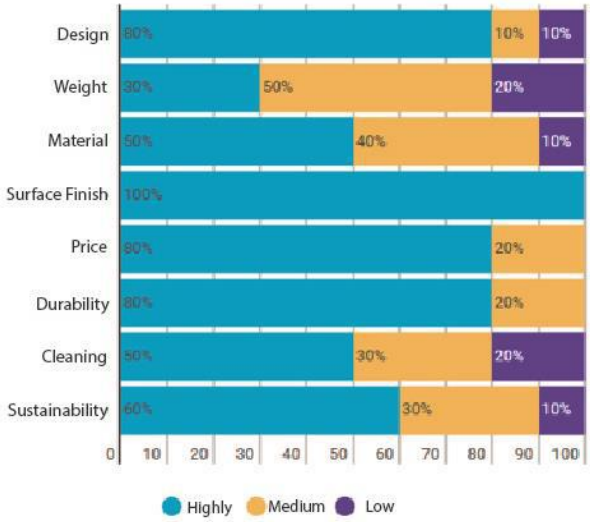

Fig.15: Importance of attributes

It was suggested [4] that the number of attributes should be reduced to make the test practical, because a smaller number of variables can lead to a more consistent and in-depth analysis of the data, focusing on the main problems to be evaluated. Thus, 8 attributes were determined in which the user would evaluate in a very, medium and not important way. The attributes that were considered very important in sacred images are: finishing (100% quoted as very important) price (80% veryimportant), durability (80% very important) and design (80% very important).

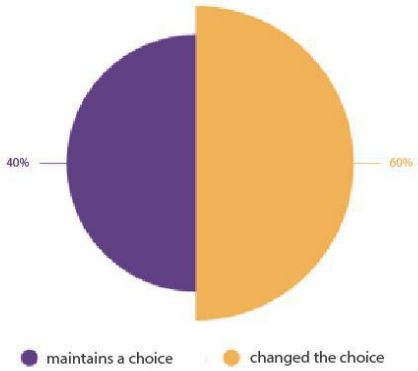

Fig.16: Choice after the interaction with the object

Figure 16 shows that most of the respondents (60%) changed the choice of which product to buy after interacting with the product. One of the factors that influenced the exchange of the chosen product was the discovery of which material was applied to the object,

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several participants were surprised by the sacred image produced in PLA in the 3D printer, demonstrating that the user cares and prestige innovation in materials even in symbolic objects such as sacred images.

V. CONCLUSION

The PERMATUS tool has proven to be efficient and inexpensive, and can be applied in many areas from design to production engineering. The study of the perception of materials by the user was extremely important for the evaluation of the user's first interaction with the product in development (Gypsum and Diatomaceous Earth). Positive results were presented on the prototype, users did not realize that there was a difference between the object made of gypsum and the composite under study. Moreover, due to the application of the method it was possible to have a base of the profile of the tourists of the city of Aparecida, improving the research. The results of the experimental study demonstrated that the material is extremely important and influences the user's choice in the product acquisition.

The model presented an important medium for knowledge about materials, products and users.The study provided knowledge about the perception of users in several aspects, related to interaction, emotional reaction, identification through the senses, preferences, among others. The presented results proved that the subjective information and measures obtained from the users have the potential to be reverted in objective specifications.

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Permeability of a Capillary Structure of Sintered Copper Powder Used in Heat Pipes

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Abstract**—** *A heat pipe is a passive device that has a high thermal conductivity, which uses a closed biphasic cycle and the latent heat of the working fluid vaporization to carry out the heat transfer. The capillary structure directly influences the thermal performance of the heat pipe, because it promotes capillary pumping and the flow path to conduct the working fluid inside the heat pipe. Among the main properties of a capillary structure, there are the critical pore radius, porosity, permeability, and thermal conductivity. Thus, in this research, the experimental evaluation of the permeability of a sintered copper powder structure was performed for use as a capillary structure in heat pipes. For this, a Capillary Extrusion Test, based on MPFI Standard 39, was used. The experimental results showed that the average permeability of the copper powder capillary structure was* $7.81 \times 10^{-13} \pm 0.38 \times 10^{-13}$ m^2.

Keywords**— permeability, capillary structure, sintered copper powder, heat pipe.**

I. INTRODUCTION

The heat pipe is a passive device with a high thermal conductivity due to the uses of a closed biphasic cycle and the latent heat of vaporization of the working fluid to perform heat transfer [1].

The capillary structure directly influences the thermal performance of the heat pipe, because it promotes capillary pumping and the flow path to conduct the working fluid inside the heat pipe [2].

The sintered metal powder capillary structures have been widely used in heat pipes because of the lower effect of the gravity on the performance of this type of capillary structure. The sintered wicks have reduced pores and a higher thermal conductivity, as a consequence of the almost perfect fit of the metal powder [3]. Moreover, the metal powder adheres to the tube wall with a high contact, reducing the thermal resistance between the wick and the tube.

The main properties of a capillary structure are the pore radius, the porosity, the permeability, and the thermal conductivity. The pore must have a small radius to pump the liquid from the condenser to the evaporator, using a high capillary pressure difference, or for a high heat carrying capacity. The permeability must be high for a small pressure drop of the liquid in the capillary structure. The thermal conductivity should be high, which results in lower temperature drops in the capillary structure of the heat pipe, a desirable quality for this passive heat transfer device [1].

In this context, in this research, an experimental evaluation of the permeability of a sintered copper powder structure was performed, which can be used as a capillary structure in heat pipes.

II. METHODOLOGY

A Capillary Extrusion Test, based on MPFI Standard 39 [4], performed the determination of the capillary structure permeability.

2.1 Copper Powder

The sintered capillary structure will be fabricated from an XF copper powder obtained by gas atomization. The copper powder is showed in Fig. 1.

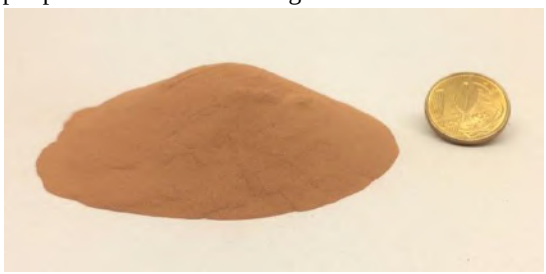

Fig. 1: XF Copper Powder

A micrograph of the copper particles with a magnification of 500x was obtained by Backscattered Electron Detector (BSD) for Scanning Electron Microscope (SEM), and is presented in Fig. 2. The volume-based average particle diameter was 33 μm [5].

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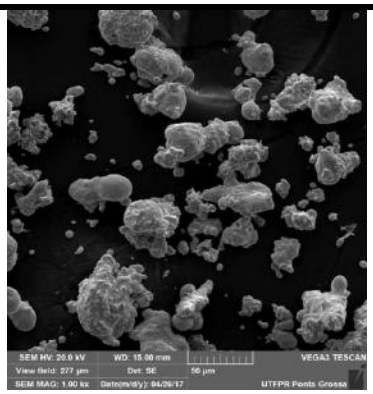

Fig. 2: SEM micrograph of the copper powder (500x).

2.2 Manufacture of Samples for Permeability

Three samples were made, according to MPFI Standard 39 [4], with a diameter of 28.7mm and a height of 3.2mm. The sintering procedure is the same that was applied to the heat pipes subsequently. A sample manufactured is presented in Fig. 3.

Fig. 3: Sample manufactured for the permeability test.

The Figure 4 presents a micrography of the sintered powder capillary structure with a magnification of 500x obtained by Backscattered Electron Detector (BSD) for Scanning Electron Microscope (SEM).

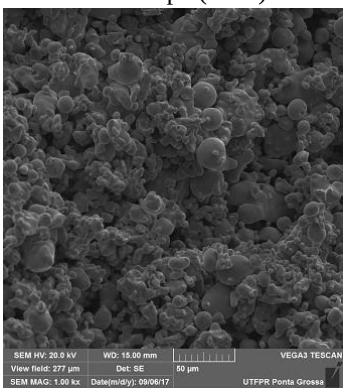

Fig. 4: SEM micrograph of the sintered powder capillary structure (500x).

The experimental apparatus used in the sintering process consisted of a controlled atmosphere horizontal tubular furnace (*Inti*™ FT-1200), a data acquisition system (*Agilent*™ 34970A with 20 channels), and a laptop (*Dell*™) – Fig. 5. The gas used in the atmosphere control was a mixture of 95% of Argon and 5% of Hydrogen. For the evaluation of the temperature inside the furnace, a K-type thermocouple *Omega Engineering*™ was used.

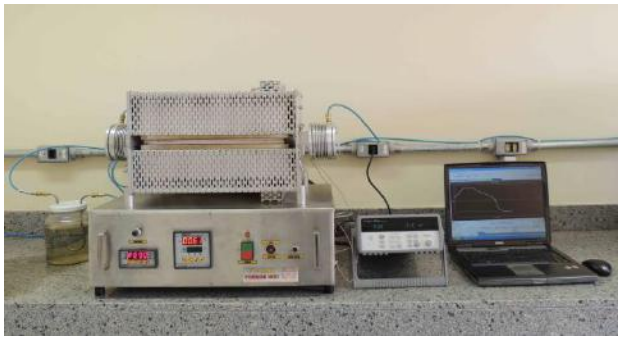

Fig. 5: Apparatus used in the sintering process.

The sintering occurred at a heating rate of 20°C/min, with a 15-minute permanency at a temperature of 800°C, and subsequent cooling by forced convection of air – Fig. 6.

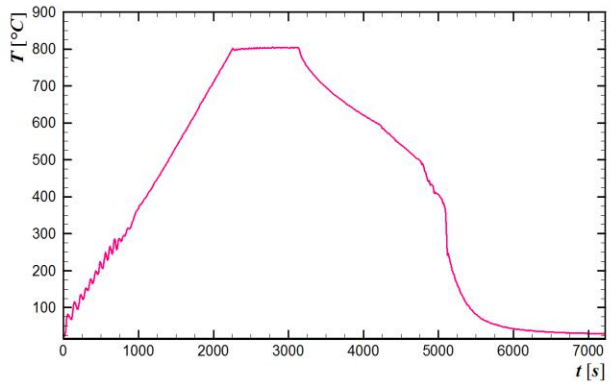

Fig. 6: Sintering curve.

2.3 Experimental Apparatus

An experimental bench consisting of a compressor (*Vonder*™), an air preparation system with pressure regulator and pressure gauge (*Pressure*™), a flowmeter (*Protec*™), a digital pressure gauge (*Digitron*™), a regulating valve, and a test section was developed for the measurement of air permeability in the structure capillary (Fig. 7).

Fig. 7: Experimental bench for evaluation of permeability.

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2.4 Experimental Procedure

A flow of compressed air is released into the system until it reaches the test section with the sample. A flowmeter controlled the airflow and a digital pressure gauge recorded the pressure difference. Figure 8 shows a schematic drawing of the fabricated section of tests with the sample placed, according to [4].

From the experimental data obtained, the permeability can be calculated by the Darcy regime, as shown in Equation 1:

$$Q = \frac{K_1 A_{st}}{\mu t} \frac{\left(p_1^2 - p_2^2\right)}{2 p_2} \quad (1)$$

where, Q is volumetric flow rate [m^3/s], K_1 is the Darcy permeability [m^2], A_{st} is the cross-sectional area of the sample [m^2], μ is the gas viscosity [Pa.s], t is the sample thickness [m], and p_1 and p_2 are the inlet and outlet absolute pressures [Pa], respectively.

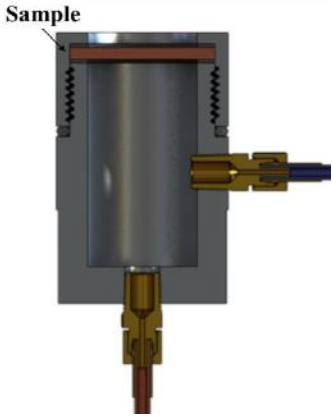

Fig. 8: Test section with the sample.

2.5 Theoretical Analysis

According to [6], the permeability, K, for packaged particulates can be estimated from Equations (2) and (3) proposed by Carman-Kozeny (1927) and Rumpf & Gupte (1971), respectively:

$$K_{\text{Carman-Kozeny}} = \frac{D_s^2 \varepsilon^3}{180(1-\varepsilon)^2} \quad (2)$$

$$K_{\text{Rumpf \& Gupte}} = \frac{D_s^2 \varepsilon^{5.5}}{5.6} \quad (3)$$

where, D_s is the average particle diameter of the sintered powder [m] and ε is the porosity of the sintered sample.

III. RESULTS AND DISCUSSION

The experimental results of the permeability with their respective uncertainties for the three samples analyzed are presented in Table 1. The average permeability of the copper powder capillary structure was 7.81 x 10^{-13} ± 0.38 x 10^{-13}.

Table 1: Experimental results of Permeability

Sample	*Permeability [m^2]*
A	7.80 x 10^{-13} ± 0.38 x 10^{-13}
B	7.41 x 10^{-13} ± 0.36 x 10^{-13}
C	8.21 x 10^{-13} ± 0.39 x 10^{-13}
Average	**7.81 x 10^{-13} ± 0.38 x 10^{-13}**

Figure 9 presents the experimental results compared to the models proposed in the literature by [6]. The results are compared considering the distribution of the particle size [4], with the diameters corresponding to each quartile of the particle size distribution (11.3 µm, 29.5 µm and 58.3 µm) and the average particle diameter of 33 µm. Moreover, the theoretical analysis considered the experimental porosity of the structure of 55.03%, obtained by [7].

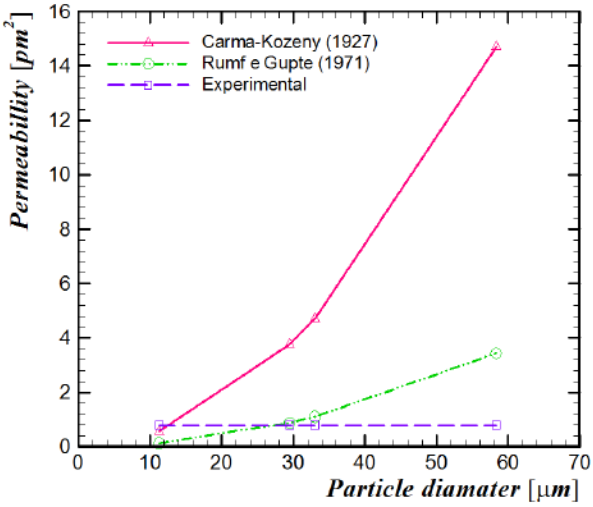

Fig. 9: Theoretical and experimental results of permeability.

The experimental results show a better match with the theoretical models for smaller particle diameter (the particle size of the first quartile). For larger diameters, the discrepancy of the values is very high. This difference can be the result of the particle idealization as spherical in the theoretical models, whereas by the evaluation of the micrograph it can be verified that the particles are not an exactly spherical shape. As a result, when the particle size is small, the shape idealization has no great influence, but for a large particle, the idealization ends up moving away from the theoretical results of the experimental values.

IV. CONCLUSION

In this research was performed an experimental evaluation of the permeability of a sintered copper powder structure, which can be used as a capillary structure in heat pipes. A Capillary Extrusion Test, based on MPFI Standard 39, was used for the permeability determination. The experimental results showed that the

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average permeability of the copper powder capillary structure was $7.81x10^{-13} \pm 0.38x10^{-13}$ m^2.

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Hermeneutics in the Strategic Innovation Processes

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Abstract— *The main objective of this theoretical essay is to approach the hermeneutics of innovation strategy. This work is based on Contingency Theory, which studies the understanding of the external phenomena that drive the internal variables of the organization's performance. The exploratory methodology takes a qualitative approach, using content analysis. It proceeds from a pre-analysis phase to a bibliographic survey, and then explores the material, which comprises a categorization of the relevant data to extract and understand their essence and effectively treat the data results. The thematic hermeneutics, strategy and innovation are connected in a process of convergence and divergence, enabling reductionism to extract the substantive details that provide an overall in-depth interpretation. The results show that the hermeneutic method works as a tool for understanding the dimensions of the organization, allowing strategies directed to innovation to be elaborated with future relevance in mind.*

Keywords— Hermeneutics, Strategy, Innovation, Contingency, Organization.

I. INTRODUCTION

The work of contemporary management highlights the challenge of understanding the nuances of the strategic process, interpreting the elements that impact on organizational innovation. As exogenous knowledge evolves in organizations, the institutional scenario is revealed by the assignment of fresh significance to roles, emphasizing the visualization of the transformational dynamics affected by gaps in their environment.

For Schwab (2016), the world is in the Fourth Industrial Revolution, subjected to powerful connectivity and excessive amounts of stored data, together with the complex processing of the essential information for radical innovation in organizational structures and society as a whole. Thus, intelligent development permeates the demands of the market where institutions are located. This influences empirical studies on the matter which help reflect the state of the art.

Thus, complex conjecture underlies the interpretation and hermeneutic treatment, under the lens of knowledge. The social actors focus on a functional understanding of the organization, including its network, and the interactions taking place in the internal and external environment. It is undeniable that these conditioning

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aspects dictate a reductionist method, to be applied to the categorization of these complexities. While directing the support of intellectual properties in the individual and functional properties in the organization, it explains the universality of the concepts.

The doctrinal advance involves creative effervescence, combined with innovation strategies, guided by society itself as the beneficiary. Such considerations lead to the following question: How can hermeneutics be characterized as an innovation strategy? To answer this question, the general objective is presented as an approach to the hermeneutics about innovation strategy. The following specific objectives are also pursued to obtain the desired results: (1) approaching the hermeneutics aspect of the innovation strategy; (2) positioning the concreteness of an innovation strategy in light of the selected sources; and (3) delineating the convergence on innovation strategy.

The construction of this theoretical essay delimited it to constructing a theoretical framework as an object with which to reflect on the hermeneutical, strategic and innovative aspects of the question. It goes on to present the methodological trajectory of the research preparation through the analysis of its content, showing the application of innovation in its results. Finally, the establishment of a common point for innovation strategies is proposed, according to the underlying themes. In its final considerations, the essay conveys the potentialities and needs of the strategic axis to consolidate the research previously developed.

II. THEORETICAL AND CONCEPTUAL REVISION

This theoretical essay is based on Contingency Theory and considers the environment of complexity that determines the perspective of the Fourth Industrial Revolution. This study converges with the adaptive organizational capacity of an immediate kind, which requires specific configurations of interdependence throughout its complex changes.

Significant early connectors in the construction of Contingency Theory are found in the studies by Woodward (1958), Burns & Stalker (1960) and Lawrence & Lorsch (1967). These authors view economic performance in organizations as strongly influencing organizational structures, either by technology or the environment to which the organization belongs. Later, Morgan (1996) revealed that Contingency Theory depends on the organization's suitability for its internal environment, while its external environment determines the various requirements to which the organization must be adjusted.

Aggregating the proposals of Contingency Theory, Vieira and Quadros (2017) emphasize that the external environment, marked by uncertainties, functions as an exogenous motor force in the organization; thus, it lacks the appropriate organizational structure for catalyzing situations as they emerge. The institution should support the creativity of the collaborators in the process of differentiating, integrating and resolving conflicts to obtain favourable results, because this support is needed for their success.

This proposed theoretical design involves the concepts of hermeneutics, strategy and innovation; they allow the cleavage and categorization of the elementary inductors, which contribute to a judgment of the effect of reductionist treatment and the results achieved.

2.1 Concept of hermeneutics

In Demo's view (1992), hermeneutics is a methodology of interpretation in the search for understanding about the form and content of human communication. It gathers the constitutive aspects present in the complexity or contextual simplicity of facts and situations. For these practices, the a priori absorbing conditions usually contained in the subject and object relationship must be protected, namely, the cognoscent individual and the cognitive element.

The core of hermeneutics is to confront credible understanding with a certain deepening of the set of principles for interpreting the approach of the subject to the interpreter. Demo (1992) adds that this dimension involves the understanding of the facts, to their subsequent validation resulting from the intrinsic veracity of present experience, and to the exhaustibly new understandings that are enriched by the subject/object relationship.

Precisely in this sense, Josgrilberg (2017) reports that the interpretation is very far from simple. For him, hermeneutics seeks to discover human uneasiness in the virtuous circle of transcendental existentialism in itself, situated on the agenda of discovering the concreteness of being and existence, which will bring about the incorporation of a new truth verified throughout the context.

The application of hermeneutics in the context of the social sciences is part of this theoretical outline. According to Gadamer (1997), the intended applicability derives from our understanding of the facts; and it is necessary to reach a cognitive level beyond what the subject interprets. It leads us to a search for strange elements, which may contrast different perspectives. This search variable allows the investigator to guide the logic and the reason for the actions pursued to exhaustion; hence, the use of historical sources may not be considered a bridge to understanding. In addition, the individual is usually motivated by social practices. Thus, in the behavioral view of the subject at the locus of meaning, the

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application of hermeneutics does not rely only on interiority, but on anteriority and the intrinsic and extrinsic comprehension of the experiences that allow us to understand what has been contextualized.

The feasibility of this instrument is justified by Minayo (2008), in that it allows an associative construction of the interpretative and reflective character of the theory. This interpretative form is, above all, the guarantee of the proposal to investigate the valid phenomena. Such measures refer to the reciprocity of the different variants of legitimacy and meanings.

Accordingly, in Foucault's (2004) conception, in the practice of hermeneutics, individuals question their own behavior, discovering new subjectivities inherent in their consciousness and in this way address the imposed objections, such as the technologies of domination resulting from a certain power achieved by the unfolding knowledge from hermeneutics.

2.2 Concepts of strategy

Initial strategy studies in Mintzberg (1978) address the exclusively deliberate mode of competence in top management. It is characterized by the stages of planning, formalization and control.

However, as described by Vieira, Lavarda, and Brandt (2016), the new typology of strategic formation approaches this perspective on the organizational actors without observing the hierarchical levels where they are located. The actors are integrated to contribute together to the emergent strategic fomentation and thus improve the institutional results.

In the evaluation of the strategic process, Jarzabkowski, Balogun & Seidl (2007) emphasize two aspects: the conceptual phase, which requires the use of cognitive mechanisms operated by social involvement, and the execution phase, which depends on the actions, contacts, and participation of several actors in the proposed activity.

Strategy is a prominent tool that employs differentiated tactics in the design of an organization's actions. The initial step of this art advocated by Oliveira and Gonçalves (2017) requires the strategy to be formulated and implemented in line with the dynamics of its internal and external environments in the organization.

In this context, strategic actions are affected by both sides; however, for those who know how to identify them, they can become powerful weapons of confrontation when conjecture becomes uncertain. To realize this teaches us how to optimize opportunities and strengths, as well as recognizing constraints, while transforming them into competitive advantages through our tangible and intangible resources.

Serving the field of action of the strategy is considered beyond the concepts of evolution and procedure, as Villar, Walter and Braum (2017) list them. The first of their concepts is the purpose of organizational survival, which adapts and copes with market demands in light of its understanding of external environmental forces. The second concept regards the satisfaction of the various internal interests, in a gradual, continuous and adaptable way that affects the rationality of the organizational actor, relating the individual's cognitive objectives in collaboration to the objectives of the organization, thus concatenating the convergent interests of its parties.

2.3 Innovation of concepts

The study by Tidd, Bessant and Pavitt (2005) indicates that the concept of innovation involves the process of transforming and developing ideas that can be materialized in practice. For this to occur, the organization must know how to absorb strategically the potentialities seen by the internal agents, with the intention of improving them according to the needs observed in the external environment.

According to Dias (2018), innovation is the complex result of accumulated learning in which new knowledge develops or the significant modification of something that already exists. Dias notes that innovation is related to an objective beyond the delivery of the final product, which is more like a set of items of processed knowledge that conceives the cognitive and interactive multiplicities favouring organizations.

Innovation is strategic when it meets society's aspirations for high performance by permitting the creation of products and services developed within organizational networks. But in this regard, according to Gomes and Lapolli (2014) and Tartari, Wilbert, Souza, and Dandolini (2014), innovation occurs only when the idea and its conception phases are evaluated and finally implemented. In this process the strategies applied to innovation contribute to the structuring of processes in which the organizational environment fosters the stimulation of innovation, guides the necessary skills in the intellectual agents, and finally allows advantageous results that can be measured. The criteria for the above include the survival and maintenance of organizations in competitive situations.

III. METHODOLOGY

In order to reach the objectives, the methodological treatment took the form of modelling a theoretical essay, with the use of qualitative theoretical review procedures that would convey the complexity of the theme. It applied the method of content analysis, allowing key elements for understanding the dynamic discursive processes addressing the subject to be categorized. For Bardin (1979), content analysis is a set of technical procedures

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for analyzing discourse that aim to obtain a systematic structure capable of producing inferences about the knowledge thus exposed.

Briefly, the method consists of a new understanding of a selected bibliographic study, in order to discover, without distorting the initial information, what is hidden in the message of the interlocutors behind a superficial view of it. This procedure concerns the transposition of general questions to specific ones, in a reductionist manner, to identify the elements that make up the context from which the desired information is extracted.

Bardin (1979) proposes that the content analysis method should be applied in three phases: first, a pre-analysis, organization and systematization of references that are sufficiently complete, representative, homogeneous and pertinent to guide the interpretation of the study. The second phase explores the gathering of raw data from the contextual material – this phase constitutes the codification by means of cutting steps, counting and classification to extract the essence. The third one then involves the treatment of the results and their interpretation: in this the researcher proposes to categorize the obtained data in order to build the theoretical framework and produce inferences aligned to the objectives proposed that elucidate the meaning of a phenomenon.

Dealing with the interpretative factor of the structure of Content Analysis reveals the depth of the dimension of the hermeneutic character, which Branco (2014) portrays as the treatment of the phenomenon divided into phases by the researcher. It does not demonstrate fictional hermeneutics, which it presumes to take an imaginary and even less artificial approach, since its own interpretations prevail in the tangible and factual modality explored.

Figure 1 shows the methods inherent to the application of content analysis, with reduced elements to confront the hermeneutical processes attributed to the strategic relations of innovation. The Table 1 reveals the significant elements.

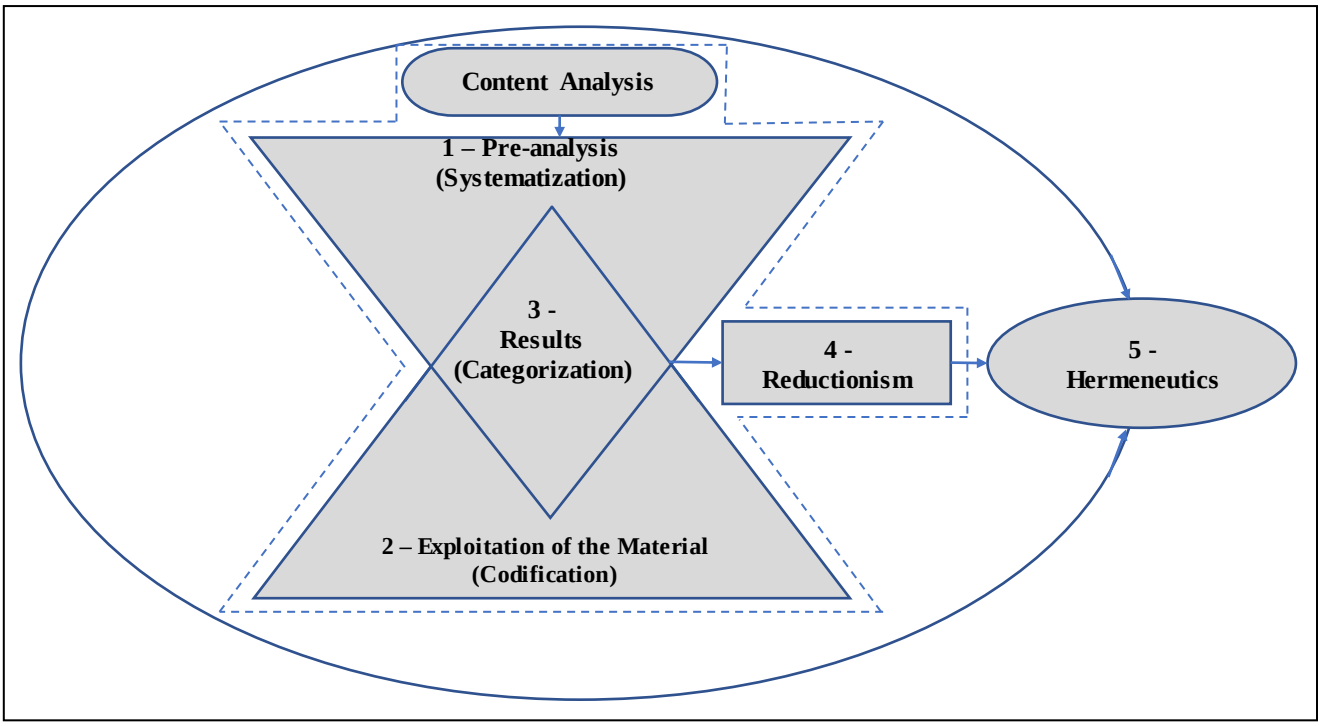

Fig.1: *Diagram of the Content Analysis method considered in this research*

Source: Prepared by the authors.

Table 1 *– Specifications for the Diagram of the method of analysis considered in this research.*

Elements	Description
Content Analysis	This is composed of a set of technical procedures for the analysis, production and drawing of inferences of new interpretation of the content.
1 Pre-Analysis (Systematization)	The procedure of bibliographical collection of significant statements that meet the objectives of the study.
2 Exploitation of the Material (Codification)	Process of guiding and coding the data chosen to extract the elements that can be understood in depth.
3 Treatment of the Results and Discussions	This embodies the effective interpretation for producing inferences capable of establishing a new vision according to the proposed objectives.

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(Categorization)	
4 Reductionism	This proposes the synthesis of the general content to focus on specific items, delimited in the technical junction of the desired factors.
5 Hermeneutics	This involves all the interpretative phases of showing how subjects are related, indicating the intrinsic features of the subject.

Source: Prepared by the authors.

IV. HERMENEUTIC APPROACH TO INNOVATION STRATEGY

This section provides the elements of the study results, according to the objectives indicated. It has used the content analysis method to interpret the data and verify which applications the hermeneutical method allows for the strategy of innovation. The contents of the selected sources were separated and integrated with the evaluation components, positioning a strategy of concreteness, to make it possible in the end to delineate the convergence of the strategic concepts of innovation.

To demonstrate the processes related to the development phases of the content analysis, under the heading of categorization, Figure 2 graphically presents an integrative summary of the validation of the cleaved concepts. Tables 2, 3 and 4 represent the treatment of the hermeneutics, strategy and innovation categories and corresponding subcategories, highlighting the key ideas and units of records taken from the documentation under evaluation, identifying the common and different features to express the corpus of the dimensions of performance.

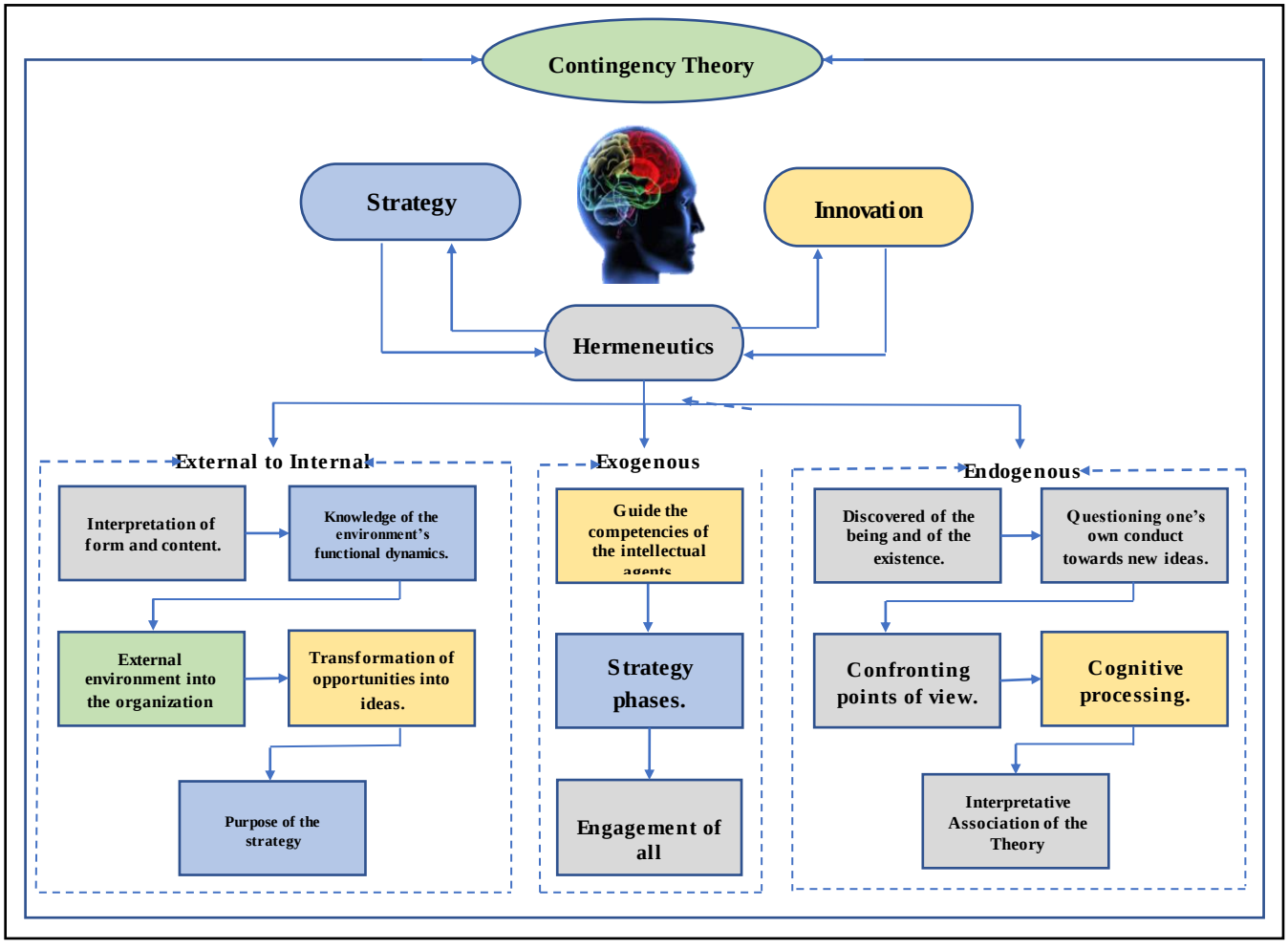

Fig.2: *Integrative flow of content analysis validation.*

Source: Prepared by the authors.

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Table 2: *Treatment of the categories of hermeneutics.*

Subcategories	Indicators	Registry Unit	Dimension
Ability to interpret.	Interpretation of the form and content of complexity or simplicity.	Methodology of interpretation by the search for understanding about the form and content of human communication; gathers the constitutive aspects present in the complexity or contextual simplicity of facts and situations. Demo (2002).	External Environment for the Internal Environment
Human relationships and context.	Discovery of being and existence.	To discover human uneasiness in the virtuous circle present in transcendental existentialism itself, situated on the agenda of discovering the concreteness of being and existence, which will bring about the incorporation of new truth verified throughout the context. Josgrilberg (2017).	Internal Environment for the External Environment
Understanding the facts.	Contrary points of view.	Gadamer (1997): the intended applicability stems from an understanding of the facts; and it is necessary to reach cognition of what lies beyond what is interpreted by the subject. This is done in the search for strange elements, which could contrast different points of view.	Internal Environment for External Environment
Theory and practice.	Association of the interpretive character of the theory.	The feasibility of this instrument is justified by Minayo (2008), who admits the associative construction of the interpretative and reflective character of the theory.	Internal Environment for External Environment
Individual questioning.	Question your conduct in front of new ideas.	Foucault (2004) discusses in hermeneutics the questioning of one's own conduct, that is, that in order to elaborate a strategy, the individual must ask himself how his actions may reflect his attitude to the introduction of new ideas, and how they can adhere to the changes in the period of acceptance and creativity.	Internal Environment for External Environment
Applies to the individual (cognition)			

Source: Elaborated by the authors.

Table 3: *Treatment of strategic categories.*

Subcategories	Indicators	Registry Unit	Dimension
Everyone, for the differences that can be made.	Engagement of all.	This requires the engagement of everyone to make a difference and add to the group, regardless of the area, as proposed by Vieira, Lavarda, Brandt (2016).	Internal Environment for Internal Environment
Conceptual and execution.	Phases of the strategy.	In the evaluation of the strategic process, Jarzabkowski, Balogun & Seidl (2007) emphasize two aspects: on the one hand, the conceptual phase requires the use of cognitive mechanisms operating in social involvement, and, on the other hand, the execution phase, which depends on the actions, contacts, and participation of several actors to carry out the proposed activity.	Internal Environment for Internal Environment
Phase of elaboration of the	Knowledge of the functional dynamics	The strategic formulation stage is the responsibility of the manager, with his intellectual agents, to understand	External Environment

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strategy.	of environments.	the dynamics of internal and external environments, as proposed by Oliveira and Gonçalves (2017).	for Internal Environment
Purpose of the strategy.	Unity of the individual and the manager for strategy.	It is possible to unite individual cognition and the role of the manager in the phase of transforming opportunities into ideas. This allows the practice of the dynamics that establish the purpose of the strategy, meeting the two demands of organizational survival and the understanding of the external environmental forces and interests, in a gradual, continuous and adaptable way. Villar, Walter and Braum (2017).	External Environment for Internal Environment
Applies to the organization (management)			

Source: Elaborated by the authors.

Table 4: *Treatment of innovation categories.*

Subcategories	Indicators	Registry Unit	Dimension
Vision of opportunities.	Transform opportunities into ideas	Innovation involves the process of transforming opportunities for the development of ideas that can be materialized in practice. Tidd, Bessant and Pavitt (2005)	External Environment for Internal Environment
Conception of innovation.	Cognitive processing	Innovation as a set of items of prior knowledge, processed in cognitive and interactive multiplication in favour of organizations. Days (2018)	Internal Environment for External Environment
Stimulating innovation.	Guiding the skills of the intellectual agents in innovation	The strategies applied in innovation contribute to the structuring of processes in the organizational environment, favour stimulation by innovation, guide the necessary skills with the intellectual agents, and finally allow measurable results. Gomes and Lapolli (2014) and Tartari et al (2014).	Internal Environment for Internal Environment
Applies to the organization (management)			

Source: Elaborated by the authors.

4.1 Survey of the hermeneutic aspect of the innovation strategy

The provision presented as part of the previous subtopic serves as the basis for the interpretive hermeneutic process of innovation, meaning the characteristics that the organization needs to understand before it can move from examining the external dimensions to examining the internal ones. It also contributes to the identification of the cognitive aspects by interested individuals, which meet the perceived demands and promote the innovation required for the survival of the organization. The next step is the intelligent integration of the constituent elements for analysis, as the task of interpretation applies the reductionist method.

When it comes to the hermeneutic process, one has in principle an individual moved by the capacity for cognition, supported by the constitutive aspects of the environment, whether each situation requires the dimensions to be taken in order from external to internal or the other way around. These dimensions reproduce the modus operandi as a result of the strategic alignment in the face of innovation. This is a practical example of the Theory of Contingency of Vieira and Quadros (2017), which works by observing the external environment as marked by uncertainties, functioning as a driving force and stimulating creativity within the organization.

4.1.1. From the external dimension to the internal

In this field, the organization's ability to absorb external forces so as to mobilize the necessary inductors for internal ordering is evaluated. In the validating literature, it begins in the hermeneutic modality applied by Demo (2002), which is shown in the capacity to interpret form and content and to promote the connection with the theme. For this the individual uses a mechanism

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that fragments the complexity of the various levels of understanding that envelop his situation, connected to the extrinsic aspects of phenomena, and reducing the inferences thanks to his initial knowledge of life, his experience and their context.

Thus, it is possible to move towards a strategic formulation, which depends, as highlighted by Oliveira and Gonçalves (2017), on the enclosure of knowledge, the provision of decision-making elements antecedent to the facts, and the knowledge of ways to remedy or take advantage of situations which might impact on the external demands.

In this intersection, the authors Tidd, Bessant and Pavitt (2005) describe how innovation emerges. From a careful study, they indicate the significant elements in the tendencies of the environment which can be seen to offer opportunities. The later development of these opportunities through brainstorming can be instigated by raising funds and finding agents capable of executing innovation.

This strategic model concerns individual cognitive attributes and joint decisions with the boss, which represent its intermediary role in fostering strategies and their implementation. Given the expected purpose of organizational survival, Villar, Walter and Braum (2017) claim, the interconnecting of external demands enables internal agents to contribute to the gradation and continuity of the changes and adaptation to them required for strengthening the institution.

4.1.2. Endogenous dimension

The evaluation of the endogenous character comes from the capacity of organizational self-recognition. The mastery of actions that establish the operating regiment has to be the angle approached by control programming.

The organization is responsible for establishing strategies that culminate in its being protectively armed against possible attacks. Among the strategic possibilities, the authors Gomes and Lapolli (2014) and Tartari et al (2014) emphasize that, in terms of competitive gains, innovation corresponds to a differentiating phenomenon. This information obliges the organization to be prepared socially and technically to expect measurable results, which only arise when conceiving the creation of a product or service. Therefore, stimulating innovation must be a continuous issue, so that it can be incorporated in the organizational practices for the sake of long-term survival.

An important consideration when it comes to strategic process is the ongoing relationship between the conceptual and the executive phases. For Jarzabkowski, Balogun & Seidl (2007), the first of these phases considers the level of preparedness of the individual, amplified by the acquisition of intellectual knowledge and mediated by the preparation to plan and organize the proposals before putting them into practice. The second, following the theoretical work, brings together the elements of resources and labor for the development of the material or some other activity. The phases described depend on how well the organization manages to prepare the internal environment for modelling the structure to house the strategic increment.

The organizational strategic elaboration requires much more than following a rational model. It depends on guiding the actors engaged in the participation and execution to act with accountability, so as to obtain the expected results.

4.1.3. Exogenous dimension

The exogenous dimension consists in gathering the main means that the organization manages to strategically create in order to excel, notwithstanding the external environment. This stage emphasizes that innovation is the linking of possible trends in the internal environment with what satisfies the demand from external interests. Thus, it enables something significantly new to be delivered by an organization to a society that requires innovation. This explains Josgrilberg's (2017) statement that the human being lives for the incessant pursuit of discoveries, trying to fulfil the satisfaction of what is to come.

For a change to occur, according to Foucault (2004), the individual must reach the moment of questioning in which one reflects on the way that his actions may affect the posture desired when confronting the new. This premise refers to the consequences of acceptance and creativity. Schwab's study (2016) of the way in which the Fourth Industrial Revolution is proceeding states that society and organizations must prepare for the emerging demands of radical innovation.

Gadamer (1997) points out that the individual is not the only possessor of information; a range of attributes must be evaluated in order to reach an effective consensus.

According to Dias (2018), when the individual manages to link previous knowledge and understanding of the environment, the moment of cognitive and interactive multiplication is established that favours the emergence of innovation. This is where the feasibility of producing an innovation begins, in Minayo's contention (2008), by admitting the associative construction of the interpretative and reflective character of the theory, exhausted and detailed in all its complexity until a specific outcome occurs through a product or service.

In summary, individuals process cognitive aspects to interpret phenomena, while organizations must prepare themselves in management terms to plan strategies that cope not only with internal conditions but also encompass

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the dynamics of environmental functioning. Apart from the competencies that organizations possess, intellectual agents must be stimulated to process an understanding of the external requirements and to use cognitive plurality to consummate the innovation. Therefore, organizations must work to understand people's anxieties and develop from these new products and services that meet the needs of the context.

4.2. Positioning the concreteness of innovation strategy in light of the selected sources

The collective strategy, as presented by Vieira, Lavarda, Brandt (2016) must be worked on by the members of the organization together, in order to think systematically and take account of everyone's accountability, with the internal organization culminating directly in the external phases.

However, this all depends on the stages in which the hermeneutic process is presented, that is, the capacity for interpretation. Evaluating the strategic position to be worked towards, the strategy must not deviate from the context and must be able to count on the participation of the leader in the conceptual and execution phases, as Jarzabkowski, Balogun & Seidl (2007) maintain.

The results of this subtopic are clearly demonstrated in Figure 2, where the blue-coloured elements represent the intermediate interconnection between hermeneutics and innovation.

The density of the changes reproduced by the Fourth Industrial Revolution, in Schwab's view (2016), gives rise to the need to know how to lead and manipulate excess information in the organization's favour. The importance of the strategic formulation is that it leads to an understanding of the nuances which can directly or indirectly affect the functional dynamics of the internal and external environment and create radical innovation in society and its organizational structures, as listed by Oliveira and Gonçalves (2017).

Gomes and Lapolli (2014) and Tartari et al (2014) add that these facts must guide the development of the necessary competences to deliver innovative solutions. When the organization manages to align the individual's conception with that of the group, according to Jarzabkowski, Balogun & Seidl (2007), it achieves the expected social involvement through its cognition of ways to operate and implement practical actions with concrete consequences.

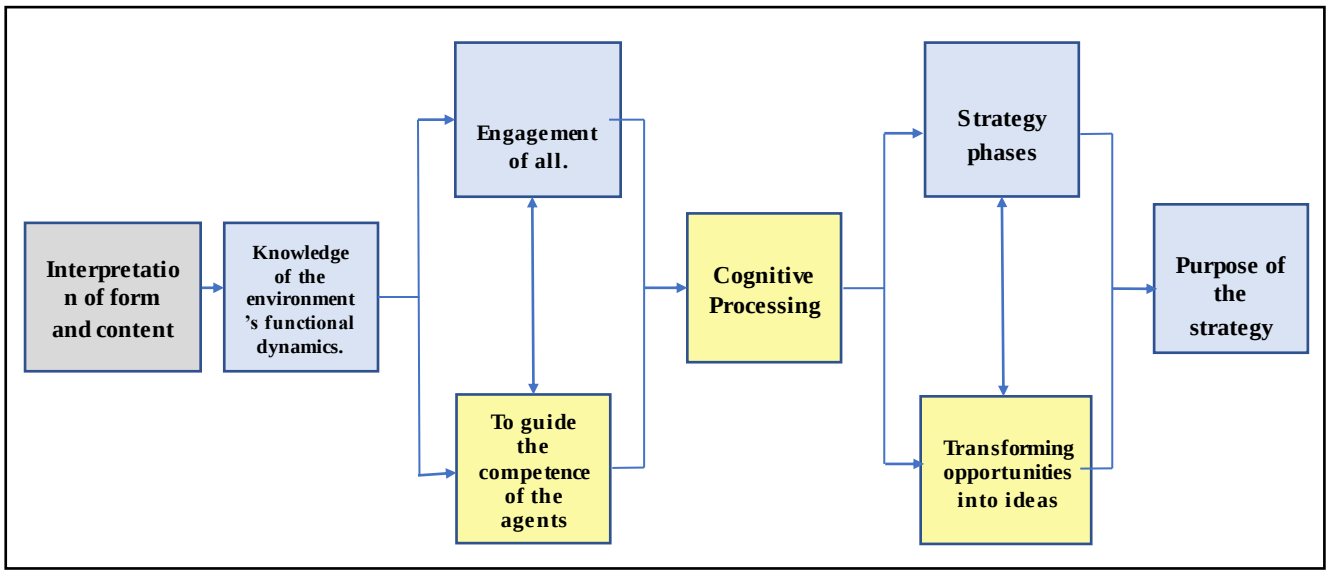
When we look at the depth of the organizational structure, we find hermeneutical complexity, which expands the networks necessary for survival. However, as indicated by Villar, Walter and Braum (2017), the ability to strategically discern where, when and how to act turns opportunities into ideas that do not wait for emergencies to encourage change but are always one or more steps ahead.

4.3. Delineation of convergence on innovation strategy

In this essay, the elements of study converged in a strategic focus on innovation, based on the hermeneutic concept that translates the extrinsic and intrinsic aspects of the environment and provides the organizations with the skills to mediate in situations and bring about success.

Next, we reformulate the systematic order of categories surrounding the strategic practice of innovation, from conception to final delivery. Figure 3 outlines the conceptual model applied in this task, and Table 5 summarizes the results.

Figure 3: *Sequential convergence diagram of the innovation strategy.*



Source: Prepared by the authors.

Table.5: Sequential diagram of the convergence of the innovation strategy.

Elements	Description
Interpretation of form and content.	This is the movement of constructing a proposition for something new and the overcoming of the dilemma of the objectivity and neutrality of the knowledge produced.
Knowledge of the functional dynamics of environments.	This involves the wisdom with which the external and internal situation of the organization is understood.
Engagement of all.	This seeks the accountability of all those involved in the organization.
Guide the skills of the agents.	Role of the leader, knowing how to coordinate efforts and encourage agents to develop innovation.
Cognitive processing.	Mechanism of primary support for the intellectual performance of employees.
Strategy phases.	This includes the capability to plan and execute the processes in the organization.
Transform opportunities into ideas.	The ability of visionary perception to understand the opportunities and the attitudes that will be required.
Purposes of the strategy.	Compatibility between individual interests and the survival of the institution.

Source: Prepared by the authors.

Although there are variables that interfere in the organizational environment, knowing which strategies can be used provides levels of security that are more adequate for the organization's permanence. To this end, the form and content that the strategies express must be carefully interpreted in all conjectures of origin and context, in order to infer plausible suggestions that will maximize the potentialities. However, this activity is not isolated, but depends on the knowledge of the functional structure that deals with the conditioning aspects of the environment. Without such knowledge, the company meets contingencies in a fragile and unprepared way and can easily be removed from circulation.

In this matter, the effective participation of employees increases the chance of strengthening ideas. When institutional policy keeps it in mind, an understanding of the employees' role in supplementing the health of the organization is extremely important. For this purpose, a conducive environment depends on stimuli that favour the conditions that process their inherent cognitive abilities as individuals in favour of innovation at any level.

The implementation of the strategy goes through phases that need social involvement, since the planning is carried out by individuals, who in fact initiate, mediate and complete the task. Therefore, the participation of the members may not be discarded, for they are the essential mediators of the process and it is their capacities that transform opportunities into ideas. An institution can progress from a vision that owns or seeks to acquire, to seeing beyond what can be seen.

To conclude the circle, we have the purpose of the strategy: meeting the desired requirements and transposing the conflict of beneficial interests to the same side as the institution and the collaborator, in conditions where both are satisfied, because one depends on the other.

V. CONCLUSION

Considering hermeneutics so far, we have a delivery from the materialistic bias that is rooted in the delivery of a product; science conditioned by power; and the relationship of profitability established by innovation, beyond knowledge. So from the social point of view, the strategy fits the integration needed to take advantage of the cognitive elements and collaborate to promote the survival of the organization.

The contribution of this study is to have brought a general perspective to bear on the proposed objectives, fragmenting the aspects to the point of reductionism and combining them to illuminate the whole. This has extracted the reflexive actions of convergence to combat the strategic procedures that stimulate innovation.

The results answer the research question, referring to the hermeneutic method as an essential tool for understanding how the external and internal structures of the organization work, and using in-depth knowledge to infer the strategic processes of innovation. Without this condition, the work can be loaded with information that does not focus on the future, and does not meet or exceed the expectations of society.

For the most part, the application of hermeneutics is directed to the area of law. Due to the high degree of complexity of legal matters of systems, the law has always needed to be interpreted to reduce the possibilities of errors. However, the same technique can be used in all areas of knowledge. In the applied social sciences, hermeneutics collaborates with the strategic context, mainly at the stage of elaborating effective proposals,

which requires an understanding of the functions and elements that affect the inside and outside of organizations in a properly systematic way.

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Soils' Pollutions by Petroleum Products Accounting for Biodegradation and Concentration-Dependent Diffusivity

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Abstract— *We have developed a model of the migration of hydrocarbon compounds in soils using diffusive formalism. Biodegradation of pollutant by microbial organisms have been considered.*
We have adopted a configuration of concentration-dependent diffusivity. The nonlinear diffusion equation governing the system was solved numerically using the DOPRI5 fourth-and-fifth-order Runge-Kutta variable step integrator. The highest depth attainable in the ground depends on the type of contaminant considered and on its initial concentration at the ground surface. We obtained that, the maximum depth reached by the contaminant increases with the increasing value of the initial concentration. This maximum depth also declined with increasing coefficient of biodegradation. The distribution profiles of the pollutant shown that the degree of penetrating of the pollutant increases with the time period. We have found a good agreement between the results derived here and those of Zygadlo and Gawdzyk. at low concentrations. While important discrepancies appear at high concentrations.

Keywords—Hydrocarbon contaminated soils, Porous media, Diffusion, Biodegradation, DOPRI5 Runge-Kutta integrator.

I. INTRODUCTION

During the last 60 years, there has been a lot of oil pollution in terrestrial areas due to human activity. As a consequence, one observes an enormous effect on the quality of the soil in some parts of the world. This study focuses on the petroleum-contaminated soils (Kang et al. 1996, Labieniec et al. 1996, Bai et al. 1996). Let us recall that, contaminants or pollutants are referred to the increase in concentration of certain substance to higher level than that they occur naturally, arising from an external source. Such actions are generally connected to human activities. Petroleum products, generally released in different sites included gasoline, jet fuel, or diesel fuel. Petroleum oil is a complex mixture of substances, the majority of which are hydrocarbons. In the present work, we address the problem of the release of hydrocarbons on the soil surface. Let us mention, firstly, that this maneuver can occur accidentally during production, transportation, tanker accidents ... It can also be caused voluntarily by the harmful actions of human beings. For instance, pipe lines can be destroyed during wars, some ill-intentioned people can dump waste oil tankers in the nature. Such actions have been reported as the main cause of soil pollution. Several researches related to this topic of soil contaminants have been carried out worldwide (Haapkylal 2007, Das and Chadron 2011, Verbruggen et al. 2011, Wolfson 2012, Aerospace 2005). So, hydrocarbon contaminants involved in this study can be located in various areas, namely, in pipelines and pumps, in intermediate and product storage facilities, waste storage and disposal areas, drainage systems, terminals and distribution centers ... Further indications can be obtained in the reference (Nancarrow et al., 2001).

As a consequence of various spills, dangerous petroleum compounds contaminate soils, leading to major detrimental effects on the environment. Anyway, a number of spills of petroleum compounds are recorded here and there all over the world. One of the more remarkable spills is the spill of about 200.000 barrels of crude oil from the oil tanker Exxon Valdez in Prince William Sound, Alaska in 1989 \cite{hagar89}. Other cases of petroleum spills onto agricultural lands through petroleum operations have been registered in many sites in Nigeria as reported by the following papers: (Awobajo 1981, Grevy 1995, Moffat and Linden 1995). This contribution relies essentially to those potential sites, scattered here and there to the four corners of the world being contaminated with petroleum products. It is very important to emphasize that: these petroleum contaminants shall not remain indefinitely on the ground surface. They must inevitably penetrate in the soil

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following the well-known diffusive model of compounds in porous media. Soils can obviously be treated as porous materials.

Here, we shall carry our studies on four particular petroleum compounds; namely: benzene, toluene, xylene, Isooctane. It can be highlighted that, in soils contaminated with petroleum and derivatives, the aforementioned compounds stand out compared to others (Andrade and Augusto 2010, Souza et al. 2011). That is why, we are particularly interested in these hydrocarbons. In the present work, we take into consideration the biodegradation aspect of the contaminants, among other things. Biodegradation is the process by which organic substances are broken down into smaller compounds by enzymes produced by living microbial organisms. The paper is organized as follows: We present the model in the next section. Section three stands for the implementation of the DOPRI5 fourth-and-fifth-order Runge-Kutta variable step integrator for the numerical investigations. In this section, computational results are followed by discussions and commentaries. Section four is devoted to the conclusion of the paper.

II. THE MODEL

It is reasonable to characterize soils as porous media material. Some unwanted substances released in the soil could, unfortunately, modified its structure. Among them, we can name petroleum derivatives, as we mentioned earlier. Theoretically speaking, a porous soil has the ability to absorb pollutants until its pores are saturated. At this stage, it is said that the soil has reached the so called capillary saturation state. Capillary suction is a fundamental transport mechanism to describe the petroleum hydrocarbons absorption in soil. Strictly speaking, this process is basically a convective phenomenon. Meanwhile, in the context of soils contaminated with petroleum it is sufficiently accurate to contemplate the liquid transport in soils as a diffusion phenomenon. The capillary petroleum compound movement is related to the capillary suction stress which emerges as the result of curved liquid surfaces in the pore system of most soils. The suction process is described by the Fick's law

$$g_C = -D(C)\nabla C \quad (1)$$

Here, $C(z,t)$ stands for the concentration of petroleum hydrocarbons at a point z at time t, D is the pollutant diffusion coefficient or the diffusivity for short; and g_C is the pollutant flux density. A certain quantity, Q of the pollutant disappears by biodegradation during the diffusion process. Biodegradation is one of mechanisms of natural attenuation of the pollutant in the ground. Q is defined as

$$Q = -\mu C \quad (2)$$

where μ refers to the biodegradation coefficient of the considered pollutant. This decrease is usually taken into account in analytical or numerical models by solving a differential equation of the type:

$$\frac{\delta C}{\delta t} = -\mu C \quad (3)$$

This approach has a sense in steady state. By contrast, in non-steady state, i.e., when the flow in each point varies with time, the Fick's equation needs to be completed by the balance equation:

$$\frac{\partial C}{\partial t} = -\nabla g_C \quad (5)$$

If we consider biodegradation of pollutant, the Fick's law (5) is transformed into

$$\frac{\partial C}{\partial t} = -\nabla g_C - \mu C \quad (6)$$

This coefficient μ describes the attenuation of the process. The attenuation consisting in the reduction of the contaminants transported by a biodegradation of the later. Biodegradation of petroleum compounds by natural populations of microorganisms represents one of the primary mechanisms by which petroleum contaminants are eliminated from the environment. Petroleum compounds are, indeed, rich sources of carbon and the hydrocarbon within it are readily oxidized aerobically with the release of carbon-dioxide by a variety of microorganisms found in the ground. More details can be found in the reviews (National Academy Press 1985, Atlas and Bartha 1992). Let's mention that expressions (4) and (5) of the flux density are associated only to the steady states: this corresponds to the situation where the flux is not a function of time. In not steady regimes, i.e. at each position the flux varies with time. In this context, the petroleum hydrocarbon balance equation should be introduced. Putting together equations (5) and (6) yields

$$\frac{\partial C}{\partial t} = \nabla[D(C)\nabla C] - \mu C \quad (7)$$

So, the general equation of the petroleum contaminant diffusion is a second order partial derivatives equation. This equation (7) cannot be solve analytically so long as the diffusivity D depends on the concentration. If we consider one-dimensional transfer of the pollutant, this master equation (7) is transformed into

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$$\frac{\partial C}{\partial t} = \frac{\partial}{\partial z}\left(D\frac{\partial C}{\partial z}\right) - \mu C \quad (8)$$

z measures the penetrating depth of the pollutants in the soil.

Now, we consider the restrictive case where the diffusion coefficient is constant. The petroleum hydrocarbons penetrating the ground is described by the following equation in one dimension:

$$\frac{\partial C}{\partial t} = D\frac{\partial^2 C}{\partial z^2} - \mu C \quad (9)$$

We introduce the following boundary conditions in the soil-hydrocarbon system under consideration:

$C(0,0)=0$ for $0 < z < S$, (10)

$C(z,0)=0$ for $0 < z < L$, (11)

$\frac{\partial C}{\partial z} = 0$ pour t 0 et z=S. (12)

Here, C_0 is the initial concentration of the petroleum component at the surface; L is the maximum depth that the pollutant can reached when penetrating in the ground. Thus, Eq. (9) corresponds to the case where the diffusivity is not a function of the concentration. This equation was used by Zygadlo and Gawdzyk (2010) for the description of the migration of petroleum compounds in soil.

In a number of works related to this topic, authors have restricted their analysis on situations where the diffusivity coefficient is considered as a constant parameter. Really speaking, this is not generally the case and the effect of the concentration-dependence of the diffusivity could be large. In this chapter, we focus our attention on the specific case where the diffusivity coefficient is expressed as a function of the concentration of the contaminant in the soil.

To begin, let's mention that it is usually impossible to obtain a closed-form analytical solution for the equation of diffusion when the coefficient of diffusion depends on concentration. This observation shall constrain us to think about the digital approach in the continuation of this work. In addition, thanks to numerical methods, one can gain some understanding of the diffusion process and propose a functional form of the concentration-dependence of the diffusivity. In this vein, Greer (Greer, 2016) made use of the finite difference technique to construct a linear composition dependence of the diffusivity. Their investigations lead them to the conclusion that the assumption of linear composition dependence for the diffusivity has a physical basis. Greer found it necessary to confirm the validity of its approach by combining its own method with the Boltzmann-Matano (Wierzba, 2013) method. They used the Boltzmann-Mateno method to build the diffusivity as a function of the composition from experimentally determined composition profiles. Meanwhile the numerical technique gave them the ability to predict the composition profile. As a result, necessary informations about the behavior of the diffusivity as a function of composition could be obtained. In this section, we treat the diffusivity as linearly dependent on the concentration under the aforementioned brilliant developments by Greer (Greer, 2016):

$$D = aC + b \quad (13)$$

The constants a and b are approximated by the values

$$a = 3{,}5.10^{-8} \text{ and } b = 5.1.10^{-7} \quad (14)$$

This expression results from a great agreement between a numerical method (Greer, 2016) and an experimental method (Wang, 1951).

III. THE IMPLEMENTATION OF THE DOPRI5 FOURTH-AND-FIFTH-ORDER RUNGE-KUTTA VARIABLE STEP INTEGRATOR FOR THE NUMERICAL RESOLUTION: DISCUSSIONS

As we mentioned earlier, the analytical resolvability of the processing of this model is questionable. Because the nonlinear equation of diffusion (6), governing the system, do not have an obvious analytical solution, we opted for a numerical computation. The master equation of this contribution is solved numerically using the DOPRI5 fourth-and-fifth-order Runge-Kutta variable step integrator. It should be recalled that only quite numerical analysis could lead to physically acceptable solutions. A numerical method is said to be stable if numerical errors, e.g., those errors generated by round off, are not amplified, and the approximate solution remains bounded. This requirement applies to time-stepping schemes and iterative solvers alike. It is worth notice that, the notion of stability highlights the relationship between the exact solution of the discrete problem and the actually computed solution that includes round off and iteration errors. Nowadays, all the mathematical tools necessary for the study of the stability

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are available in the case of linear problems with constant coefficients. The most popular technique is unquestionably the well-known Von Neumann method. See, for instance, these references (Von, 1950). On the other hand, nonlinear problems are more difficult to analyze and may require a stronger form of stability. So, it is important to solve this problem using a quite appropriate technique. In this sense, a Runge-Kutta method using DOPRI5 as integrator is introduced for describing accurately the nonlinear diffusion of petroleum contaminants in porous materials like soils.

The basis of the method is to discretize the spatial part of the operator and keep the temporal part as such. This approach allows to increase the precision of the approximation in time and space independently and easily. We choose as space discretization the finite volume approximation where the operator is integrated over reference volumes. The finite volume method is well suited for the numerical simulation of various types of conservation laws, such as the nonlinear equation of diffusion describing the migration of hydrocarbon compounds in the present work. This method was also used for the description of the nonlinear diffusion of moisture in concrete (Simo et al., 2017). As solver for the differential equations, we use the Runge-Kutta method of order 4-5 introduced by Dormand and Prince (1986) implemented as the FORTRAN with DOPRI5 code by Hairer and Norsett (1987). This integrator has the merit of ensuring an excellent control of the step sizes with a dense output. Here, a sophisticated setting of the parameters allows for the adaptation of the code to the problem and the needs of the users. With the necessary input data, the model calculates the resulting pollutant content in the ground.

The simulation we perform here are based on normalized quantities. Dimensionless quantities are introduced via below anzats

$$C = C_0\bar{C}, \quad t = t_0\bar{t}, \quad z = l_0\bar{z}, \tag{15}$$

$$\mu = \mu_0\bar{\mu}, \quad a = a_0\bar{a}, \quad b = b_0\bar{b} \tag{16}$$

where $\bar{C}$ is the normalized concentration of the pollutant measured in units C_0; $\bar{\mu}$ is the normalized coefficient of degradation measured in units μ_0; $\bar{a}$ and $\bar{b}$ are the normalized coefficients of the function of diffusivity measured in units a_0 and b_0, respectively. l_0 is the characteristic distance. Here, $\bar{t}$ is the dimensionless time parameter measured in units t_0. So, t_0 is the time constance. Plugging the transformations (15) and (16) into the diffusion equation (6) leads us to the following equation, in dimensionless units, after some algebra:

$$\frac{\partial \bar{C}}{\partial \bar{t}} = \frac{\partial}{\partial \bar{z}}\left[\left(CC_1\bar{a}\bar{C} + \bar{b}\right)\frac{\partial \bar{C}}{\partial \bar{z}}\right] - \mu\mu_1\bar{\mu}\bar{C} \tag{17}$$

With

$$t_0 = \frac{l_0^2}{b_0}; \quad CC_1 = \frac{a_0 C_0}{b_0} \quad \text{and} \quad \mu\mu_1 = \frac{l_0^2\mu_0}{b_0} \tag{18}$$

Table. 1: Input data related to four different types of petroleum hydrocarbon

Petroleum Hydrocarbon	Benzene	Toluene	Xylene	Isooctane
Diffusion coefficient $D_0.10^7$ $[m^2/s]$	3.5	3.6	8.1	24
Biodegradation rate constant in the soil $\mu.10^8$ $[s^{-1}]$	5.55	4.63	2.89	6.94

The Tab.1 represents the input data used for the computational process according to the contribution of Zygadlo and Gawdzyk (2010).

Our numerical investigations focus on four different types of petroleum components. Namely, Benzene, Toluene, Xylene and Isooctane. To really dig inside this crucial environmental problem, we firstly perform calculations based on benzene, a well-known hydrocarbon contaminant. At the beginning of the process, only the surface of the ground is polluted. All the pores of the soil are supposed to be empty; so far as this petroleum component is concerned. As soon as the hydrocarbon is spilled on the surface of the ground, the pollutant component does not cross the concerned portion of the soil instantaneously from the surface to the maximal depth. It takes some time to penetrate the soil. The rate of penetration can be observed in Fig. 1. This figure clearly indicates the positions reached by benzene inside the ground at given periods. The pollution of the entire portion of the ground necessitates some time. Benzene moves gradually and slowly through the porous media. So, in this case where the initial concentration of benzene at the surface is setting to the value $C_0 = 100\ Kg/m^3$, one can notice, for instance that: after a period $t = 50\ days$ only 340.36 m depth has been attacked by the pollutant product. The remaining of the ground is not yet affected by benzene as it can be seen

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in Fig. 2. The covering of the maximum depth attainable 728.92 m is observed approximately $t = 250\ days$ after the spill of pollutants. Figs. (1, 2) also indicate that as the benzene moves through the soil, its amplitude decreases gradually from its maximal value at the surface to zero. The concentration of the pollutant does not decreases significantly at the beginning of the process, as soon as one pours the hydrocarbon compounds. It first declines slowly before falling abruptly to zero, after a certain time. In Fig. 2, we can obtain precise indications on the maximum distances reached by the pollutant in the ground at different periods.

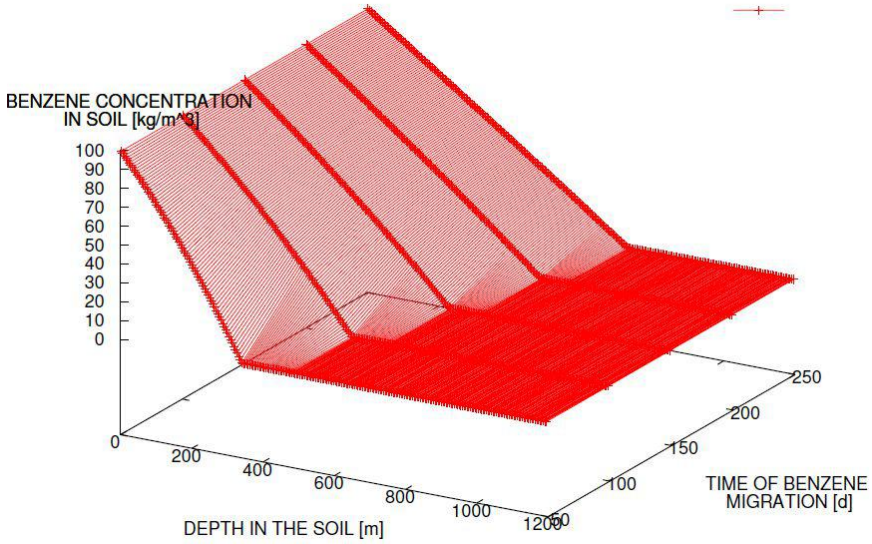

Fig. 1 Time evolution of Benzene content in the ground. The initial concentration of benzene at the surface is setting to the value $C_0 = 100\ Kg/m^3$.

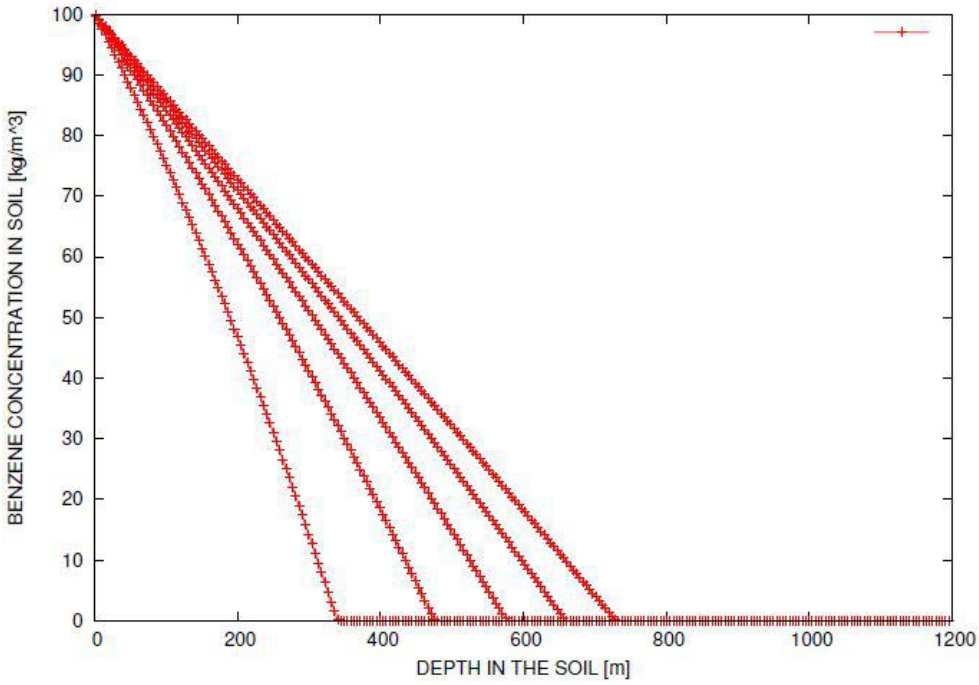

Fig. 2 Benzene content in the ground in terms of the distance from the ground surface. The initial concentration of benzene at the surface is setting to the value $C_0 = 100\ Kg/m^3$

During the migration's process described in this paper, a constant concentration is maintained at the surface.

Now, our numerical investigations focus on three other types of petroleum contaminants. Namely, Toluene,

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Isooctane and Xylene. We analyze the contaminant distribution in the ground as a function of the time for each single hydrocarbon. As a result, we obtain that computational processes lead practically to the same profile as in the case of benzene. This allegation is clearly expressed on Figs. (3, 4, 5). These curves show that the maximal depth attainable by the contaminant in the ground is not always the same. It varies from one contaminant to another, depending on the value of its biodegradation coefficient in the soil. So, for an initial concentration on the surface of the ground fitted at $C_0 = 50\ Kg/m^3$ and for the same temporal period, i.e. d $t = 250\ days$, the maximal depth attainable is obtained with Xylene $z_{max} = 534.61\ days$ whereas the minimal one is obtained with Isooctane $z_{min} = 412.65\ days$. As a bit of explanation, we can hypothesize that the most penetrating contaminant is the one associated to the lowest coefficient of degradation in soil.

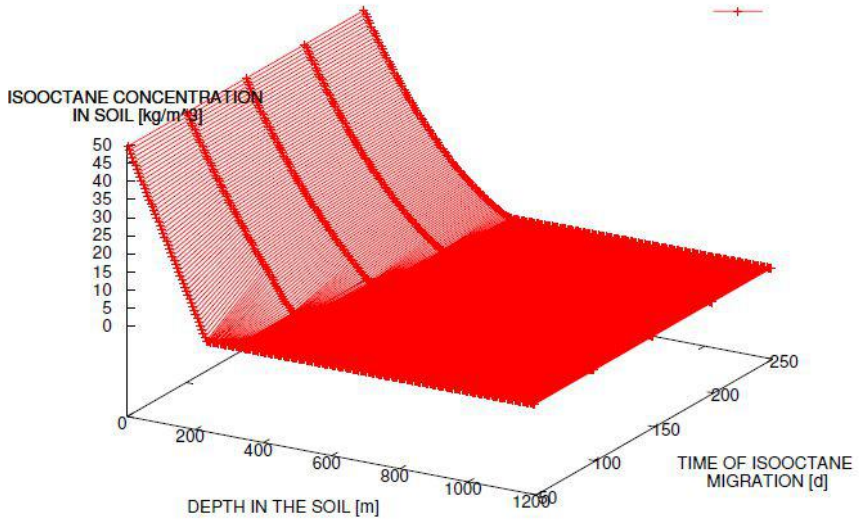

Fig. 3 Time evolution of Isooctane content in the ground. The initial concentration of Isooctane at the surface is setting to the value $C_0 = 50\ Kg/m^3$

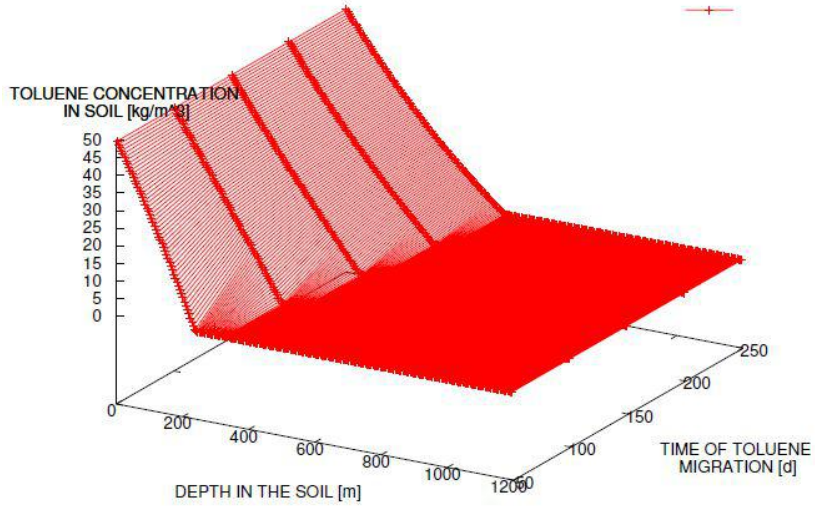

Fig. 4 Time evolution of Toluene content in the ground. The initial concentration of Toluene at the surface is setting to the value $C_0 = 50\ Kg/m^3$

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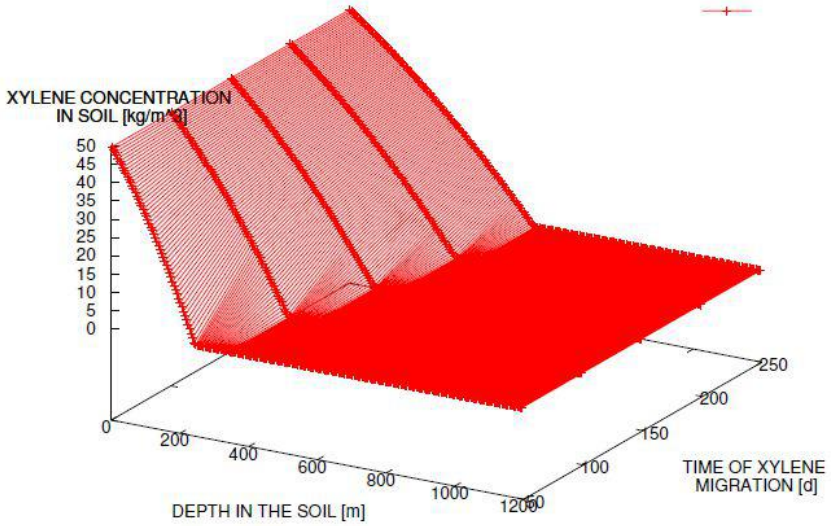

Fig. 5 Time evolution of Xylene content in the ground. The initial concentration of Xylene at the surface is setting to the value $C_0 = 50\ Kg/m^3$

From the Fig. 6, it is clear that the maximum depth attainable by the contaminant increases as the coefficient of biodegradation decreases, as it was expected. The general trend, in terms of the maximum depth of hydrocarbon penetration through the ground, is as follows:

Xylene > Toluene > Benzene > Isooctane

This trend is consistent with the data from the table Tab. 1 relating to the coefficient of biodagradation of the contaminants considered in this contribution.

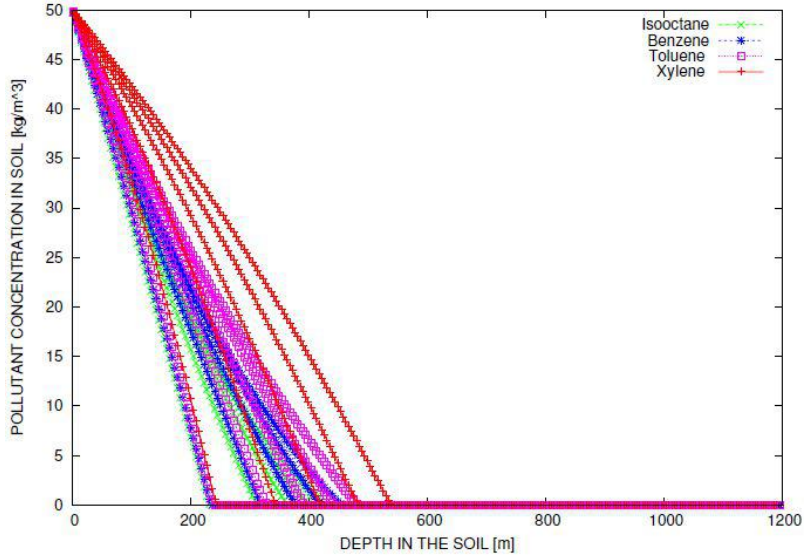

Fig. 6 Contaminants' content in the ground in terms of the distance from the ground surface. Curves are drawn for the four hydrocarbon components considered in his paper: the green curve corresponds to the Isooctane, the blue curve corresponds to the Benzene, the purple curve corresponds to the Toluene and the red curve corresponds to the Xylene. The initial concentration of each contaminant at the surface is setting to the value $C_0 = 50\ Kg/m^3$

3.1 IMPACT OF THE INITIAL CONCENTRATION OF THE POLLUTANT ON ITS PENETRATION IN THE GROUND

Analyses are carried out using benzene as the pollutant. The profile of benzene distribution is shown if Figs. (7, 8) for three different values of the initial concentration of the benzene on the ground surface. These curves give clear indications on the maximum depth attainable by the contaminant according to its initial concentration. These plots reveal that: any decrease of the initial concentration would lower the maximum depth of penetration of the benzene through the ground.

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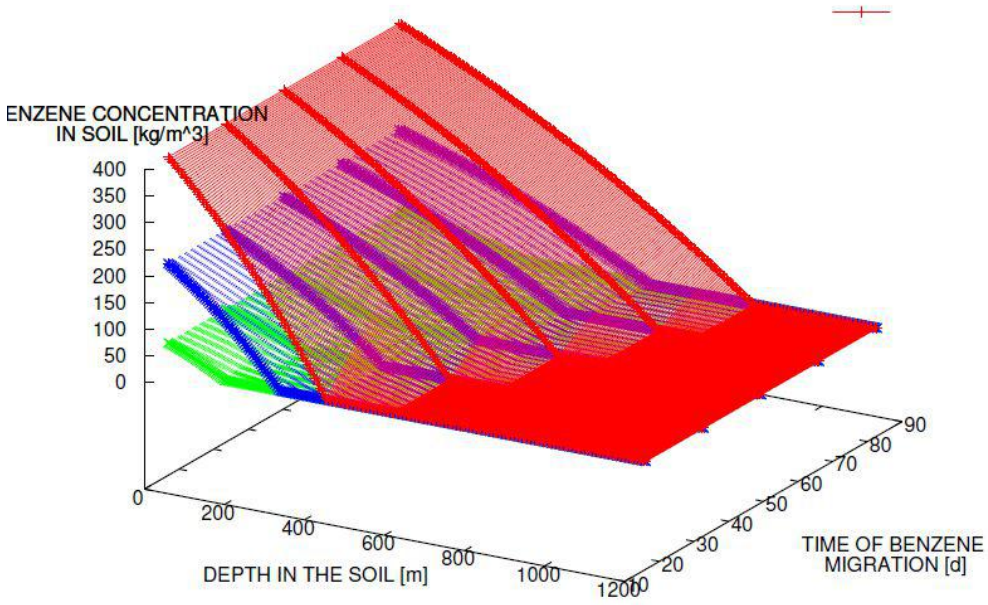

Fig. 7 Time evolution of Benzene content in the ground. In this figure, three initial concentrations are considered: $C_0 = 50\ Kg/m^3$ *is shown by the green curve;* $C_0 = 200\ Kg/m^3$ *is shown by the blue curve and* $C_0 = 400\ Kg/m^3$ *is shown by the red curve. The temporal period is fitting to* $t_0 = 83.33\ days$

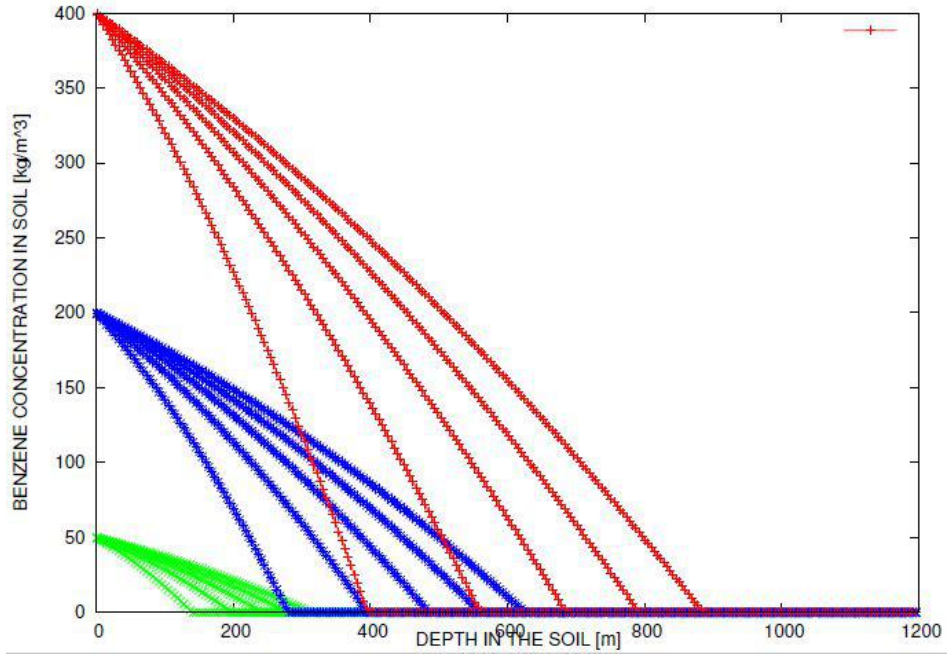

Fig. 8 Spatial profile of benzene distribution in the soil at different time intervals. In this figure, three initial concentrations are considered: $C_0 = 50\ Kg/m^3$ *is shown by the green curve;* $C_0 = 200\ Kg/m^3$ *is shown by the blue curve and* $C_0 = 400\ Kg/m^3$ *is shown by the red curve. The temporal period is fitting to* $t_0 = 83.33\ days$

We perform computations for different values of the initial concentration of the petroleum component on the surface of the ground. For each single value of the initial concentration, we determined the highest depth attainable by the pollutant in the ground. In this section of the work, were our analyses are based on benzene, some selected values describing this process are given in Tab.2.

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Table.2 - Different values of the initial concentration of benzene at the surface (ICS) and associated maximum depth of benzene penetration through the ground (MDBP). It should be recalled that MDBP is expressed in meters and ICS in Kg/m^3.

ICS	50	75	100	125	150	175	200	225
MDBP	314.77	385.54	444.28	498.49	543.67	588.86	629.52	665.66

ICS	250	275	300	325	350	375	400
MDBP	701.81	737.95	769.58	801.20	823.83	859.84	887.05

To get an idea about the progress of the pollutant in the soil, based on its initial concentration at the ground surface. We have plotted the curve indicating the maximum depth reached by benzene versus the initial concentration of the hydrocarbon spilled at a given location. We obtain that, for initial concentration ranging from 50 to $400Kg/m^3$, the evolution of the maximum depth reached by the pollutant experiences a quasi-parabolic process. One can refer to the results plotted in Fig. 9. The maximum depth of benzene penetration through the ground (MDBP) as a function of the initial concentration of benzene at the surface of the ground.

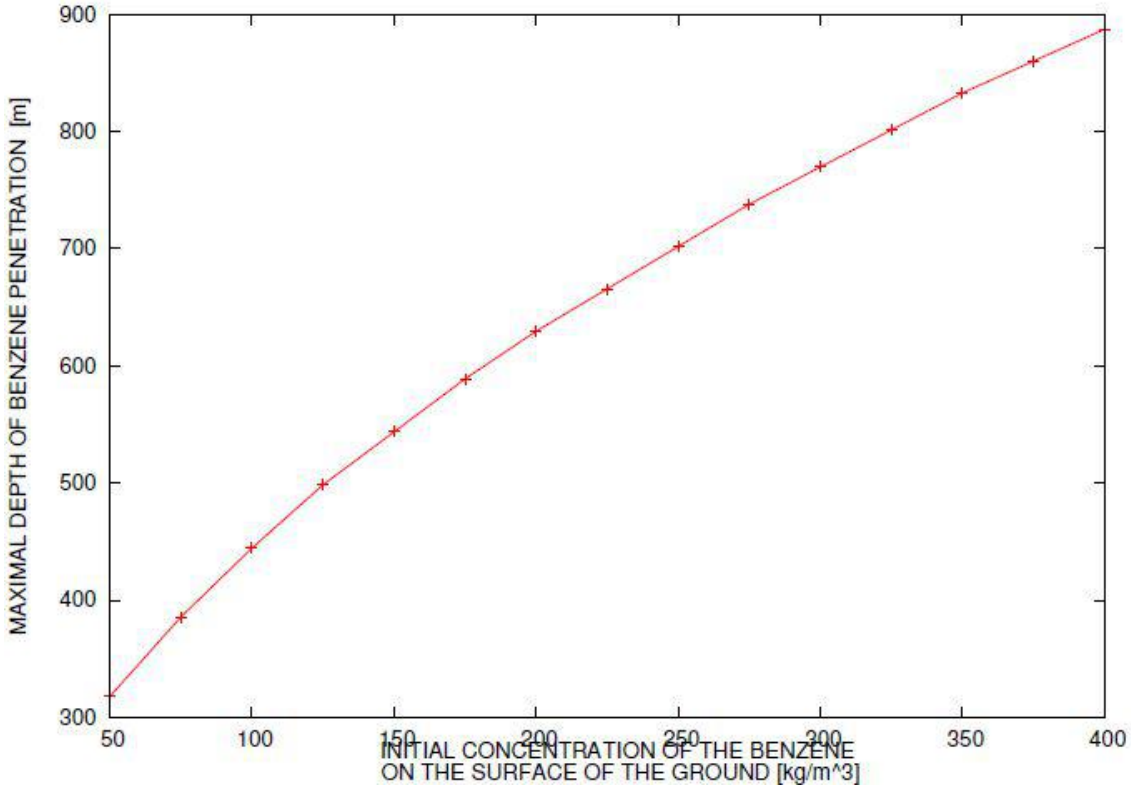

Fig. 9: *The maximum depth of Benzene penetration through the ground (MDBP) as a function of the initial concentration of benzene at the surface of the ground.*

3.2 IMPACT OF THE TEMPORAL PERIOD ON THE POLLUTANT MIGRATION IN THE GROUND

Now, we want to gather some informations about the impact of the temporal period on the depth of the pollutant migration. In order to compare the degree of benzene penetration in the ground, according to the duration, we present three different configurations in Figs. (10, 11, 12). Each of these figures results from the plotting of the computational results at two different temporal periods. The profiles of the contaminant distribution in the ground are exhibited. From these curves, one can infer that the maximum depth attainable by the pollutant grows with the temporal period. To confirm this aspect of the problem, we perform a series of computations for different values of the temporal periods ranging between 41 days and 416 days. Fig. 13 confirms the above profile of the maximum depth attainable as a function of the temporal period. We can notice that, when

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we consider two fairly close temporal periods, the shift between the results is not very important. The reader can refer to Fig. 10, for instance. Here, the two periods involved are: $t_0 = 41.66\ days$ and $t_0 = 83.33\ days$. In contrast, the shift between the results becomes very significant when the difference between temporal periods is very large. Figs. (11, 12) illustrate very well such a situation. The couple of periods considered here are $(41.66\ days, 250\ days)$ and $(208.33\ days, 416.67\ days)$, respectively.

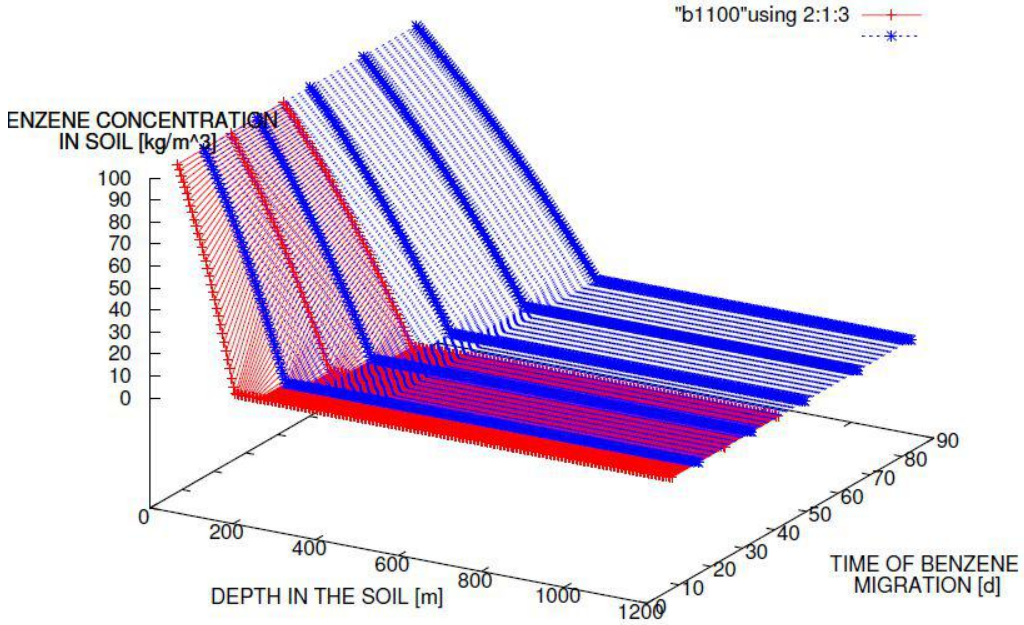

Fig. 10 Time evolution of Benzene content in the ground. Here, two different temporal periods are considered: The red curve shows the case corresponding to the period $t_0 = 41.66\ days$. *The blue curve shows the case corresponding to the period* $t_0 = 83.33\ days$. *The initial concentration of benzene at the surface is setting to the value* $C_0 = 100\ Kg/m^3$.

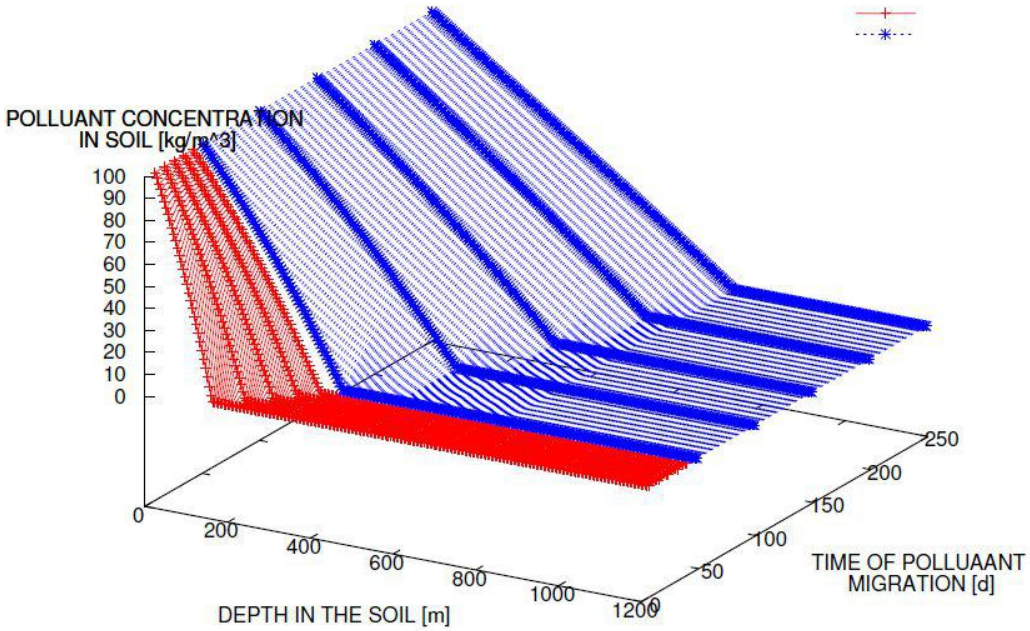

Fig. 11 Time evolution of Benzene content in the ground. Here, two different temporal periods are considered: The red curve shows the case corresponding to the period $t_0 = 41.66\ days$. *The blue curve shows the case corresponding to the period* $t_0 = 250\ days$. *The initial concentration of benzene at the surface is setting to the value* $C_0 = 100\ Kg/m^3$.

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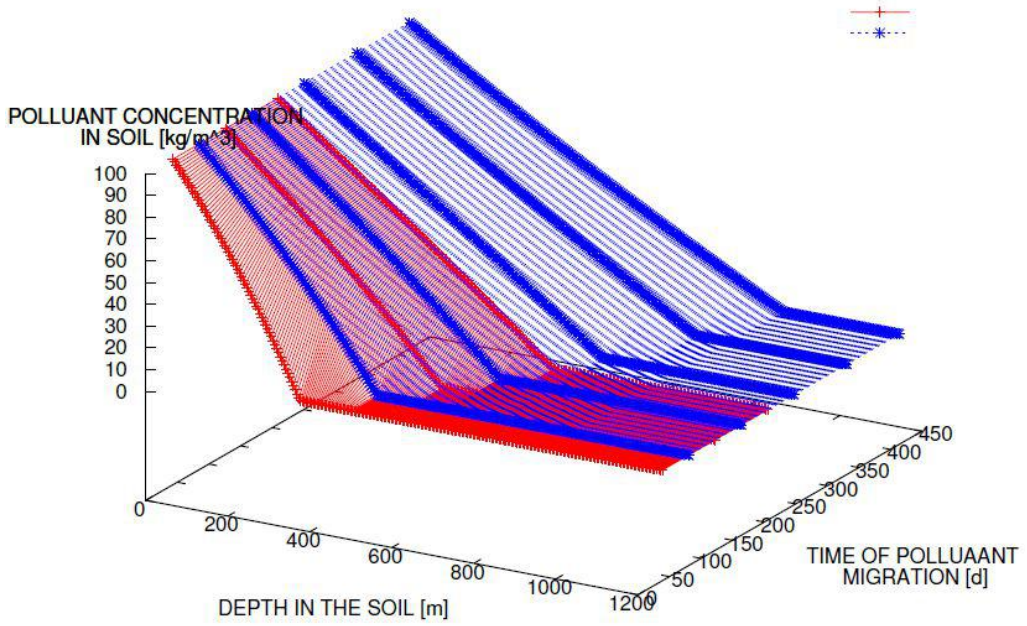

Fig. 12 Time evolution of Benzene content in the ground. Here, two different temporal periods are considered: The red curve shows the case corresponding to the period $t_0 = 208.33\ days$*; The blue curve shows the case corresponding to the period* $t_0 = 416.67\ days$*. The initial concentration of benzene at the surface is setting to the value* $C_0 = 100\ Kg/m^3$.

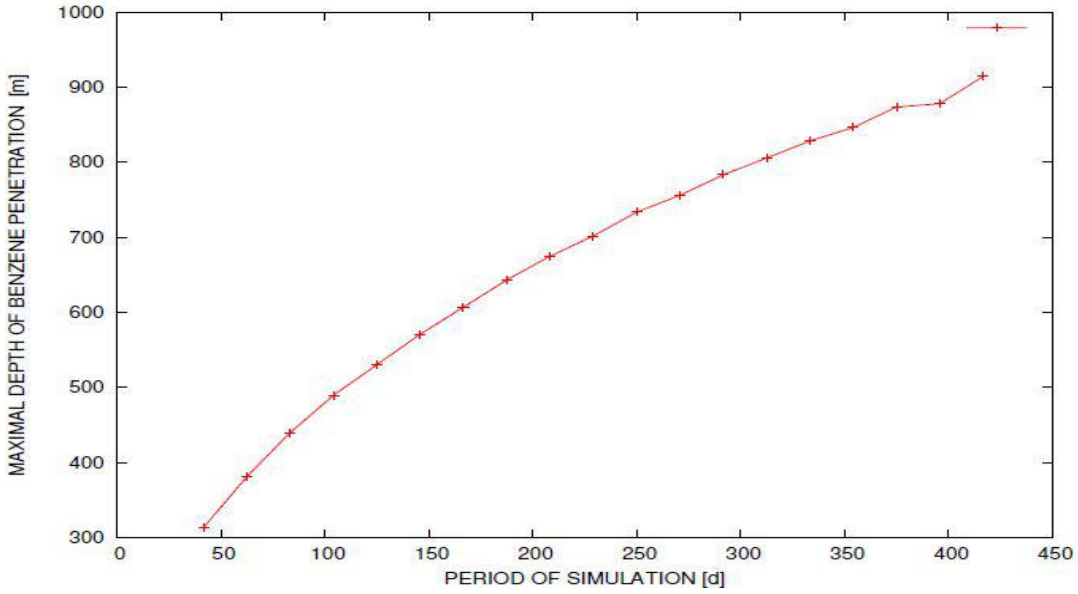

Fig. 13 The maximum depth of benzene penetration through the ground (MDBP) as a function of the temporal period for an initial concentration of benzene at the surface of the ground fitting at the value $C_0 = 100\ Kg/m^3$.

3.3 COMPARAISON BETWEEN THIS MODEL AND ZYGADLO MODEL

We compare the composition profiles generated by our numerical technique to those derived from the diffusion equation with constant diffusivity proposed by Zygadlo and Gawdzyk (2010). The computational results plotted in Fig. 14 for an initial concentration $C_0 = 25\ Kg/m^3$, shows very good agreement with the results by Zygadlo and Gawdzyk (2010). This agreement persists for $C_0 = 50\ Kg/m^3$ (see Fig. 15). As the initial concentration C_0 increases, one notice a discrepancy between the two results. This is, in fact, visible in Fig.16. This offset grows and becomes quite significant for somewhat large values of C_0. The reader can refers to the Fig. 17.

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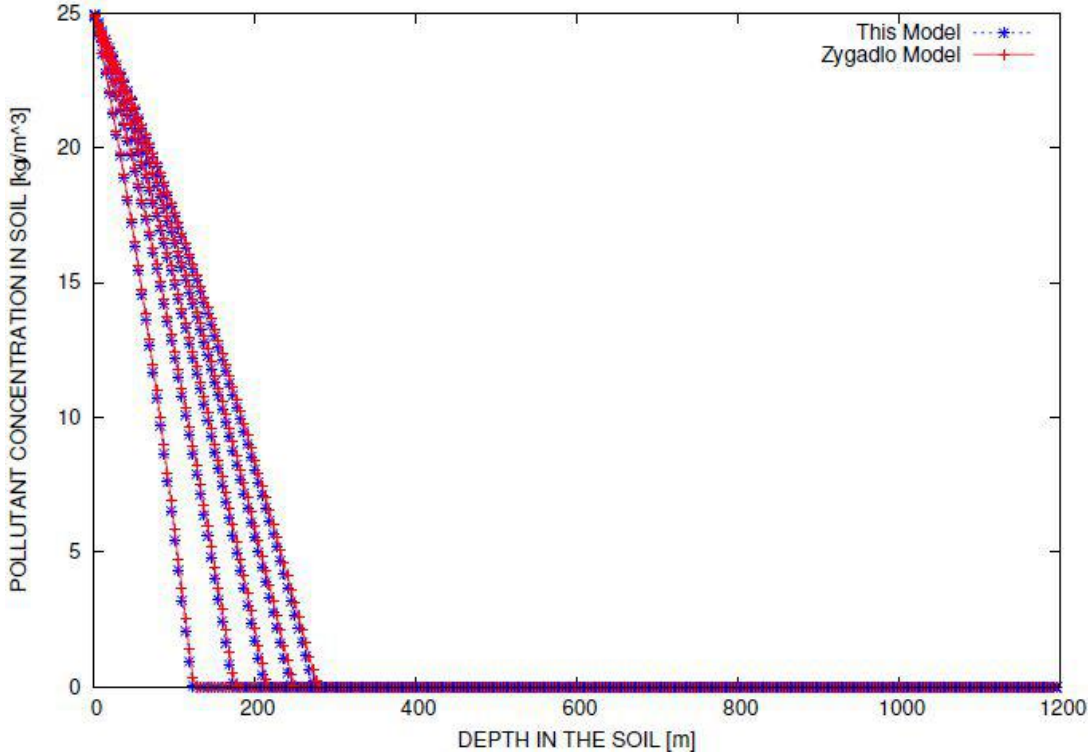

Fig. 14 Benzene content in the ground in terms of the distance from the ground surface for this model and Zygadlo model. The initial concentration of benzene at the surface is setting to the value $C_0 = 25\ Kg/m^3$.

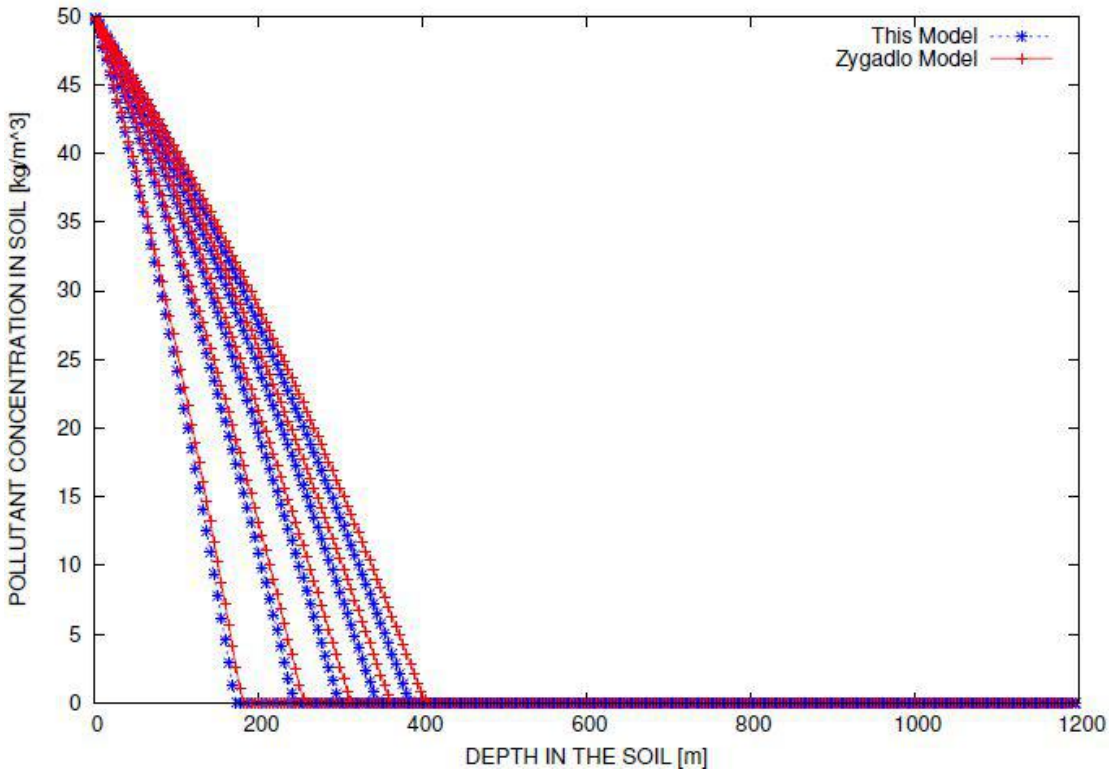

Fig. 15 Benzene content in the ground in terms of the distance from the ground surface for this model and Zygadlo model. The initial concentration of benzene at the surface is setting to the value $C_0 = 50\ Kg/m^3$.

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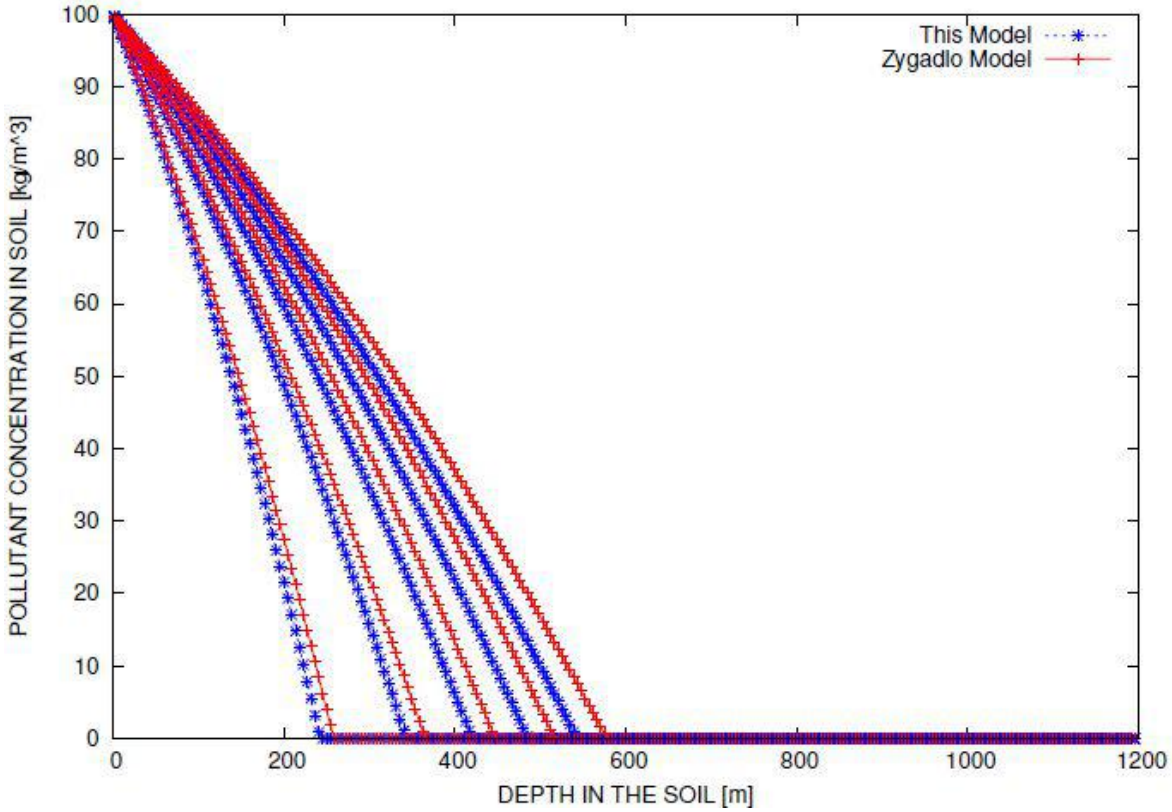

Fig. 16 Benzene content in the ground in terms of the distance from the ground surface for this model and Zygadlo model.

The initial concentration of benzene at the surface is setting to the value $C_0 = 100\ Kg/m^3$.

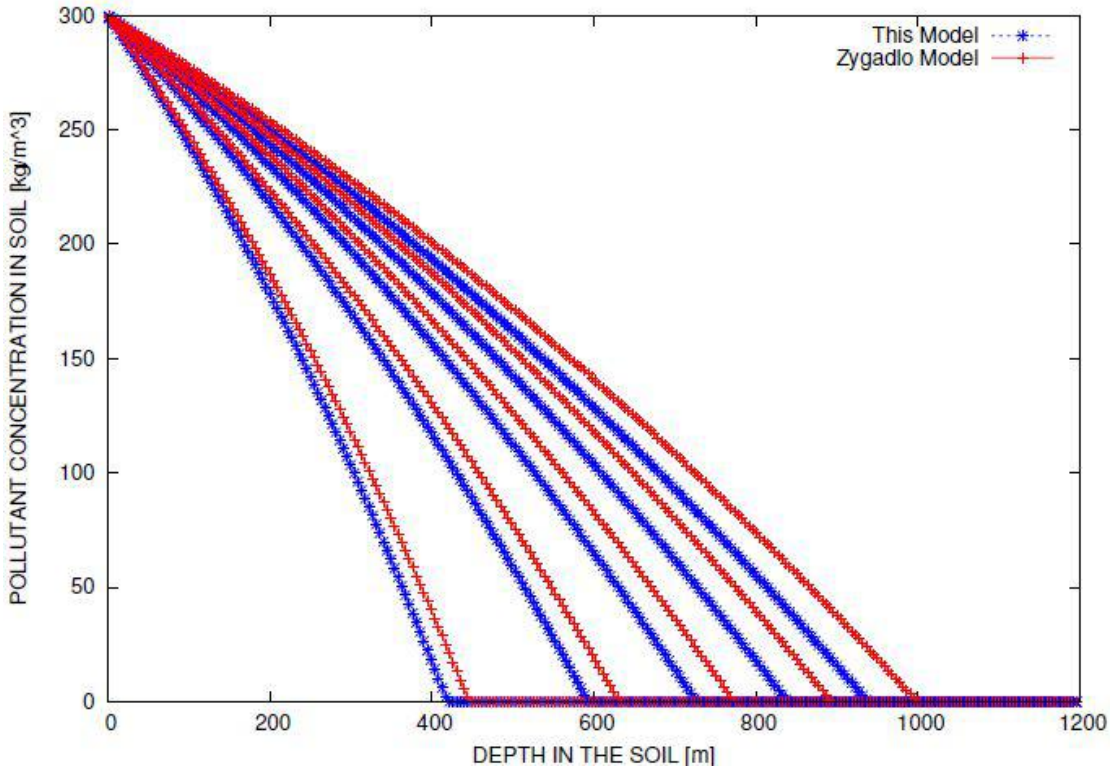

Fig. 17 Benzene content in the ground in terms of the distance from the ground surface for this model and Zygadlo model.

The initial concentration of benzene at the surface is setting to the value $C_0 = 300\ Kg/m^3$.

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Our computational technique reveals that, it is incorrect to ignore the concentration-dependence of the coefficient of diffusivity in the process of migration of petroleum contaminants in soils. This assertion is mostly justified in the case of somewhat higher concentrations. The conclusion could be different for small concentrations. In this case, the change between the results derived from the two models is could be neglected.

IV. CONCLUSION

We have considered petroleum hydrocarbon contaminated soils in this paper. The migration of these petroleum contaminants was investigated. Calculations were carried out with regard to the biodegradation process of the components. The reason being that the majority of toxic hydrocarbon components of petroleum are biodegradable. We assumed that the coefficient of the diffusion is not constant and we introduced a concentration-dependent function. Boltzmann-Matano analysis was used to approximate the linear composition dependence of the diffusivity.

The master equation of diffusion describing the system could not be solved analytically. To gain some understanding of the system behavior, we introduced the fourth-and-fifth-order Runge-Kutta method using DOPRI5 code as the integrator. The discretization of space followed the finite volume technique. The DOPRI5 code has been used as the integrator. Four hydrocarbon components are involved in this contribution, namely Xylene,Toluene, Benzene and Isooctane. For each pollutant, we are interested by the profile of its distribution in the ground. We have plotted a number of curves to show the distribution of contaminants in the ground and their degree of penetration.In various circumstances, the maximum depth of hydrocarbon penetration through the ground has been computed. Computational results have shown that, for the same period of time and for the same initial concentration of contaminant at the ground surface, Xylene was the most penetrating contaminant in our context. For a bit of explanations, we can remind that Xylene has the smallest Coefficient of biodegradation.

The efficiency of our formalism was checked by comparing the concentration profile obtained in our case with those exhibited by Zygadlo and Gawdzyk . Calculations were performed for different values of the initial concentration of the petroleum component. We have presented the profile of the distribution of contaminant in soil at different concentration ranges. Then, the predictions by Zygadlo and Gawdzyk (2010) are plotted in the same figures. By doing so, some discrepancies have emerged. Although, we have obtained very good agreement at low concentrations, important shifts are confirmed for high concentrations. We arrived at the conclusion that Zygadlo and Gawdzyk formalism has underestimated the pollutant distribution in soil at somewhat high concentrations. In fact, the discrepancies between the two models are increased at high concentrations.

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Nomenclature

C	hydrocarbon concentration in the ground $[Kg/m^3]$
$\bar{C}$	normalized hydrocarbon concentration $[-]$
C_0	initial concentration of the hydrocarbon at the surface $[Kg/m^3]$
D	coefficient of the diffusion of the hydrocarbon $[m^2/s]$
g_c	hydrocarbon transport flux density $[Kg/(m^2 s)]$
L	maximum depth attainable in the ground $[m]$
l_0	units of the measurement of a distance $[m]$
Q	quantity of pollutant disappearing by biodegradation
t	time $[d]$
$\bar{t}$	normalized time parameter $[-]$
t_0	units of the measurement of time
z	depth of penetration of the pollutant $[m]$

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The Analysis of the Road Network Assignment Due to Residential

(A Case Study of the Development of Citra Mitra City Residence Banjarbaru)

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***Abstract*—** *By the establishment of Citra Mitra City Residence in Banjarbaru City, it then will cause the attraction and production of the traffic on the roads around the Citra Mitra City Residence, and will also increase the traffic volume. As the research object, that is the Street of Taruna Bhakti. This research used primary and secondary data, with the analysis was carried out by the IHCM 1997, and was assisted by the VISUM Program. The performance of the existing road network of all road sections had the LOS A value with the VC Ratio of 0.01 – 0.19; the performance of the road network while in the development of all road sections still had the LOS A value with the VC Ratio of 0.01 – 0.19; the performance of the road network of the post-development of all road sections had the LOS A value, with the VC Ratio of 0.08 – 0.20; change that occurred was around ±0.17, or 17% were at Street of Citra Mitra City; and the performance of the road network, five years after the development of all road sections, had the LOS A value with the VC Ratio of 0.08 – 0.20. The largest DS decline value was experienced by the road section segment of Citra Mitra City as much as 0.17, and the change of DS value was as musch as 0.01 on the other road sections. Referring to the analysis results, it had been concluded that the development of the DEEPDENE District 4 of Citra Mitra City Residence to the road section in all conditions had not been affected negatively. The next analysis was carried out to obtain the time; a handling needed to be done on the observed road section; after being analysed, it was found a 60-year period after the operational in which the occurred VC ratio value was beyond the limit of ≤ 0.75, that was on section Street of Mistar Cokrokusumo, with the VC Ratio value of 0.85 – 0.88; as for the section Street of Taruna Bhakti was on the VC Ratio value of 0.64*

***Keywords*— level of service, loading, land use.**

I. INTRODUCTION

One of the housing developments in downtown Banjarbaru is the Citra Mitra City Residence Banjarbaru, Sub-district of Cempaka, Municipality of Banjarbaru. By the establishment of such housing, it will then cause the attraction and production of the traffic on the roads around the houding, and will increase the traffic volume. From that condition, it then should be required to carry out analysis about road network Assignment due to the assignment establishment. By creating such analysis, hopefully the traffic disturbances can soon be figured out which later is used as the evaluation material of the road performance, and can give the best solution to overcome the traffic problem in that area.

II. LITERATURE REVIEW

2.1 Definition Traffic Impact Analysis

The analysis of the traffic impact as particular study from the establishment of a building facility and other land uses, to the city transportation system especially the road network around the building location [1]. The analysis of the traffic impact is basically the analysis of the influence of the land use development to the system of the traffic flow trip around it, which is caused by the new traffic production, by the switched traffic, and by the in-and-out vehicles from/to that land [2][3]. The phenomenon of the traffic impact is caused by the establishment and operation of activity center which cause the quite-large traffic production such as office space, shopping center, terminal, residential, and others [4]. The number of trips in the plan year is determined by the characteristic of the land use/land squares (sectors) and also by the socio-economic characteristic of those each sector, which are included in the scope of particular study area such as the town area, regional/province or national [3][5].

2.2 Review of Implementation of Traffic Impact Analysis

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The implementation of the traffic impact analysis in several countries varies based on particular approach/criterion. Nationally, there has been no provision which regulates the implementation of traffic analysis until now. The provisions regarding the recent applied road traffic as in the Minister Regulation No. 96 of 2015 [6], and the Minister Regulation No. 75 of 2015 [7] about the traffic impact analysis and its implementation regulation, do not regulate about the traffic impact.

III. RESEARCH METHODOLOGY

3.1 Activity Flow

The analysis activity in this research can be described into a flow chart as in Figure 1.

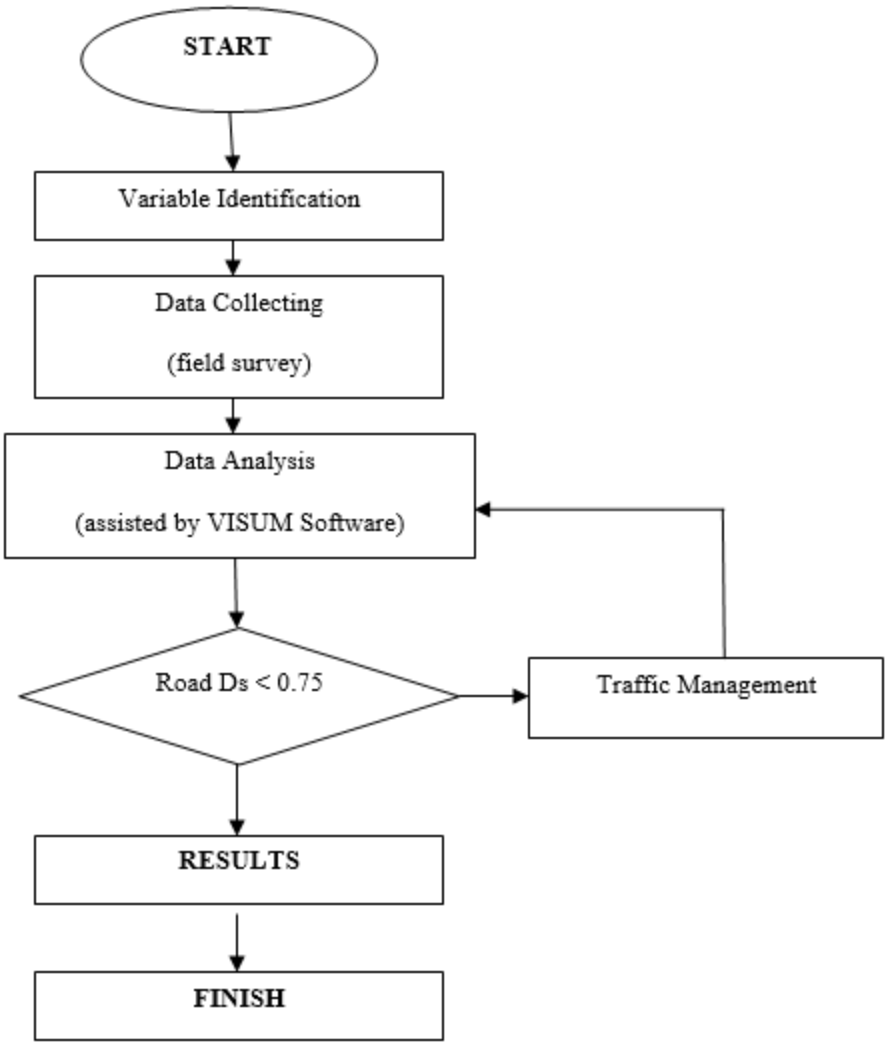

Fig.1: Flow Chart of Analysis

The analysis is to calculate some parameters which influence the section performance such as: degree of saturation, and velocity. The method that is used is the IHCM, 1997 [8], assisted by the VISUM software [9]. The analysis to carry out are:

1. Analysing the condition of the traffic performance around the location before the development.
2. Analysing of how big the attraction and production are, during the housing development.
3. Analysing the condition of the traffic performance after the development.
4. Analysing the impact magnitude caused by the development which influences the traffic performance around, after five years ahead.

The stages in the use of VISUM program which assisted by using the field data in the form of ADT and Destination Origin Matrix , which then inserted in matrix calculation and from some stages of the VISUM program analysis, it can be shown in the form of flow chart as in Figure 2.

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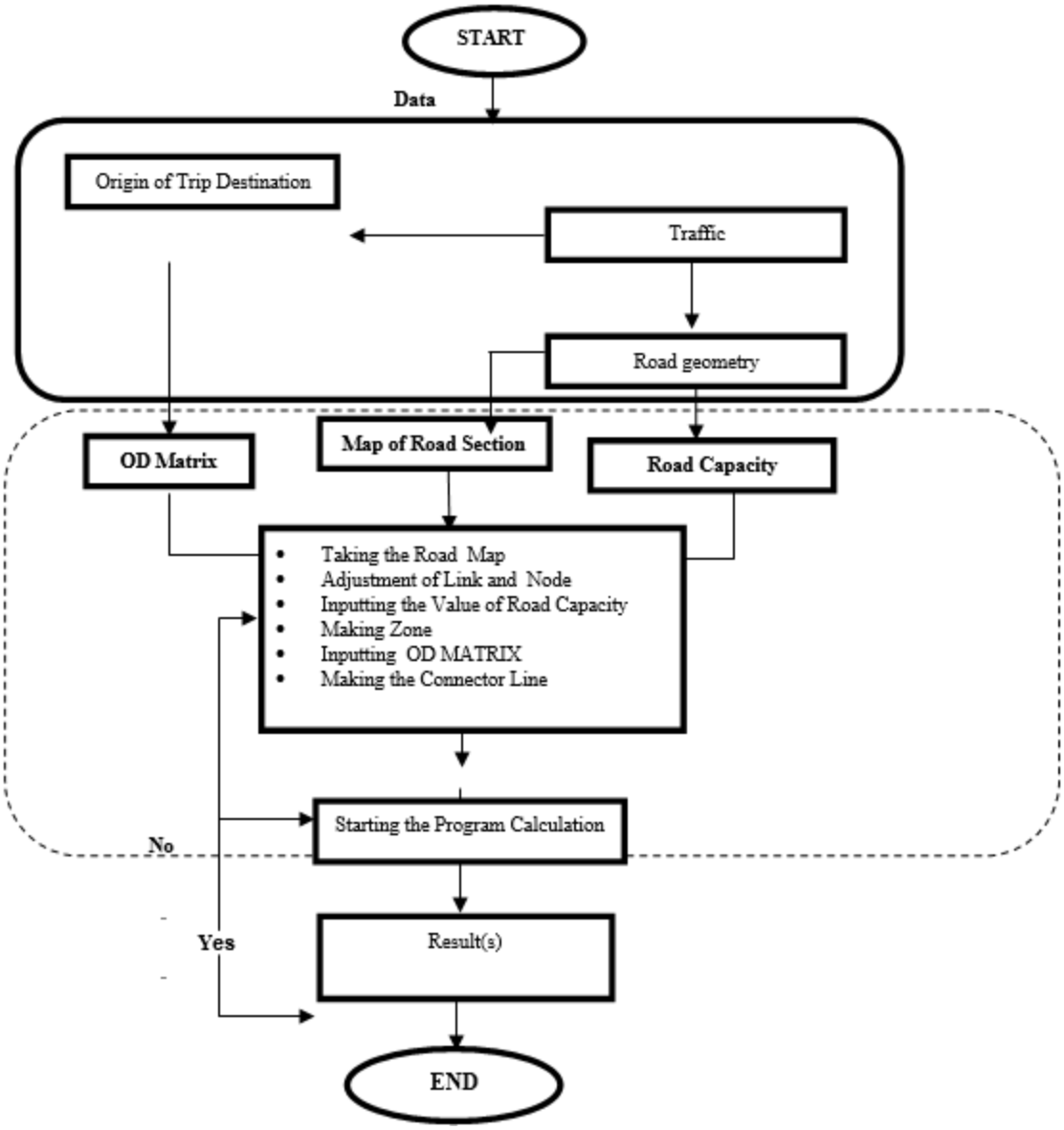

Fig.2: The Flow Chart of VISUM Program Analysis

3.2 Needs of Research Data

This research data includes the primary and secondary data. The secondary data are obtained from the previous research and from the related agencies, including:

1. The data of socio-economic conditions and the General Plan of City Spatial (abbreviated a RUTRK in Indonesian); these data are obtained from the Central Bureau of Statistics and the Regional Development Planning Agency of Banjarbaru city.
2. The data of vehicle ownership and the data of traffic growth rate; these data are obtained from the Department of Transportation of Banjarbaru or the Central Bureau of Statistics of Banjarbaru city.
3. The data of the Citra Mitra City Residence Banjarbaru.

Meanwhile the primary data is obtained by conducting the on-the-field direct survey which includes:

1. The inventory of land use, which is carried out to see the use and potential of the land use around the area of Street of Palam, and the Road influences the production and attraction of the existing trip, and will burden the road.
2. The road network survey, which is carried out by identifying the existing network pattern around Street of Palam and Street of Taruna Bhakti, road section inventory, ADT.

IV. DATA ANALYSIS

4.1 Road Inventory Data

The Geometric conditions of the studied road section, as seen on Table 1.

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Table.1: The Geometric Condition on the Road Section

No.	Road Section Names	Road Type	Width (m)	Road side (m)		Median (yes/no)	Capacity (pcu/hour)
				right	left		
1.	Street of Taruna Bhakti	2/2 UD	6,5	2	2	No	2636
2.	Street of Mistar Cokrokusumo (Cempaka)	2/2 UD	8	2	2,5	No	2916
3.	Street of Mistar Cokrokusumo (Banjarbaru)	2/2 UD	8	2	2	No	2975
4.	Street of Palam	4/2 D	6,5	1,8	1,5	Yes	5080
5.	Street of Merdeka	2/2 UD	4,5	1	1,2	No	1418
6.	Street of Citra Mitra City	4/2 D	13	2	2	Yes	5949
7.	Street of Purnawirawan	2/2 UD	5	1	1	No	1359

4.2 Road Traffic Volume

The results of the traffic volume obtained during conducting the survey can be defined on the graph of the flow fluctuation of each section as shown in Figure 3 until Figure 5.

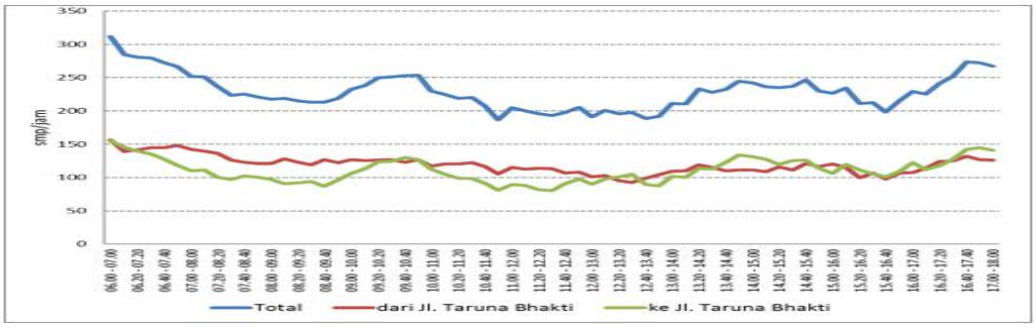

Fig.3: Flow Fluctuation of Street of Taruna Bhakti

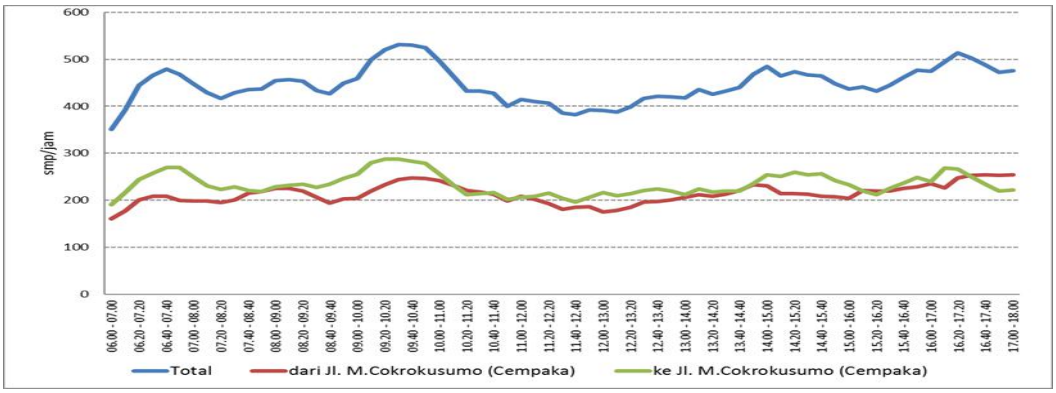

Fig.4: Flow Fluctuation of Street of Mistar Cokrokusumo (Cempaka)

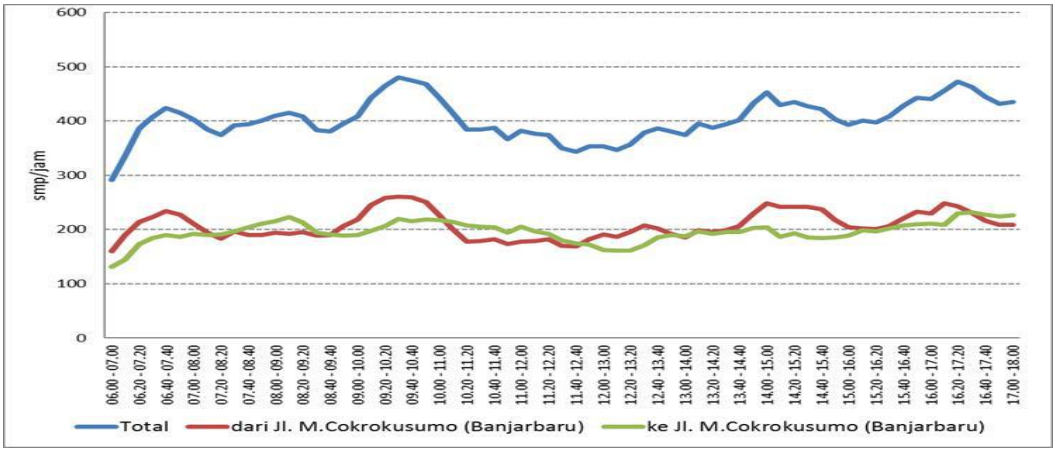

Fig.5: Flow Fluctuation Street of Mistar Cokrokusumo (Banjarbaru)

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The peak volume occurs in the morning period at 9.30 - 10.30 Wita at 480. pcu/hour.

4.3 Trip Demand Data

The trip demand data is used to the traffic model depicting the traffic demand condition, along with the performance of the supplied transportation system service in the study area which is based on the results of the data collecting, both the primary and the secondary. All process of the road network model development is assisted with "*VISUM*," a transportation planning software. According to the characteristic of the road network system in the study area, several road sections are selected to be analyzed and will be used as the road network model of the study area, as in Figure 6.

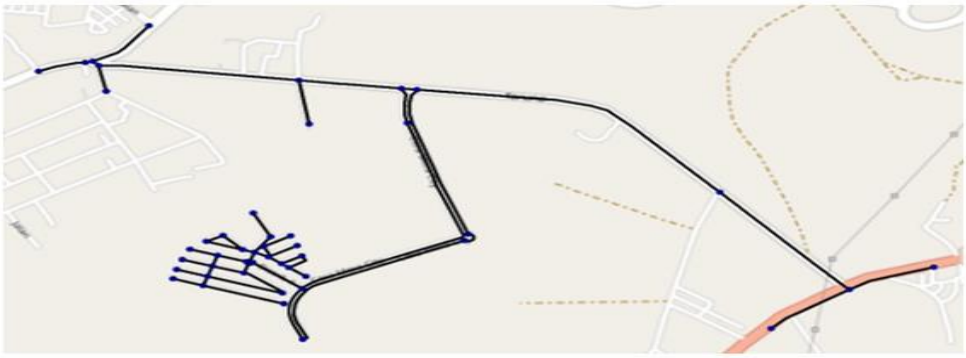

Fig.6: Basic Model of the Selected Road Network of the Study Area

4.3.1. OD Matrix of Basic Year

The estimation of the trip production and distribution in basic year (2018), from every zone in the study area, uses the traffic data approach. In the process, the prior matrix in the pcu/hour unit is charged on the basic year road network model. The form of the road production in the study area in the basic year (2018) is shown in the OD Matrix as on Table 2.

Table.2: The OD Matrix of the Basic Year (2018) in Peak Hour (pcu/hour)

No.	Destination / Origin	1 Banjarbaru	2 Cempaka	3 Taruna Bhakti	4 Merdeka	5 Amanah Park	6 Palam	7 CMC (Distrik 4)	Total
1	Banjarbaru	0	173	10	6	2	28	0	219
2	Cempaka	149	0	38	10	4	14	0	215
3	Taruna Bhakti	12	10	0	32	23	31	0	108
4	Merdeka	8	14	21	0	12	70	0	125
5	Amanah Park	0	4	7	10	0	36	0	57
6	Palam	20	40	36	74	16	0	0	186
7	CMC (Distrik 4)	0	0	0	0	0	0	0	0
	Total	189	241	112	132	57	179	0	910

To show the linkage among the zones within the study area, the OD Matrix of basic year (2018) is pictured in the form of desire lines as served in Figure 7.

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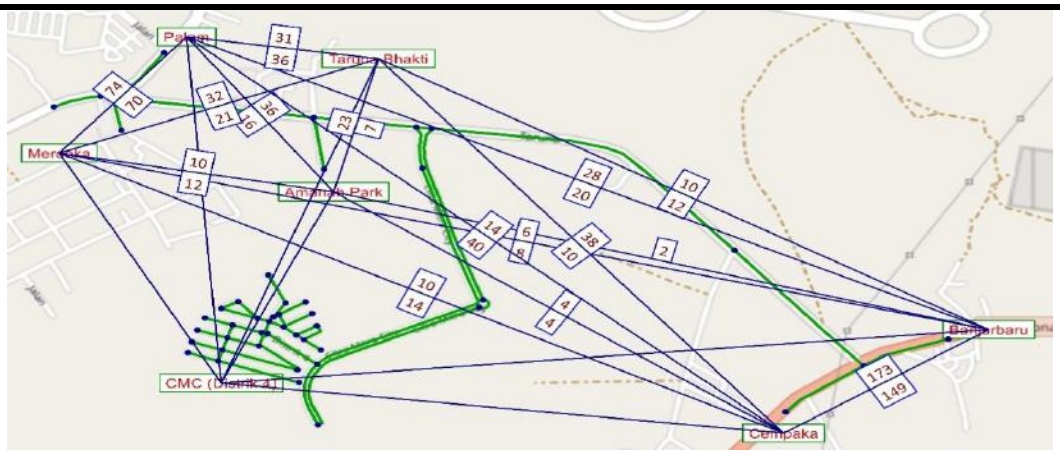

Fig.7: Desire Lines Movement

4.3.2 OD Matrix during Construction

The production and attraction of this goods vehicle are obtained based on the used components namely the number of project workers, and the operational of project vehicle or the project material vehicle, as on Table 3.

Table.3: The Vehicles Used during the Construction

No	Vehicle Type	Amount	pce	Volume (pcu)
1	Motorcycle	40	0,3	12
2	Car	6	1	6
3	Dump Truck	6	1,5	9
	Total			**27**

Below are the distributions of the trip origin/destination during the development as seen on Table 4.

Table.4: The OD Matrix during the Construction in Peak Hour (pcu/hour)

No.	Origin \ Destination	1 Banjarbaru	2 Cempaka	3 Taruna Bhakti	4 Merdeka	5 Amanah Park	6 Palam	7 CMC (Distrik 4)	Total
1	**Banjarbaru**	0	173	10	6	2	24	4	219
2	**Cempaka**	149	0	38	10	4	14	0	215
3	**Taruna Bhakti**	12	10	0	32	23	29	2	108
4	**Merdeka**	8	14	21	0	12	65	0	120
5	**Amanah Park**	0	4	7	10	0	25	5	51
6	**Palam**	20	40	36	74	16	0	16	202
7	**CMC (Distrik 4)**	0	0	0	0	0	5	0	5
	Total	189	241	112	132	57	162	27	920

4.3.3 OD Matrix during Post-Construction

The analysis of the trip production model, which comes from the research object, uses the ITE method with based on the land use type and the activity intensity of a region; the trip production rate is carried out to obtain the value of the trip production level of a region. The procedure used for the analyzing is the ITE (Insitute of Transportation Engineer) method [10], by estimating the land area of a study area in a certain period of time, by not looking too many influenced factors. It is then compared to a variable which becomes the bases (land area, etc.) as on Table 5.

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Table.5: The Attraction and Production of the Comparative Objects [10]

No	Type of Land Use	Morning Peak		Afternoon Peak	
		Enter	Exit	Enter	Exit
1	Office Space (pcu/100m² gross area)	1,17	0,46	0,50	1,19
2	Shopping Center (pcu/100m² gross area)	0,17 (0,25)*	0,08 (0,25)*	0,68 (1,45)*	0,81 (1,68)*
3	Hotel (pcu/room total)	0,32	0,21	0,27	0,27
4	Residential (pcu/unit)	0,06	0,25	0,25	0,12
5	Apartment (pcu/unit)	0,2	0,38	0,29	0,20
6	School (pcu/100m² gross area)	0,16	0,13	0,21	0,17
7	Hospital (pcu/100m² gross area)	0,37	0,26	0,29	0,28
8	Warehousing	0,32	0,38	0,36	0,39

Table.6: The Calculation of the Building Production and Attraction

Land Use	Unit	Info	Vehicle Total (pcu/hour)		Production/Attraction Rate	
			Enter	Exit	Enter	Exit
Citra Mitra City Residence District 4 DEEPDENE	310	Unit	19	78	0.06	0.25

The form of the OD Matrix during the Post-construction is shown on Table 7.

Table.7: The OD Matrix during the Post-construction in Peak Hour (pcu/hour)

No.	Destination / Origin	1 Banjarbaru	2 Cempaka	3 Taruna Bhakti	4 Merdeka	5 Amanah Park	6 Palam	7 CMC (Distrik 4)	Total
1	Banjarbaru	0	183	11	6	2	26	6	234
2	Cempaka	158	0	40	11	4	15	3	231
3	Taruna Bhakti	13	11	0	34	24	31	0	113
4	Merdeka	8	15	22	0	13	69	0	127
5	Amanah Park	0	4	7	8	0	26	0	45
6	Palam	15	38	34	72	17	0	10	186
7	CMC (Distrik 4)	29	10	4	8	0	30	0	81
	Total	223	261	118	139	60	196	19	1016

4.3.4 OD Matrix During 5-year of Post-Construction

The next 5-year of the post-construction production projection (assuming 2-year development) is used the Detroit approach method due to the inhomogeneous of the growth factor of all zones. Such form of the OD Matrix 5 years later is shown on Table 8.

Table.8: The OD Matrix of the 5-year post-construction in the Peak Hour (pcu/hour)

No.	Destination / Origin	1 Banjarbaru	2 Cempaka	3 Taruna Bhakti	4 Merdeka	5 Amanah Park	6 Palam	7 CMC (Distrik 4)	Total
1	Banjarbaru	0	211	12	7	2	30	7	269
2	Cempaka	182	0	45	12	5	17	4	265
3	Taruna Bhakti	15	12	0	39	28	35	0	129
4	Merdeka	10	17	25	0	14	79	0	145
5	Amanah Park	0	5	8	10	0	30	0	53
6	Palam	17	43	39	83	19	0	11	212

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7	**CMC (Distrik 4)**	33	12	5	10	0	34	0	94
	Total	257	300	134	161	69	225	22	1168

4.4 Road Network Performance Simulation

By considering the valid network system to every road section, the traffic tripin the form of OD Matrix, and the road capacity of each observed road section, then by using the VISUM Software, the performance value and the traffic flow tripcan be obtained, as shown in Figure 8 until Figure 11. Further, the LOS value of every section is recapitulated as described on Table 9.

4.5 Results Discussion

4.5.1 Impact Forecast

The evaluation of the impact on the road section can use the indicator of the occurred Degree of Saturation (DS). From the results of the analysis of road network for those four conditions, the changes of the DS for each condition can be seen as on Table 9.

Fig.8: LOS and the Amount of the Traffic Flow of the Road Section at Existing Condition at Peak Hour

Fig.9: The LOS Simulation and the Amount of the Traffic Flow of the Road Section during the Development at Peak Hour

Fig.10: The LOS Simulation and the Amount of the Traffic Flow of the Road Section of Post-development at Peak Hour

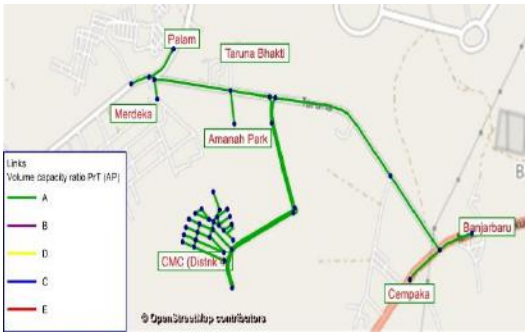

Fig.11: The LOS Simulation and the Amount of the Traffic Flow of the Road Section of the 5-year Post-development at Peak Hour

Table.9: Changes of the DS Value

No.	Road Section Name	Degree of Saturation (DS)				LOS
		Existing Condition	Development Condition	Post-development Condition	Condition after 5 Years of Post-development	
1	Street of Mistar Cokrokusumo (Banjarbaru)	0,15	0,15	0,16	0,16	A
2	Street of Mistar Cokrokusumo (Cempaka)	0,17	0,17	0,18	0,18	A
3	Street of Taruna Bhakti	0,14	0,14	0,15	0,15	A
4	Street of Merdeka	0,19	0,19	0,2	0,2	A
5	Street of Purnawirawan	0,14	0,14	0,15	0,15	A
6	Street of Palam	0,06	0,06	0,08	0,08	A
7	Street of Citra Mitra City	0,01	0,01	0,18	0,18	A

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Almost all observed road sections experience DS value reduction as the impact of the development and the growth of the existing traffic flow. The largest DS value reduction is experienced by the segment of the street section of Citra Mitra City as much as 0.17; and in other road sections, the DS value reduction is as much as 0.01; the LOS value does not experience any change, and remains having the LOS A.

4.5.2 Handling Implementation

From the DS value of every condition, and concerning the criterion limit of the allowed DS value, then generally the road sections in the observed area are still below the required limit value for the handling (> 0.75). Furthermore, the correlation of the DS value for those four conditions, towards the required limit value, is illustrated as in Figure 12.

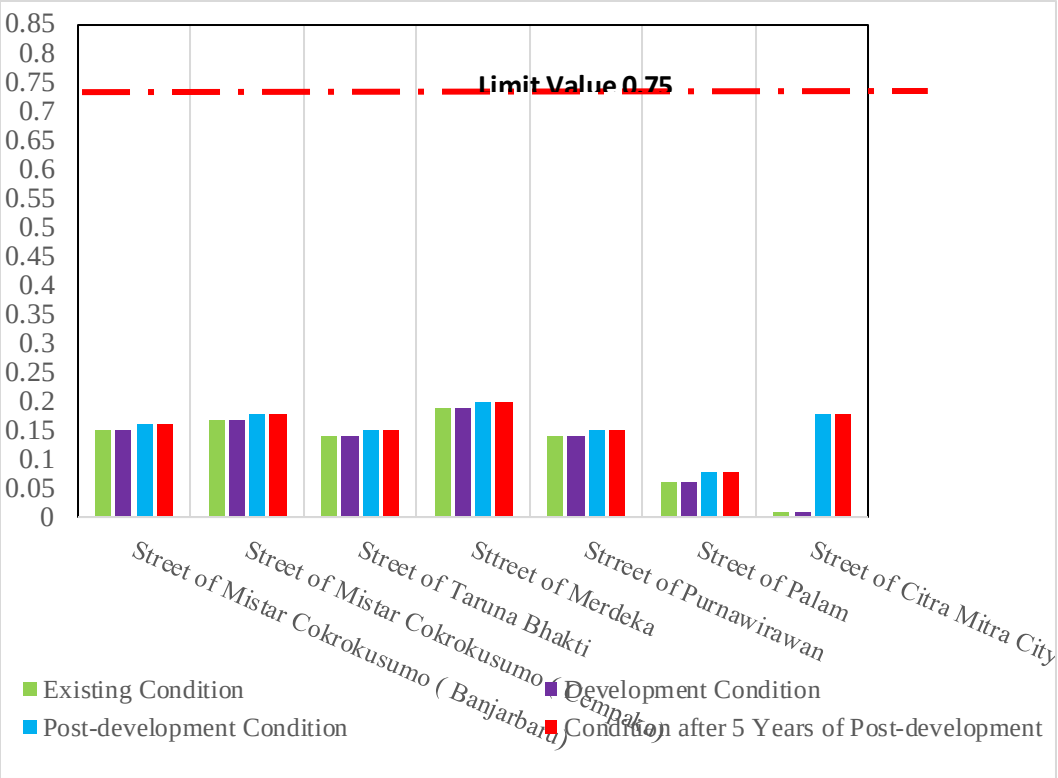

Fig.12: The DS Values of Each Condition towards the Limit Value of Handling

All the DS values of the observed road section are below the limit value (< 0.75), and this hints that no handling is needed in those road section.

4.5.3 Traffic Impact Prediction

From the results of the traffic impact analysis, along with the development of the Citra Mitra City Residence Distric 4 DEEPDENE, it can be obtained up to 5 years of post-construction. With the largest DS value of 0.20, a sequel analysis needs to be carried out to obtain the time where the observed road sections need the handling. In this analysis, assuming there is no additional number of housing, and the surrounding condition is normal/existing, the traffic condition is normal, and the traffic growth rate uses the growth rate as on Table 10.

Table.10: Growth Rate

	Zone	Growth	
		i	60
1	Banjarbaru	2.95	5.72244
2	Cempaka	2.77	5.15207
3	Taruna Bhakti	2.77	5.15207
4	Merdeka	2.77	5.15207
5	Amanah Park	2.77	5.15207
6	Palam	2.83	5.33568
7	CMC (District 4)	2.77	5.15207

Based on the analysis results, it can be obtained that the traffic impact of that development occurs in 60 years from the post-construction. The production projection in the next 60 years uses the approaching method of Detroit since the growth factors of all zones are non-homogeneous. The form of the OD Matrix in the next 60 years is shown on Table 11.

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Table.11: The OD Matrix, 60 years of the post-construction at Peak Hour (pcu/hour)

No.	Origin \ Destination	1 Banjarbaru	2 Cempaka	3 Taruna Bhakti	4 Merdeka	5 Amanah Park	6 Palam	7 CMC (Distrik 4)	Total
1	Banjarbaru	0	948	66	38	13	160	36	1260
2	Cempaka	819	0	171	43	18	64	12	1127
3	Taruna Bhakti	76	43	0	159	116	152	0	546
4	Merdeka	50	60	108	0	60	340	0	618
5	Amanah Park	0	17	36	40	0	133	0	227
6	Palam	95	167	177	363	87	0	45	933
7	CMC (Distrik 4)	161	41	19	37	0	139	0	397
	Total	1200	1275	577	680	294	987	93	5107

At the same time, with the similar way, the value of the road network performance in the 60 years of post-development can be simulated as shown in Figure 13.

Fig.13: The LOS Simulation and the Amount of the Traffic Flow of Road Section, 60 Years of Post-development at Peak Hour

The LOS value for every observed section in that area in the projection year (after 60 years) due to the traffic flow growth, and the operated housing are recapitulated as described on Table 12.

Table.12: The LOS of the Observed Sections at Peak Hour, 60-year Condition of Post-Development

Section	DS	LOS
Banjarbaru	0.85	D
Cempaka	0.88	D
Taruna Bhakti	0.64	C
Merdeka	0.66	C
Purnawirawan	0.32	B
Palam	0.39	B
Citra Mitra City	0.18	A

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In terms of the occurred VC ratio value in the road sections of the 60-year post-development, the VC ratio which exceeds the limit of ≤ 0.75 is in the section of Street of Mistar Cokrokusumo, with the value of VC Ratio of 0.85 – 0.88; the section of Street of Taruna Bhakti is in the value of VC ratio of 0.64; thus, there needs handling in the sections of Street of Mistar Cokrokusumo and Street of Taruna Bhakti.

The analysis results per 5 years can be seen in Figure 14.

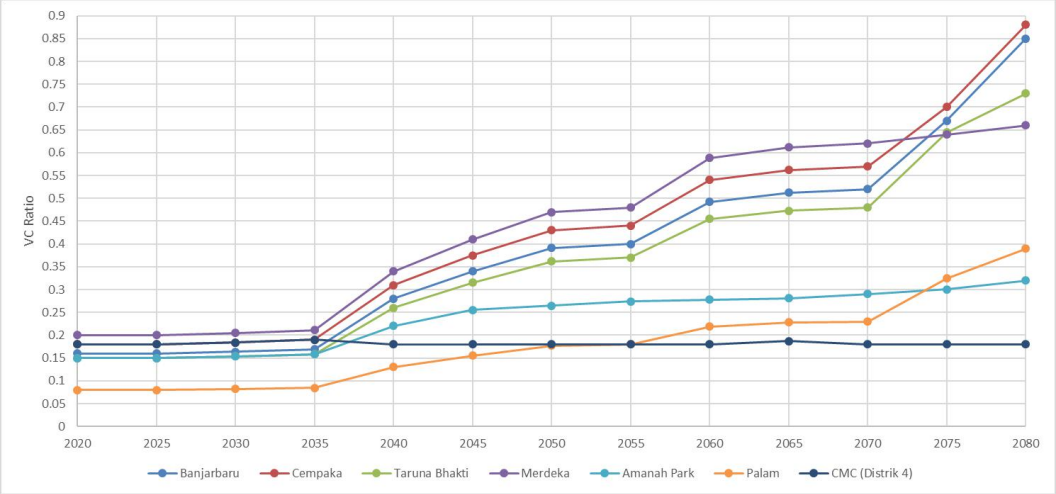

Fig.14: The Increment of VC Ratio per 5 years

V. CONCLUSION

The performance of the existing traffic in all observed road sections was still in the good category, which was reviewed from the value of VC Ratio ranged between 0.01 – 0.19, or in other words, the LOS showed the A value. The identification of the traffic impact, from the housing development to the traffic Assignmentin the road sections around the housing location, was carried out in three conditions namely in a condition during the development, in a condition after the development, and in a condition after 5 years of the development. From the analysis results, that in the condition during the development, the performance in terms of the LOS value in all road sections had a value of A, along with the VC Ratio which experienced changes ranged around 0.01 – 0.02 from the existing condition. In the condition of post-development and 5 years of post-development, the performance in terms of the LOS value in road section had a value of A, along with the VC Ratio which experienced changes of 0.01 – 0.17 from existing condition. It can be concluded based on the analysis results that the road sections around the housing development did not experience the traffic Assignmentimpact which led to the degradation of the road section performance. The traffic impact in the observed Road sections existed in the 60 years of post-development, for the VC ratio was on the value of 0.99, and the LOS was D.

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Principles of the Law of Universal Gravitation Applied to the Potential to Attract People

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Abstract**—** *Principles of the law of universal gravitation applied to the potential to attract people. This work discusses the association of the Law of Universal Gravitation to estimate the potential to attract people by municipality, aiming to investigate regional economic dynamics. Such conceptions were applied in an experiment involving information of the flows of passengers in the intercity public transportation in the Second Paraná Plateau, State of Paraná, Brazil, besides economic factor of the regions. The flows observed in the intercity public transportation are proportional to the size of the population masses and inversely proportional to the distance that separates the municipalities. Therefore, according to the Law of Universal Gravitation, the larger the population in the municipality and the more centralized the force, the greater the potential to attract people. However, with the exhaustion of the production factor land in the central location, occurs greater use of this factor than other places, resulting in an increase in prices in areas adjacent to or closer it. Other associations are also presenter in this paper, including applications of the law of universal gravitation in studies of regional economic dynamics.*

Keywords**— Central location, population masses, population distances, regional economy.**

I. INTRODUCTION

The idea of associating the Law of Universal Gravitation with travel distribution emerged with the American sociologist and economist Henry Charles Carey between 1858 and 1859 when he suggested that the phenomena of migration followed the laws of Newtonian physics. In which the number of people "attracted" or migrating to a given region (M_{ij})is proportional to the product of the two populations P_i and P_j and inversely related to the distance between them.

However, it was with the theories of the Laws of Migration (1888/89) of the English geographer and theorist Ernest Raveinstein (1834-1913) that the idea that migration was governed by the "push-pull process". It means unfavorable conditions in one place (lack of employment, few development opportunities, bad governments) pushed people to other places (chances of getting jobs, better living standards) and associated distance as an impedance factor for this process, so Carey's ideas began to gain more strength and meaning in the field of applied social sciences.

Raveinstein established the theory of human migration in the 1880s, which is still the basis for the theory of modern migration.He considered the implications of distance and different types of migrants, with women more likely than men to migrate within the country of their birth, but less likely than men to leave the country of their birth.

In 1931, William John Reylli published at the University of Texas the work "The Law of Retail Gravitation" in which applying Newton's theory explained the patterns of interaction of the retail trade.Some principles formulated by Reilly were thus denominated: a) the attraction of customers varies directly with the population of the area in which the retail is; b) the attraction of customers varies inversely with the square of the distance to be covered by them; c) a city of greater population attracts the consumption of a smaller locality, in the direct proportion of the number of inhabitants; d) a city with larger population attracts the consumption of a smaller locality, in the inverse proportion to the square of the distance between them.

In 1955, with the consolidation of traffic engineering with the work published by HJ Casey ("Applications to traffic engineering of the Law of retail gravitation") that adapting the researches of Reylli and of other scholars, analyzed the flow of purchases in the retail trade between several cities. Several further researches were carried out after Casey's work. However, the work developed by Voorhees showed that although the

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principle of the Law of Universal Gravitation could be applied in the distribution of trips, the measure of attractiveness of a zone and the exponent of the distance factor varies with the purpose of the trip (BRUTON, 1979).Therefore the model proposed by Henry Carey was considered a very simplistic analogy with the Law of Universal Gravitation and there were soon improvements, falling in the form that is used today.

Then, anchored in the ideas of Ernest Raveinstein and the mathematical improvements of Voorhess and coming to understand the transit as a huge set of migratory flows (pendular movements). It is considered to apply the Gravitational Model to measure the number of trips attracted between two or more entities (neighborhoods, cities, states, regional, and towns) and with this tool can start urban and regional planning.It also opens the possibility of understanding the origin of social, economic and environmental problems, among others.

In this way, a new concept of planning arises, where the gravitational equation tends to be calibrated within the municipality in favor of being able to attract the population that today lives in pendular movement with the more developed cities where specialized products and services are offered.According to Richardson (1975), although several uses have been suggested for models of this nature, the vast majority of applications have been related to retail trend forecasts or intercity travel patterns.These Gravitational Models can provide a universal approach to the interpretation of nodal regions.

Gravitational models are related to the idea of pole of attraction or development.Thus, for Arango (2000) the location could be explained by the distance to a pole of attraction and its importance, which would function as a mass analogy in Newton's Universal Gravitation Model. In the case of space economy, this type of model suggests a strong emphasis on distance and market size.

"The gravitational model is a heuristically derived expression for synthesizing travel exchanges" (Hutchinson, 1979).According to Clemente (1994), the analogy called the gravitational model consists of considering the intensity of flows between two places instead of forces of attraction and replacing the concept of mass of bodies with some indicator of size of places.

According to Meyer (1971), for gravitational models in urban transport analysis, the transit between two points must be hypothetically positively related to the mass at each point and in a negative way to the friction. Friction can be measured in terms of distance, time, cost and various other factors.Likewise, mass has been defined as population, number of car owners.

According to Isard (1975), the working day and other travel patterns in a given region can develop a model of gravity.The author comments that in respect to the working day, or "commuting fields," this set fits into the general class of space phenomena that involve movement and communication over space.In addition, there is a general pattern for many diverse and important communications and movements of populations.

According to Isard (1975), in this case, the predicted number of trips must correspond to the real numbers of trips. Assuming, measure the number of actual trips along the horizontal axis and predict the number of trips along the vertical axis.Then, for the pair of subareas, "A" and "B", you can draw on the figure that indicates both the actual number of trips originating from "A" and ending with "B" and the theoretical number predicted by the formula. For the author, "if the theory is good, the real and predicted numbers should be the same, or roughly."

Isard (1975) comments that this type of relationship has been found, in his studies, may be valid not only for transportation, but also for intrametropolitan rail travel, plane travel, and bus travel between pairs of cities, for movement of commodities, such as by rail express, by communication phenomena such as telephone numbers and telegrams between city pairs. His studies can even be valid for many other types of goods, people and movements of ideas, such as the dissemination of rumors, circulation newspapers, and the diffusion of innovations.

According to Isard (1975), as with gravitational phenomena in physics, we are not able to explain the spatial interaction phenomena of the journey to work and the relationship in the social world. We can only speculate on the "why" of them.

Isard (1975) argues that cities with high incomes and education generate more air travel, express train shipments, letters, telephone calls, telegrams, and other communications when compared to low-income, lower-education cities.

Several authors have used the gravitational model as a data analysis tool to explain their research.Portes and Rey (2005) and Head and Ries (2008) using the gravitational model observed that a large part of foreign direct investment (FDI) takes the form of mergers and acquisitions.For Vietze (2008), in social phenomena, the dependent variable is the interaction force between two social elements that would represent the "masses" in Newton's traditional model.These social elements could be: the population, the GDP, the quantities of beds available in hotels, the amount of food companies, educational institutions, and finally any kind of social element.

Družić, Anić and Sekur (2011) observed that the use of relatively simple and easy to obtain data, such as GDP and distance, made the gravitational model particularly popular in explaining the trade patterns of economies in transition, which lack more data

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sophisticated and longer series on foreign trade.Arkolakis, Costinot and Rodríguez-Clare (2012) investigated how micro-level data have had a profound influence on trade research in the last ten years. Nijkamp (2013) addresses the validity of Newton's law of universal gravitation in the emerging world.Schneider et. Al. (2016) observed the potential of attracting people by municipalities.Allen, Arkolakis, and Takahashi (2017) propose a new strategy to estimate the gravity constant using an instrumental variable approach that is based on the overall equilibrium structure of the model.Chaney (2018) studied bilateral international trade.

Thus, through these various researches, the potentiality of applying the model to explain several aspects of the economic dynamics is evidenced. In this way, the purpose of this study was to associate the Law of Universal Gravitation to estimate the potential of attraction of people by municipality, aiming to investigate regional economic dynamics.

II. MATERIALS AND METHODS

2.1 SELECTION OF THE STUDY LOCATION

This research was developed in the region of Second Paraná Plateau, state of Paraná, Brazil.In the experiment we observed in particular the municipalities of Telêmaco Borba, Ortigueira, Sapopema, Curiúva, Figueira, São Jerônimo da Serra, Imbaú, Reserva, Tibagi and Ventania.

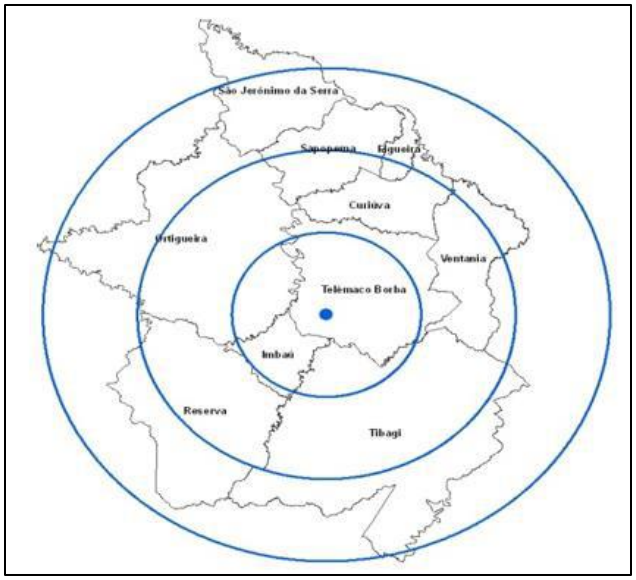

Fig.1: Municipalities of the region Second Plateau of Paraná.

Why was this region chosen in the state of Paraná?The main reason for the choice of this region is that the economy of the region presents itself in a diversified way, highlighting the timber sector, assuming that the municipality of Telêmaco Borba was initially driven by the activity of pulp and paper process wood, located there, and later the Forest Activity was disseminated to the neighboring municipalities.In view of this context, it is worth mentioning Myrdal's brief quotation (1957), "from an initial agglomeration, a region in which economies of scale and technological development existed would attract new resources that would reinforce its expansion."

2.2 GRAVITATIONAL MODEL TO EXPLAIN THE POTENTIAL OF ATTRACTION IN MUNICIPALITIES

In the application of the model proposed by Isard (1975), the distances between the studied municipalities, their respective populations and the flows of passengers in the year 2010 in intermunicipal collective transport were used.The mass of the gravitational model in the present study corresponds to the variable population (P_i). The data come from the censuses conducted in the year 1991, 2000 and 2010 by the IBGE.To compose the original Gravitational Model, the values of the distance (d_{ij}, in kilometers) between the municipalities were provided by the Department of Roads and Drive of the State of Paraná (DER / PR, 2010).

The number of journeys made in the study area originated from the data observed by DER / PR (2010), and it corresponds to the number of intermunicipal trips made in intercity public transportation, among the municipalities of the region in 2010. Among the 90 possibilities of flows, 43 were obtained, since the rest did not occur, due to the lack of regular and direct lines of intermunicipal collective transportation among some municipalities.It was observed that on the sample was 309,079 displacements in the year 2010.

The study has the characteristics of being exploratory, with a quantitative approach from secondary data. For the application of the model proposed by Isard (1975), the distances between the municipalities, their respective populations and the flows of passengers observed in the intermunicipal collective transport were used.

Thus, according to Newton's proposals, the value of the force of attraction (F) is directly proportional to the masses of the two bodies and is inversely proportional to the square of the distance between them.The forces appear in pairs, that is, if one body attracts another, it is also attracted by the first.In the present study, the constant (G) represents a correction factor between the mass units and the distance that separates it.

With all the variables and constants obtained through these mathematical procedures, the model developed by Isard (1975) was applied to obtain a new flow estimated by the gravitational model of the displacements of the people through intermunicipal collective transportation.As such, it is expressed by:

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$$I_{ij} = G \frac{P_i * P_j}{(d_{ij})^b} \quad (1)$$

In which:I_{ij} = Estimated flow; G = Correction factor; P_i = Population ofi; P_j = Population ofj; d_{ij} = distance between i and j; b = exponential coefficient

In order to determine or estimate the Potential of Attraction (V_i) of the municipalities of the Second Parana Plateau, the Principle of Superposition was observed.This means that when two or more waves propagate simultaneously in the same medium and instant and in the same direction, it is said that there is a superposition of waves.The resulting wave is equal to the algebraic sum of the waves that each would produce individually. This principle can be applied to obtain a resulting scalar magnitude.Thus, considering passenger flows in inter-municipal collective transport, such as waves, the greater the volume and intensity of these flows to the same municipality, the greater its potential attraction (V_i).

According to Schneider et.al. (2016), two interpretations can be given to the concept of attraction potential (V_i). On the one hand, it is a measure of their influence or impact on point i, and the set of masses distributed in space i itself.On the other hand, it is a measure of accessibility of point i to the set of masses distributed in the space under study.In this way, the greater the intensity at point i, when compared to the other points, the greater its attraction potential (V_i)

In this context, the interaction (or flow) between points *i*andjestimated by the presented model can be calculated in order to obtain the interaction between i and all points j, which represents the attraction potential (V_i) of point i. It should be noted that the attraction potential (V_i) of point i is equal to its own mass (P_i), plus the masses of the remaining points, each corrected by its distance i, multiplied by a constant (G). As described, the interaction between i and*j*is expressed by:

$$V_i = 1 + (I_{i1} + I_{i2} + I_{i3} + \cdots + I_{in}) \quad (2)$$

In which:V_i = Potential of Attraction of the municipality *i*;I_{i1} = Estimated flow from municipality 1 to*i*;I_{i2} = Estimated flow from municipality 2 to *i*;I_{i3} = Estimated flow from municipality 3 to*i*;I_{in}= Estimated flow of the municipality*n* to*i*.

The first approach was made using the original gravitational model by means of the original intermunicipal collective transport called the gravitational model 1, observing the data referring to the population in the year 1991 and the observed flows (I_{ij}) in the year 2010 and the respective distances between municipalities.

The gravitational model 2 was observed to the population in the year 2000 and the flows in the intermunicipal collective transport in the year of 2010.The gravitational model 3 was observed in the population in the year 2010 and the observed flows(I_{ij}) in the same period.In all the adjustments made it was estimated the potential of attraction (V_i) of people through the proposed method.

The adjusted models were evaluated using the coefficient of adjusted determination, F statistic and standard error in percentage.

III. RESULTS

When comparing the three situations, the gravitational models presented the same coefficient of determination (R^2) (TABLE 1). The gravitational model 3 presented the best R^2 (0,7287) and the gravitational model 1 the largest F (110,16).

The coefficient $b_1$is directly related to the friction that the distance gives to the displacement of the people, be it friction of physical, psychological, behavioral order, among others.In the gravitational model 1 (b_1 = -3,189), the population presented greater elasticity in relation to the friction relative to the distance to be traveled in their movements or trips between the municipalities (TABLE 1).On the other hand, in the gravitational model 3(b_1 = -3,087), it was less elastic to the displacements.

Table.1: Adjustment statistics of the models referring to the flows of displacements and distance between the municipalities of the region of the second Parana plateau

TEMPLATE	R^2	S_{xy}%	F	b_0	b_1
Gravitational model1	0,7281	16	110,16	5,24	-3,189
Gravitational model2	0,7247	17	107,98	5,06	-3,092
Gravitational model3	0,7287	17	109,80	5,05	-3,087

Among the constants calculated in the three different situations, the gravitational model 1 obtained the highest constant k (1.71), that is, the largest mean displacement per individual (TABLE 2).

When the correction factor (G) is analyzed, it was observed that in the situation of the gravitational model 1, the correction factor had a higher value (1.63) when compared with the other situations under analysis (TABLE 2).This factor caused an increase in the

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magnitude of the quotient between the product of the masses and the distance that separates them.This factor provided a better fit in the gravitational model so that the equality between the estimated flux quantities (I_{ij}), the magnitude of the quotient between the size of the masses and the distances separating them would occur.

Table.2: Constants of the gravitational model of passenger displacements in intermunicipalities collective transportation in the Second Plateau of Parana

TEMPLATES	K	Correction factor (G)
Gravitational model1	1,71	1,63
Gravitational model2	1,65	1,01
Gravitational model3	1,55	0,87

It was observed in gravitational model 1; the correction factor was higher when compared to the other situations.The correction factor (G) in the gravitational model 3 was 0.87, that is, this factor caused a decrease in the magnitude of the quotient between the size of the masses and the distance separating them.This factor provided the equality between the analyzed quantities.In this specific situation, it can be affirmed that the population increase (1991/2010), has made the factor, over time, decrease. In 1991, the correction factor was higher when compared to the other situations, because the estimated flows (I_{ij}) were greater than the quantity of the quotient between the size of the masses and the distance that separates them.

When the gravitational model 2 is observed, this factor was equal to 1.01, that is, in this situation the estimated flows (I_{ij}) were equal to the magnitude of the quotient between the size of the masses and the distance separating them.In this case, it is true to say that the flow of people in the intercity bus service of the region of the Second Parana plateau is directly proportional to the size of the populations of the respective municipalities and inversely proportional to the distance that separates them. In this model we can observe a perfect situation with regard to the law of physics, developed by Isaac Newton, where the force of attraction between two bodies is directly proportional to its size and inversely proportional to the square of the distance that separates them.

When the regression of the gravitational model 1 was performed, the equation obtained was:

$$\text{Log } (I_{ij}/T_{ij}) = 5{,}2371 - 3{,}1889 \text{ Log } (d_{ij}) \qquad (3)$$

The estimated flows(I_{ij}) in the intercity bus service should occur in less quantity than was observed for the equilibrium between the two sides of the equation to occur. The correction factor provided an increase in the value of the quantity of the quotient between the size of the masses and the distance that separates them, so that the mathematical equality occurred in the gravitational model.

The adjusted gravitational model can then be written as:

$$I_{ij} = 1{,}63 \frac{P_i * P_j}{(d_{ij})^{3,18}} \qquad (4)$$

With respect to the attraction potential(V_i),that is, an attraction capacity of each municipality in the region can be represented by the equation:

$$V_i = 1{,}63 * P_i + 1{,}63 * \frac{P_i * P_1}{(d_{i1})^{3,18}} + 1{,}63 * \frac{P_i * P_2}{(d_{i2})^{3,18}} + \cdots + 1{,}63 * \frac{P_i * P_n}{(d_{in})^{3,18}} \qquad (5)$$

When the regression of the gravitational model 2 was performed, the equation obtained was:

$$\text{Log } (I_{ij}/T_{ij}) = 5{,}0558 - 3{,}0921 \text{ Log } (d_{ij}) \qquad (6)$$

In this specific case, the magnitude of the quotient between the size of the populations and the distance that separates them are in equilibrium or in equality with the estimated flows (I_{ij}) occurred in the municipality of the Second Plateau Paranaense.

The estimated flows (I_{ij}) in intermunicipal collective transport occur in quantities identical to what was observed, so it can be said that a balance exists between the two sides of the equation.The correction factor does not provide correction between the two sides of the mathematical equation, and it can be said that the estimated flows (I_{ij}) are directly proportional to the size of the masses (population) and inversely proportional to the distance that separates them.

The adjusted gravitational model can then be written as:

$$I_{ij} = 1{,}01 \frac{P_i * P_j}{(d_{ij})^{3,09}} \qquad (7)$$

With respect to the attraction potential (V_i), that is, the attractiveness of each municipality in the region can be represented by the equation:

$$V_i = 1{,}01 * P_i + 1{,}01 * \frac{P_i * P_1}{(d_{i1})^{3,09}} + 1{,}01 * \frac{P_i * P_2}{(d_{i2})^{3,09}} + \cdots + 1{,}01 * \frac{P_i * P_n}{(d_{in})^{3,09}} \qquad (8)$$

When the regression of the gravitational model 3 was performed, the equation obtained was:

$$\text{Log } (I_{ij}/T_{ij}) = 5{,}0505 - 3{,}087 \text{ Log } (d_{ij}) \qquad (9)$$

The estimated flowsI_{ij}in intermunicipal collective transport should occur in less quantity than was observed for the equilibrium between the two sides of the equation to occur.The correction factor provided an

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increase in the value of the quantity of the quotient between the size of the masses and the distance that separates them so that the mathematical equality occurred in the gravitational model.

The adjusted gravitational model can then be written as:

$$I_{ij} = 0{,}87 \frac{P_i * P_j}{(d_{ij})^{3,08}} \qquad (10)$$

With respect to the attraction potential (V_i), that is, the attractiveness of each municipality in the region can be represented by the equation:

$$V_i = 0{,}87 * P_i + 0{,}87 * \frac{P_i * P_1}{(d_{i1})^{3,08}} + 0{,}87 * \frac{P_i * P_2}{(d_{i2})^{3,08}} + \cdots + 0{,}87 * \frac{P_i * P_n}{(d_{in})^{3,08}} \qquad (11)$$

IV. DISCUSSION

Observing the configuration of the attraction potential distribution (V_i) of people in the municipalities of the Second Paraná Plateau, this refers to the theory proposed by Chirstaller (1966), where the author sought to understand the laws that determine the number, size and distribution of cities, which, according to him, are known as central places. In this case, the municipality of Telemaco Borba is characterized as the main nucleus and the neighboring municipalities as a complementary region.Therefore, a nodal or polarized region behavior is observed.

The spatial distribution of the municipalities of the Second Paraná Plateau results in an economic space organized around a main urban nucleus.Observed in this perspective, the spatial distribution of the population can be considered as being in a hierarchical system and with the most varied functional connections, providing a hierarchical system of the attraction potential (V_i) of people proportionally identical to the population distribution.

The region of the Second Parana plateau, Telêmaco Borba is the dominant center with the largest population, and in its surroundings gravitate flows of populations, goods and services, communication and traffic contemplating the complementary region.The proportional centrality of the population of Telemaco Borba determines the centrality of the attraction potential (V_i) of people, making this potential more intense in the regions closer to the center due to distance factor, when compared to municipalities more distant from the central place.

In this context, the theory proposed by Hirshman (1958) is emphasized, based on the assumption that economic progress does not occur everywhere at the same time and that, once it has occurred, certain forces provoke a spatial concentration of economic growth, around the points where the process begins.

According to Schneider et. al. (2018), among the factors that make up the economic activities of cities, the Gross Value Added to industrial activity offers the best potential to attract people (V_i).

The municipality of Telêmaco Borba was initially driven by the activity of process wood for paper, and later for pulp.Due to the demand generated by this process, Forest Activity (forest plantations) was first disseminated in the municipality of Telêmaco Borba and later to the nearest municipalities.

This process of development of the central place began in the 1950s, and intensified in the 1980s, with APL installed in the municipality.Forest plantations for commercial purposes in Telêmaco Borba and neighboring municipalities (Imbaú, Curiúva and Ventania) increased as a result of fiscal incentives for reforestation in the 1970s, in order to increase the supply of wood.

The neighboring municipalities, or closer to the central place, when compared with the more distant municipalities, benefit because of the decrease of the friction regarding the distance between them and the central place.Thus, the greater the increase of the benefits pertinent to this potential and consequently an increase occurred in the population of these municipalities.The more distant ones lose the potential of attraction(V_i) of people to the central place, provided a diminution of that potential over time, when compared to those closest to the center of attraction.During this period, a policy of private forestry development was developed in the region of the Second Parana Plateau, called Fomento Florestal, with the purpose of increasing the supply of reforested wood in the region and, consequently, the development of the municipalities closest to Telêmaco Borba due to the lack of the "land" factor in the central place.

According to Richardson (1973), in his proposed theory, the movements of the factors of production may not be balanced, and the backward or less developed counties suffer from capital flight as well as emigration.From this point of view, the behavior of the attraction potential (V_i) of people from the most distant municipalities of the central place tended to lose strength due to the emigration occurring in the municipalities of Ortigueira, São Jerônimo da Serra, Figueira and Sapopema due to the decrease in opportunities for the population of these municipalities.

This characteristic of production factors movement is due to the opportunities generated in the central place.Thus, the greater the centrality of a place, in this case Telêmaco Borba, the greater the surroundings, or area of influence, and the neighboring municipalities depend on the central place.In addition, the more complex the services offered, the greater will be the region served

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by this center. Thus, the larger the population, the more likely their growth rates and economic development levels are to be higher when compared to their peers.

In the region of Second Parana plateau it is noted the interdependence of economic growth between the municipalities and the central place.Telêmaco Borba has the best index regarding the number of companies, higher income per capita, more and better services, number of bank branches, number of beds, among other public or private services, generating a spatial concentration.The central place generates positive externalities for the nearest municipalities.

The spatial concentration can be understood as access to a larger market, with more abundant and more qualified labor supply, as well as the presence of commercial, banking, financial and legal facilities, among others.On the other hand, large concentrations result in pecuniary diseconomies such as elevated land values, higher rental costs, among other factors.Nevertheless, seldom do these diseconomies destroy the attraction potential (V_i) of the central place, leading to an increase in the agglomeration of the municipalities closest to the center of attraction, in this case Telemaco Borba.

This assertion is justified because, in the municipalities of Ventania, Imbaú, Curiúva and Tibagi, population growth occurred between 1991 and 2010, and consequently an increase in the attraction potential(V_i) of people. This behavior was not observed in the most distant municipalities, and São Jerônimo da Serra, Sapopema, Figueira and Ortigueira lost part of their population in the period from 1991 to 2010, and as a consequence, part of their potential to attract (V_i) people

Between 1991 and 2000, the region of the Second Paraná Plateau had the potential of attraction(V_i) of people greater than the total population of the region. Thus, it is assumed that during this period there was an intense use of the Capital (K) and Natural Resources (land) production factor, increasing the total population in the region, due to the greater availability of opportunities in the municipalities, especially in Telemaco Borba.

In the year 2000, there is a balance between the factors of production.This characteristic is linked to the meeting of the attraction potential (V_i) and the total population of the region.

In the period between 2000 and 2010, the potential of attraction (Vi) of people decreased, making it smaller than the population of the region.This feature may be associated with a decrease in the supply of factors of production, especially the "land" factor, providing a limit of growth and, consequently, stabilizing the centrality of the region.

Throughout the decades of 1991 to 2010, the potential of attraction (Vi) of people in the region of the Second Plateau Paranaense presents a line with negative slope due to the decrease of the potential of the municipalities more distant from the central place.In the year 1991, the potential had a value of 295,202.In the year 2000, this value decreased to 188,026 and in 2010 it increased to 174,236 (TABLE 03).

Differently, the total population of the region presents a positively inclined line, due to the increase in the population of Telemaco Borba and the municipalities closest to the central place.Given this scenario, it was observed that there was a population increase in the municipalities closest to Telêmaco Borba, mainly in Ventania, Imbaú and Curiúva.This characteristic may be related to the supply of the "land" production factor.In the municipality of Telemaco Borba the supply of this factor is limited, making it scarce when compared to other municipalities in the region.According to DERAL (2014), the price of mechanized land increased by 375%, from R $ 4, 400.00 per hectare to R $ 16, 500.00 between 2000 and 2010.

Table.3: Potential attraction of the municipalities of the second plateau of Paraná.

MUNICÍPALITY	1991	(%)	2000	(%)	2010	(%)
Telêmaco Borba	94.984	32,18%	61.595	32,76%	61.085	35,06%
Reserva	39.029	13,22%	24.117	12,83%	22.007	12,63%
Ortigueira	44.914	15,21%	25.363	13,49%	20.440	11,73%
Tibagi	26.820	9,09%	18.543	9,86%	16.913	9,71%
Curiúva	17.152	5,81%	12.980	6,90%	12.173	6,99%
São Jerônimo da Serra	21.678	7,34%	11.819	6,29%	9.911	5,69%
Imbaú	13.038	4,42%	9.534	5,07%	9.861	5,66%
Ventania	10.347	3,51%	8.071	4,29%	8.705	5,00%
Figueira	15.653	5,30%	9.091	4,84%	7.251	4,16%
Sapopema	11.587	3,93%	6.913	3,68%	5.890	3,38%
TOTAL	295.202	100 %	188.026	100 %	174.236	100 %

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With the public and private development policies implemented, there was an increase in the supply of raw materials, that is, with this increase of the policies, the use of the land factor in the municipalities around the central place, due to the scarcity of this resource in the municipality of Telêmaco Borba. Thus, it can be affirmed that there was an increase in the area of influence of the municipality of Telêmaco Borba, due to the increase in the radius of influence of the central place, causing an increase in the attraction potential (V_i) of people in the municipalities more near the central place. Consequently, the scarcity of the "land" factor of production, in the central place, provided new investments in the nearest municipalities.

At the outset, these investments were made in forest plantations for commercial purposes to supply the demand of the municipality of Telêmaco Borba. Moreover, in the second moment, in small and medium-sized companies, directed to forest-based products, in order to obtain the facilities and benefits from the local productive arrangement installed in Telêmaco Borba and the distance from the raw material, located there from these plantations.

In the more distant municipalities, Ortigueira, São Jerônimo da Serra, Figueira and Sapopema, there was a decrease in the total population over time. This feature is linked to the attraction potential (V_i) of people from Telêmaco Borba, causing these municipalities to lose population to the central place and to the nearest municipalities due to the rural-urban migration that occurred during the period in the region, mainly between the years 1991 and 2000. The rural population of the more distant municipalities migrated to the urban area of Telêmaco Borba and to the municipalities of Ventania, Imbaú, Curiúva.

In Reserva, an atypical situation was observed when compared with other municipalities. The municipality presented a stabilization in the population growth and, consequently, a stabilization in the potential of attraction (V_i) of people, being the second greater potential of the region. This characteristic may be related to the balance between the supply and demand of the factors of production available in the municipality, making it a "node" with less dependence on Telêmaco Borba, when compared to the nearest municipalities (Imbaú, Ventania and Curiúva) and more distant municipalities (Ortigueira, São Jerônimo da Serra, Sapopema, Figueira).

When observed the behavior of the potential attraction (V_i) of people in the region of the Second Plateau Paranaense and the individual behavior of each municipality that makes up the region, those that differed in relation to their peers were Imbaú, Ventania and Curiúva. In 1991, the municipality of Imbaú represented 4.4%, growing to 5.1% in 2000 and 5.7% in 2010. A trend of proportional potential growth has been observed in the last ten years, resulting in a positive trend when compared to the region. This feature is linked to the new investments made in the municipality, making it more dynamic with the increase of new business opportunities, services and jobs, providing a better quality of life for residents.

The municipality of Ventania obtained 3.5% of the attraction potential (V_i))ofpeople of the region in the year of 1991. In the year 2000, the potential grew to 4.3% and in 2010 was 5%. The same growth trend occurred when compared to the municipality of Imbaú. This positive trend may be due to the significant increase in the total population between 1991 and 2010, due to new opportunities in the agricultural sector developed in the municipality. These municipalities were the ones that added more population in that period due to the potential of attraction (V_i) of people.

An inverse situation occurred with Ortigueira, which in 1991 represented 15.2%, in 2000 13.5%, being the second largest potential in this period. In 2010, the potential of attraction (V_i)ofpeople in the municipality decreased to 11.7%, representing the third largest potential. Among the municipalities observed, Ortigueira showed the greatest proportionality oscillation of this index. This result is directly related to the fact that in the same period the municipality lost 14.99% of its total population, mainly between 1991 and 2000. When compared to its peers, the one lost more population in absolute numbers. This feature is linked to the reduction or non-emergence of new investments in the municipality, providing an emigration of the population to municipalities that presented new opportunities in this period.

V. FINAL CONSIDERATIONS

The flows observed in intermunicipal collective transport are directly proportional to the size of the masses and inversely proportional to the distance that separates them, and can be expressed by a central, attractive force, hierarchically organized by the size of the populations and the distances that separate them.

In gravitational modeling, the larger the population of the municipality, the greater its potential for attracting people. The municipality with the greatest potential for attracting people is Telêmaco Borba, followed by the municipality of Reserva. The municipalities highlighted in the study are Imbaú, Ventania and Curiúva, due to the greater proximity of their areas of the central region. There is an increase in the potential for attracting people over time and, consequently, an increase in the population of the respective municipalities.

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In the more distant municipalities of the central area occurs a decrease of the population, due to the proportionality of the decrease of the potential of attraction of people. These municipalities are Ortigueira, Tibagi, Sapopema, São Jerônimo da Serra and Figueira.

The population variable alone does not fully explain the behavior of people in terms of displacement in intercity bus service The model developed by Newton has as characteristic to be static and closed, demonstrating limitation in the explanation of the attractiveness of people between the municipalities. Hence, the importance in establishing the correction and weighting factors that were presented in this work.

By means of the "land" production factor, which has the characteristics of constraints, causing its exhaustion in the central place, a greater use of this factor causes a rise of the prices in the areas adjacent to or closer to the centrality, resulting in a significant increase of the potential of attracting people to these areas.

By means of the correct modifications in the gravitational model developed by Newton, presented in this work, good results are evidenced with respect to practical applications for the regional development that is, enabling to develop studies of regional economic development. Using the proposed model, future scenarios can be developed where the present scenario can be evidenced and the impact generated by new regional investments can be quantified.

In future research it is suggested to add the potential of attraction of information, replacing the flows in the intermunicipal collective transport by the flows of intermunicipal telephone calls, and, thus, to determine the degree of information generated by a certain municipality.

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Application of Weighted Total Acceleration Equation on Wavelength Calculation

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***Abstract*—*In this research, total acceleration equation is formulated where there is time scale coefficient at its time differential term. The formulation was done based on Courant Number equation and by using Taylor series. Then this total acceleration is applied to kinematic free surface boundary condition and Euler momentum equations. Potential velocity and water surface equations of linear water wave theory as well as wave number conservation equation were substituted to momentum and kinematic free surface boundary condition equations produced dispersion equation with wave amplitude as its variable and which fits with wave number conservation equation. Wave number conservation equation is an equation that regulates changes in wavelength as a result of water depth changes. This equation was extracted from potential velocity equation.*

Keywords*—*Courant Number, Taylor Series, Total Derivative, Wave Number Conservation Equation.

I. INTRODUCTION

This research aims at finding a dispersion equation with a wavelength that fits with what exists in the nature. Dispersion equation of linear wave theory (Dean, 1991), was formulated using kinematic free surface boundary condition and Bernoulli equations where this Bernoulli equation is formulated from Euler momentum equation. Both at the kinematic free surface boundary condition and Euler momentum equations there are total change term of spatial and time function.

In the formulation of total acceleration equation, it is defined that at $limdx$ and dt close to zero, $u = \frac{dx}{dt}$, where u is a velocity of material movement. Courant number in fluid mechanics (1928) stated that in order to be defined that $u = \frac{dx}{dt}$, there are certain criteria for the size of space length (dx) and time step (dt). In general, it can be stated that in order to be defined that at $limdx$ and dt close to zero, $u = \frac{dx}{dt}$, there are certain conditions.

The accuracy of Taylor series is determined not only by the number of its terms but also by its interval size. Meanwhile, Taylor series is often used only up to the first derivative where in this case, truncation error can only be reduced by reducing the size of its interval. Based on Courant criteria it is assumed that Taylor series for a spatial and time function must contain a coefficient at the time interval. Then minimizing truncation error at Taylor series obtains time coefficient value and interval size that produces the level of accuracy that fits with what has been demanded.

II. THE FORMULATION OF TOTAL ACCELERATION EQUATION WITH COEFFICIENT

In this section total acceleration equation will be formulated where there is a coefficient at the time differential term.

2.1. Base of the Theory

a. Courant Number

Courant (1928) introduced Courant Number which is a criteria relation between length interval (δx) with time step (δt) to conduct numerical analysis at the fluid flow, i.e.

$$C = \frac{u\delta t}{\delta x} < C_{max} \quad \text{.....(1)}$$

where u is a velocity, δt is time step and δx is length interval, $C_{max} = 1$. If at (1) $u = \frac{\delta x}{\delta t}$ is defined, hence $C = 1$ which does not meet the Courant Number criteria. However, if $u = \frac{\delta x}{\gamma \delta t}$ is defined where γ is a positive number greater than 1, then it will meet (1). From this equation, a conclusion can be made that there is a coefficient γ at time step δt to define a velocity. This coefficient can be stated as a time scale coefficient.

b. Taylor Series Review

Taylor series is often used only up to the first derivative or with an accuracy of $O(\delta^1)$ at numerical analysis as well as the formulation of a conservation law. Total acceleration equation, at Euler momentum equation at fluid flow, is also often formulated using Taylor series $O(\delta^1)$. Using Taylor series up to the first derivative, the accuracy is depended only on the interval measurement.

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Therefore, interval size that produces a good accuracy should be determined. .

For a continuous function $f = f(x,t)$, where $x$is horizontal axis and $t$is time, Taylor series approach $O(\delta^1)$ (Thomas (1996)),

$$f(x+\delta x, t+\delta t) = f(x,t) + \delta x \frac{\partial f}{\partial x} + \delta t \frac{\partial f}{\partial t}$$

Using time scale coefficient γ,

$$f(x+\delta x, t+\gamma\delta t) = f(x,t) + \delta x \frac{\partial f}{\partial x} + \gamma\delta t \frac{\partial f}{\partial t}$$

.....(2)

At (2) there is a truncation error,

$$R = \frac{\delta x^2}{2}\frac{\partial^2 f}{\partial x^2} + \frac{\gamma^2\delta t^2}{2}\frac{\partial^2 f}{\partial t^2} + \delta x\, \gamma\delta t \frac{\partial^2 f}{\partial x \partial t} + \cdots$$

Rcan be ignored if

$$\left|\frac{R}{\delta x\frac{\partial f}{\partial x} + \gamma\delta t\frac{\partial f}{\partial t}}\right| < \varepsilon \quad \text{.....(3)}$$

where εis a very small number. (3) can be achieved by a small size of $\delta x$and$\delta t$and with a time scale value of γ. The size of$\delta x$and$\delta t$and the value of γ where Taylor series can be used only up to the first derivative can be determined with (3).

2.2. Determining δx,δt and γ.

With an assumption that there are the values of δx,δtandγ, where the number of the third derivative term with higher derivatives is much smaller than the number of the second derivative term, then as R, only the second derivative that can be used, and (3) becomes

$$\left|\frac{\frac{\delta x^2}{2}\frac{\partial^2 f}{\partial x^2} + \frac{\gamma^2\delta t^2}{2}\frac{\partial^2 f}{\partial t^2} + \gamma\delta x\delta t\frac{\partial^2 f}{\partial x\partial t}}{\delta x\frac{\partial f}{\partial x} + \gamma\delta t\frac{\partial f}{\partial t}}\right| < \varepsilon \quad \text{.....(4)}$$

Wave length is $L = CT$where$C$ is wave celereties or wave velocity and T is wave period. From this wave length equation, $\delta x = C\delta t$ is defined. With $L = \frac{2\pi}{k}$where $k$is wave number, relation $C = \frac{\sigma}{k}$is obtained, then,

$$\delta x = \frac{\sigma\delta t}{k} \quad \text{.....(5)}$$

Substitute (5) to (4) and the upper and lower part of the equation are divided by δt

$$\left|\frac{\frac{1}{2}\left(\frac{\sigma}{k}\right)^2\delta t\frac{\partial^2 f}{\partial x^2} + \gamma\left(\frac{\sigma}{k}\delta t\right)\frac{\partial^2 f}{\partial t\partial x} + \frac{\gamma^2\delta t}{2}\frac{\partial^2 f}{\partial t^2}}{\left(\frac{\sigma}{k}\right)\frac{\partial f}{\partial x} + \gamma\frac{\partial f}{\partial t}}\right| < \varepsilon \quad \text{....(6)}$$

Furthermore a sinusoidal function is reviewed with the form$f(x,t) = coskxcos\sigma t$. This equation is a water wave surface elevation equation of the linear wave theory (Dean, 1991). Substitute $f(x,t) = coskxcos\sigma t$to (6) and perform it at the condition $coskx = sinkx = cos\sigma t = sin\sigma t$, will produce

$$\frac{\left|-\frac{1}{2} + \gamma - \frac{\gamma^2}{2}\right|\sigma\delta t}{(1+\gamma)} \leq \varepsilon \quad \text{....(7)}$$

At (7), the lower part of equation can be taken out from the absolute operation| |, since it always has positive value. At (7) there are two unknowns, i.e. γandδt. Another equation is needed, therefore Taylor series is performed with a change in $t$time only,

$$f(x,t+\delta t) = f(x,t) + \delta t\frac{df}{dt} + \frac{\delta t^2}{2}\frac{d^2 f}{dt^2} + \cdots \text{ (8)}$$

In this case the time scale coefficient γ was not performed since the one to be reviewed is only the change in function against time t. In order for (8) to be able to be performed only up to the first derivative, then

$$\left|\frac{\frac{\delta t^2}{2}\frac{d^2 f}{dt^2}}{\delta t\frac{df}{dt}}\right| \leq \varepsilon \text{ ....(9)}$$

Substitute$f(x,t) = coskxcos\sigma t$to (9) and the equation is performed at $coskx = sinkx = cos\sigma t = sin\sigma t$, hence

$$\delta t_{max} < \frac{2\varepsilon}{\sigma} \quad \text{....(10)}$$

δtat (10) is the value of δt_{max}since it is determined only based on the function of time without the interaction with the changes toward space. With$\delta t = \delta t_{max}$, the value of γ can be calculated at (7).

Table.1: The Value ofγ*and*δt_{max}*for* $f(x,t) = coskxcos\sigma t$.

	γ	δt_{max}
Wave period T: 7 sec.		
R^2	3	0,02228
R^3	3,14301	0,02243
R^4	3,15978	0,02214
Wave period T: 8 sec.		
R^2	3	0,02547
R^3	3,14301	0,02564
R^4	3,15978	0,0253
Wave period T: 9 sec.		
R^2	3	0,02865
R^3	3,14301	0,02884
R^4	3,15978	0,02846
Wave period T: 10 sec.		
R^2	3	0,03183
R^3	3,14301	0,03205
R^4	3,15978	0,03162

Table (1) presents the result of the calculation of values γandδt_{max} for various wave periods and various level of accuracy R, whereR^2shows that $R$is calculated only with the second derivative only, R^3shows that$R$is calculated up to the third derivative and R^4 , $R$is calculated up to the fourth derivative. It can be seen that for the same period, the higher the accuracy of $R$the bigger the value of γ but with small change. Whereas at the similar accuracy level of R, for different wave period, the value of γ is the same. The uses of accuracy up to R^5does not change the value

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of γconsidering the terms of $\frac{\delta x^5}{120}$and$\frac{\delta t^5}{120}$at$R^5$is a very small number close to zero.

The function $f(x,t) = coskxcos\sigma t$has been used to calculate the value γ. If the form of function $f(x,t) = sinkx\ sin\sigma t$ is used, where this equation is the change of water particle velocity at space and time for standing wave, then relation equation between $\gamma$and$\delta t$is obtained which is similar to (7) for accuracy R^2, i.e.

$$\frac{\left|-\frac{1}{2}+\gamma-\frac{\gamma^2}{2}\right|\sigma\delta t}{(1+\gamma)} < \varepsilon \quad .....(11)$$

However, accuraciesR^3andR^4have different shapes and produce different value γ, although with a not too big different, as shown on Table (2).

Table.2: The Value of$\gamma$and$\delta t_{max}$for$f(x,t) = sinkxsin\sigma t$

	γ	δt_{max} (sec.)
Wave period $T = 7$ sec.		
R^2	3	0,02228
R^3	2,85619	0,02243
R^4	2,87499	0,02214
Wave period $T = 8$ sec		
R^2	3	0,02547
R^3	2,85619	0,02564
R^4	2,87499	0,0253
Wave period $T = 9$ sec		
R^2	3	0,02865
R^3	2,85619	0,02884
R^4	2,87499	0,02846
Wave period $T = 9$ sec		
R^2	3	0,03183
R^3	2,85619	0,03205
R^4	2,87499	0,03162

Table (2) shows that at $f(x,t) = sinkxsin\sigma t$,the value of γ is fluctuating against the level of accuracy Rbut with relatively small fluctuation. From the two analysis of coefficient γ for the two shapes of the function, the hydrodynamic analysis for water wave can use the value of $\gamma = 3$. For numerical analysis where discretization of space and time is needed, than the space length size $\delta x = \frac{\sigma\delta t_{max}}{k}$with time step$\delta t = \frac{\delta t_{max}}{\gamma}$.

2.3. Total Acceleration with coefficient

As has been shown that by performing coefficient on time differential term, Taylor series can be performed up to the first derivative, i.e.

$$f(x+\delta x, t+\delta t) = f(x,t) + \gamma\delta t\frac{\partial f}{\partial t} + \delta x\frac{\partial f}{\partial x}$$

The first term of the right side of the equation is moved to the left and the equation is divided by δt

$$\frac{f(x+\delta x, t+\delta t) - f(x,t)}{\delta t} = \gamma\frac{\partial f}{\partial t} + \frac{\delta x}{\delta t}\frac{\partial f}{\partial x}$$

With the presence of time coefficient γat time differential term, it can be defined that at $lim\delta x,\ \delta t$approaches zero can be defined that$\frac{\delta x}{\delta t} = u$. Therefore, the total acceleration equation is

$$\frac{Df}{dt} = \gamma\frac{\partial f}{\partial t} + u\frac{\partial f}{\partial x} \quad .....(12)$$

III. EQUATIONS FROM VELOCITY POTENTIAL

This part has been written by Hutahaean (2019), however; considering that equations in this part are very important for this research, it will be rewritten.

3.1. Velocity Potential Equation

Velocity potential from linear wave theory which is the product of Laplace equation operation (Dean, 1991) is

$$\Phi(x,z,t) = Gcoskxcoshk(h+z)sin\sigma t \quad .....(13)$$

$x$is horizontal axis,$z$is vertical axis where $z = 0$at the surface of still water level, $t$time, Gwave constant, k wave number, $\sigma = \frac{2\pi}{T}$, angular frequency, T wave period and$h$ still water depth.

The equation was formulated at flat bottom condition, however Hutahaean (2008) found out that the effect of slopping bottom on velocity potential is small, only on its hyperbolic term, i.e.

Flat bottom:

$$coshk(h+z) = \frac{e^{k(h+z)} + e^{-k(h+z)}}{2}$$

Slopping bottom:

$$\beta(z) = \alpha e^{k(h+z)} + e^{-k(h+z)}$$

Where$\alpha$is a coefficient that is a function of bottom slope (equation 14). It is seen that$\alpha \approx 1$.Therefore, (13) can be performed at sloping bottom where there will be values of $\frac{\partial k}{\partial x}and\frac{\partial G}{\partial x}$.

$$. \alpha = \frac{1}{2}\left(\frac{1+\frac{\partial h}{\partial x}}{1-\frac{\partial h}{\partial x}} + \frac{1-\frac{\partial h}{\partial x}}{1+\frac{\partial h}{\partial x}}\right) .....(14)$$

$\frac{\partial h}{\partial x}$is bottom slope.

3.2. Wave Number Conservation Equation

The velocity potential equation (13) is obtained from variable separation method, where velocity potential is considered as multiplication between 3 functions, i.e. $\Phi(x,z,t) = X(x)Z(z)T(t)$, $X(x)$is just an $x$function ,$Z(z)$is just a $z$function and $T(t)$is just a time function. At (1), $Z(z) = \cosh k(h+z)$. If (13) is performed at sloping

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bottom $\frac{\partial Z(z)}{\partial x} = \frac{\partial \cosh k(h+z)}{\partial x} = \sinh k(h+z)\frac{\partial k(h+z)}{\partial x} = 0$, in this equation the one with the value of zero is,

$\frac{\partial k(h+z)}{\partial x} = 0$ .....(15)

for all z value. Therefore the value of $k(h+z) = c$, where c is constant, i.e. the same for the entire flow field of the wave moves. If (3) is performed on $z = 0$, then $\frac{\partial kh}{\partial x} = 0$ or,

$\frac{\partial k}{\partial x} = -\frac{k}{h}\frac{\partial h}{\partial x}$ .....(16)

With (16), derivative equations higher than wave number can be formulated, for example for $z = 0$, by ignoring $\frac{\partial^2 h}{\partial x^2}$,

$\frac{\partial^2 k}{\partial x^2} = \frac{2k}{h^2}\left(\frac{\partial h}{\partial x}\right)^2$ .....(17)

From this point onward, the calculation of $\frac{\partial k}{\partial x}$ and $\frac{\partial^2 k}{\partial x^2}$ refers to $z = 0$. With (17) the third differential can be obtained, and so forth. Based on (15), the following relations apply,

$tanhk(h+\eta) = tanhk_0(h_0+\eta) = 1$ .....(18a)

$coshk(h+\eta) = coshk_0(h_0+\eta)$.....(18b)

$sinhk(h+\eta) = sinhk_0(h_0+\eta)$.....(18c)

$coshk_0(h_0+\eta) = sinhk_0(h_0+\eta)$ .....(18d)

Where η is the water surface elevation. Therefore, based on (18a-d), equations containing the three elements are elements with values similar to the value in deep water.

3.3. Energy Conservation Equation

From velocity potential (1) horizontal$-x$ velocity equation is obtained

$$u = -\frac{\partial \Phi}{\partial x} = \left(Gksinkx - \frac{\partial G}{\partial x}coskx\right) coshk(h+z)sin\sigma t$$ .....(19)

$$\frac{\partial u}{\partial x} = \left(Gk^2coskx + G\frac{\partial k}{\partial x}sinkx + 2\frac{\partial G}{\partial x}ksinkx - \frac{\partial^2 G}{\partial x^2}coskx\right) coshk(h+z)sin\sigma t$$ .....(20)

and vertical$-z$ velocity equation,

$$w(x,z,t) = -\frac{\partial \Phi}{\partial z} = -Gkcoskxsinhk(h+z)sin\sigma t$$ .....(21)

$\frac{\partial w}{\partial z} = -Gk^2coskxcoshk(h+z)sin\sigma t$ .....(22)

Substitute equations (20) and (22) to continuity equation $\frac{\partial u}{\partial x} + \frac{\partial w}{\partial z} = 0$ and performed at the condition $coskx = sinkx = cos\sigma t = sin\sigma t = \frac{\sqrt{2}}{2}$ and $z = \eta = \frac{A}{2}$, then the equation is divided by $coshk\left(h+\frac{A}{2}\right)$, to obtain,

$G\frac{\partial k}{\partial x} + 2k\frac{\partial G}{\partial x} - \frac{\partial^2 G}{\partial x^2} = 0$.....(23)

This equation is another form of energy conservation equation. This equation is a relation between G and $\frac{\partial G}{\partial x}$. The simplest way is by performing the assumption of a long wave where $\frac{\partial^2 G}{\partial x^2}$ can be ignored, and in this case the following equation is obtained,

$\frac{\partial G}{\partial x} = -\frac{G}{2k}\frac{\partial k}{\partial x}$, ...(24)

(23) can be written as,

$\frac{\partial^2 G}{\partial x^2} = G\frac{\partial k}{\partial x} + 2k\frac{\partial G}{\partial x}$ .....(25)

(25) is differentiated twice against horizontal-x axis and substituted to the term $\frac{\partial^2 G}{\partial x^2}$, and an assumption is performed that $\frac{\partial^4 G}{\partial x^4}$ is a very small number that is considered to be equal to zero which produce,

$\frac{\partial G}{\partial x} = \mu G$ .....(26)

$$\mu = -\frac{\left(\frac{\partial^3 k}{\partial x^3} + 5\left(\frac{\partial k}{\partial x}\right)^2 + 2k\frac{\partial^2 k}{\partial x^2} + 4k^2\frac{\partial k}{\partial x}\right)}{\left(4\frac{\partial^2 k}{\partial x^2} + 16k\frac{\partial k}{\partial x} + 8k^3\right)}$$ .....(27)

Therefore particle velocity equation at horizontal-x direction becomes

$u = G(ksinkx - \mu coskx)coshk(h+z)sin\sigma t$ ....(28)

IV. DISPERSION EQUATION

At the potential velocity equation (13), there are 2 (two) unknowns, i.e. energy constant G and wave number k; therefore, two equations are needed to calculate those two unknowns. Governing equation for analyzing the two unknowns are kinematic free surface boundary condition and momentum equation. In its movement from the deep water to shallower water, evolution or transformation of the two unknown values will happen. The evolution is arranged by wave number conservation equation (15) and energy conservation (23) or (25). The two conservation equations are absorbed to the two governing equations.

4.1 Kinematic Free Surface Boundary Condition

Using total derivative equation(12), kinematic free surface boundary condition becomes $w_\eta = \gamma\frac{\partial \eta}{\partial t} + u_\eta\frac{\partial \eta}{\partial x}$. Substitute (21) , (28) and $\eta(x,t) = Acoskxcos\sigma t$ and the equation is performed at the condition $coskx = sinkx = cos\sigma t = sin\sigma t$,

$$G\left(k\,tanhk\left(h+\frac{A}{2}\right) - \gamma\sigma A - (k-\mu)\left(\frac{kA}{2}\right)\right) coshk\left(h+\frac{A}{2}\right) - \gamma\sigma A = 0$$ ....(29)

4.2. Horizontal Momentum Equation

For a function $f = f(x,z,t)$, where the main change is in the direction of horizontal-x axis, then (12) can be performed to obtain total acceleration equation, and horizontal-x and vertical-z total velocity equations are

$\frac{Du}{dt} = \gamma\frac{\partial u}{\partial t} + u\frac{\partial u}{\partial x} + w\frac{\partial u}{\partial z}$ .....(30)

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$\frac{Dw}{dt} = \gamma \frac{\partial w}{\partial t} + u\frac{\partial w}{\partial x} + w\frac{\partial w}{\partial z}$.....(31)

respectively, where $u$is water particle velocity at horizontal-$x$direction and $w$is particle velocity vertical-z direction. With (30) and (31), then Euler momentum equation becomes,

$\gamma \frac{\partial u}{\partial t} + u\frac{\partial u}{\partial x} + w\frac{\partial u}{\partial z} = -\frac{1}{\rho}\frac{\partial p}{\partial x}$ .....(32)

$\gamma \frac{\partial w}{\partial t} + u\frac{\partial w}{\partial x} + w\frac{\partial w}{\partial z} = -\frac{1}{\rho}\frac{\partial p}{\partial z} - g$ .....(33)

At (33) the characteristics of irrotional flow is performed at space differential, $\frac{\partial w}{\partial x} = \frac{\partial u}{\partial z}$, and integrated against vertical-z axis and dynamic free surface boundary condition is performed where $p_\eta = 0$, pressure equation is obtained, i.e.

$$\frac{p}{\rho} = \gamma \int_z^\eta \frac{\partial w}{\partial t} dz + \frac{1}{2}\left(u_\eta^2 + w_\eta^2\right) - \frac{1}{2}\left(u^2 + w^3\right) + g(\eta - z)$$

The pressure equation is differentiated against horizontal-$x$axis and substituted to (32) where at (32) the characteristics of irrotional flow is performed

$$\gamma \frac{\partial u}{\partial t} = -\gamma \frac{\partial}{\partial x}\int_z^\eta \frac{\partial w}{\partial t} dz - \left(\frac{1}{2}\frac{\partial}{\partial x}\left(u_\eta^2 + w_\eta^2\right) + g\frac{\partial \eta}{\partial x}\right)$$

The completion of $\frac{\partial}{\partial x}\int_z^\eta \frac{\partial w}{\partial t} dz$will be done using potential velocity theory of the linear wave theory(21).

$$\frac{\partial w}{\partial t} = -G\sigma k sinhk(h+z)\, coskx cos\sigma t$$

$$\int_z^\eta \frac{\partial w}{\partial t} dz = -G\sigma\left(coshk(h+\eta) - coshk(h+z)\right) coskx cos\sigma t$$

$$\frac{\partial}{\partial x}\int_z^\eta \frac{\partial w}{\partial t} dz = G\sigma\left(coshk(h+\eta) - coshk(h+z)\right)(ksinkx - \mu coskx)\, cos\sigma t$$

From (28),

$\frac{\partial u}{\partial t} = G\sigma(ksinkx - \mu coskx)coshk(h+z)cos\sigma t$, ,hence

$\frac{\partial}{\partial x}\int_z^\eta \frac{\partial w}{\partial t} dz = \frac{\partial u_\eta}{\partial t} - \frac{\partial u}{\partial t}$, horizontal-$x$momentum equation becomes

$\gamma \frac{\partial u_\eta}{\partial t} = -\left(\frac{1}{2}\frac{\partial}{\partial x}\left(u_\eta^2 + w_\eta^2\right) + g\frac{\partial \eta}{\partial x}\right)$ .....(34)

4.3. Simple Dispersion Equation

To obtain a simple dispersion equation, convective acceleration at (34) is ignored,

$\gamma\left(\frac{\partial u}{\partial t}\right)_{z=\eta} = -g\frac{\partial \eta}{\partial x}$ .....(35)

Substitute (28) and water surface equation $\eta(x,t) = Acoskxcos\sigma t$, and the equation is performed at the condition $coskx = sinkx = cos\sigma t = sin\sigma t$

$\gamma G\sigma(k-\mu)coshk\left(h + \frac{A}{2}\right) = gkA$ ....(36)

Equation (29) is written as an equation for $G$and substituted to (36),

$$\gamma^2\sigma^2(k-\mu) = gk\left(k\, tanhk\left(h + \frac{A}{2}\right) - (k-\mu)\left(\frac{kA}{2}\right)\right)$$

.....(37)

If the bottom slope is ignored, then (37) becomes

$\gamma^2\sigma^2 = g\left(k\, tanhk\left(h + \frac{A}{2}\right) - \frac{k^2 A}{2}\right)$.....(38)

If wave amplitude is considered as a very small number, both to water depth and wave length, (38) becomes

$\gamma^2\sigma^2 = gktanhkh$ .....(39)

Then if$\gamma = 1$is taken, (39) becomes

$\sigma^2 = gktanhkh$ .....(40)

(40) is a dispersion equation of linear wave theory (Dean, 1991).

Dispersion equations (37), (38), (39) and (40) have not met wave number conservation equation. At (37) wave number conservation equation (18a) is performed, hence

$\gamma^2\sigma^2(k-\mu) = gk\left(k - (k-\mu)\left(\frac{kA}{2}\right)\right)$.....(41)

(41) is used to calculate wave number at the deep water. The dispersion equation at the shallow water is obtained by substituting wave number conservation (15) that can be stated as

$k\left(h + \frac{A}{2}\right) = k_0\left(h_0 + \frac{A_0}{2}\right)$

Keeping in mind that$tanhk_0\left(h_0 + \frac{A_0}{2}\right) =$ 1where$k_0\left(h_0 + \frac{A_0}{2}\right) = \psi\pi$, this research used $\psi = 1.1$, where$tanh(1.1\pi) = 0.998009$,

$k\left(h + \frac{A}{2}\right) = \psi\pi$,or$\frac{kA}{2} = \psi\pi - kh$ .....(42)

Substitute (42) to (41),

$\gamma^2\sigma^2(k-\mu) = gk\left(k - (k-\mu)(\psi\pi - kh)\right)$...(43)

This equation is dispersion equation at the shallow water. However,calculation with (43) should be performed consecutively from deep water depth. To obtain deep water depth,$k_0$is calculated with (41), then deep water depth $h_0$is the deepest between $k_0\left(h_0 + \frac{A_0}{2}\right) = \psi\pi$ and $\frac{A_0}{2h_0} \leq 0.10$. For water depth more than h_0 the wave number conservation equation can't be applied.

4.4.Complete Dispersion Equation

In this complete dispersion equation, the surface momentum equation is used completely and the wave number conservation equation is applied. The resulted equation is for calculating wave number at the shallow water only. Substitute (42) to (29) the first $f(k,G) =$ 0equation is obtained.

$f_1(k,G) = G\left(k - (k-\mu)(\psi\pi - kh)\right)$

$coshk\left(h + \frac{A}{2}\right) - \gamma\sigma A = 0$ .....(44)

The second equation is surface momentum equation, i.e.

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$$f_2(k,G) = \gamma \frac{\mathrm{d}u_\eta}{\mathrm{d}t} + \left(\frac{1}{2}\frac{\mathrm{d}}{\mathrm{d}x}\left(u_\eta^2 + w_\eta^2\right) + g\frac{\mathrm{d}\eta}{\mathrm{d}x}\right) = 0$$

..... (45)

Where,

$\gamma \frac{\mathrm{d}u_\eta}{\mathrm{d}t} = \gamma G\sigma(k-\mu)coshk\left(h+\frac{A}{2}\right)$ ....(46a)

$u_\eta \frac{\mathrm{d}u_\eta}{\mathrm{d}x} = \frac{1}{2}G^2k^2(k-\mu)cosh^2k\left(h+\frac{A}{2}\right)$ ....(46b)

$w_\eta \frac{\mathrm{d}w_\eta}{\mathrm{d}x} = -\frac{1}{2}G^2k^2(k-\mu)sinh^2k\left(h+\frac{A}{2}\right)$ ....(46c)

$g\frac{\mathrm{d}\eta}{\mathrm{d}x} = -2g(\psi\pi - kh)$ ...(46d)

At (46d) kA is substituted with wave number conservation equation (42). Keep in mind that based on wave number conservation equation, $coshk\left(h+\frac{A}{2}\right)$ is constant number, i.e. $coshk\left(h+\frac{A}{2}\right) = coshk_0\left(h_0+\frac{A_0}{2}\right)$, where k_0 is calculated with (41) and deep water depth h_0 is the deepest between $h_0 = \left(\psi\pi - \frac{k_0A_0}{2}\right)\frac{1}{k_0}$ and $\frac{A_0}{2h_0} \le 0.10$. The values of k and G can be obtained by completing (35) and (36) with Newton-Rhapson method, with the inputs wave period, wave amplitude and water depth.

V. THE ADJUSTMENT OF γ VALUE

The value of $\gamma = 3$ from the previous analysis is theoretical value based only on Laplace equation solution. In this part, the adjustment of γ value will be done using observation on deep water wave height. The adjustment is done using the relation between deep water wave height and wave period from Silvester (1974) and from Wiegel (1949 and 1964).

By ignoring bottom slope, then (41) which is a dispersion equation at deep water, becomes a quadratic equation for k.

$\gamma^2\sigma^2 = gk\left(1 - \left(\frac{kA}{2}\right)\right)$ .....(47)

This equation has a solution if the determinant value is $D \ge 0$, where

$D = g^2 - 4\left(\frac{gA}{2}\right)(\gamma^2\sigma^2)$.

For $D = 0$, $A_{max} = \frac{g}{2\gamma^2\sigma^2}$ With the value of $H_{max} = 2A_{max}$, wave period is calculated from empirical equations of Silvester (1974), $T_{Sil} = \sqrt{19.68H_{1/3}}$ and Wiegel equation (1949 and 1964), $T_{Wieg} = 15.6\left(\frac{H_m}{g}\right)^{0.5}$, H_m is maximum deep water wave height, g is the force of gravity. As $H_{1/3}$ and H_m, H_{max} is used.

Table.3: Wave height maximum at deep water, at γ = 2.483.

T (sec.)	H_{max} (m)	T_{Sil} (sec.)	T_{Wieg} (sec.)	$\frac{H_{max}}{L}$
6	1,45	5,34	6	0,32
7	1,97	6,23	7	0,32
8	2,58	7,12	8	0,32
9	3,26	8,02	9	0,32
10	4,03	8,91	10	0,32
11	4,88	9,8	11	0,32
12	5,8	10,69	12	0,32
13	6,81	11,58	13	0,32
14	7,9	12,47	14	0,32
15	9,07	13,36	15	0,32

The result of the calculation on Table (3) was done using the value of $\gamma = 2.483$. Wavelength L on Table (3) was calculated using (47) obtained that $\frac{H_{max}}{L}$ for all reviewed wave period is 0.318 or $\frac{1}{\pi}$, where it is in accordance with the analytical result (Hutahaean (2019)) i.e. breaking occurs when $\frac{H_b}{L_b} = \frac{1}{\pi}$, H_b breaker height and L_b breaker length. Therefore H_{max} on column 2 is deep water wave height maximum for wave period on column 1, where the wave period is similar to T_{Wieg} and is close enough to T_{Sil} that was calculated using H_{max} on column 2. Therefore a conclusion can be made that the value of $\gamma = 2.483$ is a quite good value, and the maximum deep water wave height H_0 for wave period on column 1 is on column 2.

VI. EXAMPLE OF THE RESULT OF WAVELENGTH CALCULATION

The example of the result of wavelength L calculation wave with wave period of 8 second, with $A_0 = 0.6$ m and $\frac{dh}{dx} = -0.01$ is shown on Fig.1., Fig 2. and Fig.3.

Fig.1 shows the comparison between wavelength (40), (39), (38) and (43) where it is seen that (40) as dispersion equation of linear wave theory produces wavelength that is much longer than the three comparing equations. Wavelength (39), (38) and (43) look close, but further information can be seen on Fig.2.

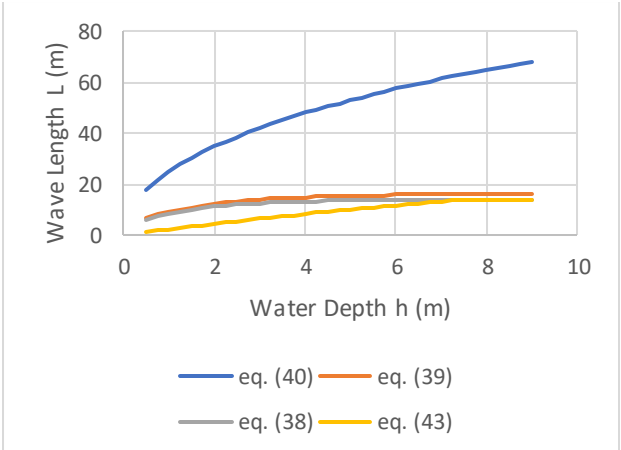

Fig.1: Comparison between wavelength (40), (39), (38) and (43).

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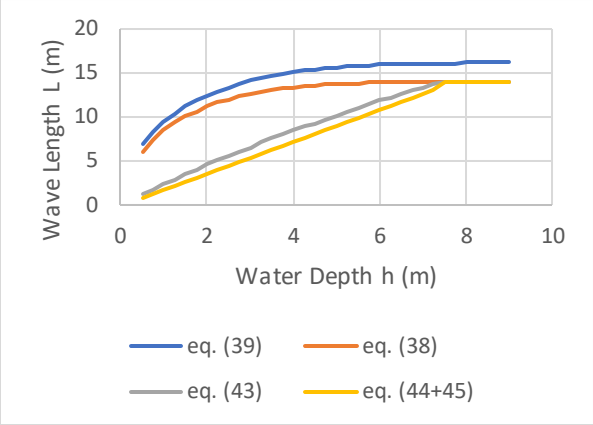

Fig.2: Wavelength (39), (38), (43) and (44+45)

Fig. 2 shows the result of the calculation using (39), (38), (43) and (44+45). At shallow water, wavelength from (39) and (38) looks much bigger than from (43) and (44+45). Whereas at deep water, (38) produces wavelength similar to that of (43) and (44+45). This shows that wave number conservation has a major role in the transformation of wavelength at shallow water, where at (39) and (38) wave number conservation equation is not performed. In addition, the changes in wavelength from (43) and (44+45) look linear which shows that the changes in wavelength as a result of water depth changes is dominated by wave number conservation equation (15). Between (39) and (38), there is a relatively big difference, where at (39) there is no wave amplitude as its variable as it is with (38). This shows that the effect of wave amplitude on wavelength is shortening wavelength. To study the effect of wave amplitude on wavelength, (38) is performed with different wave amplitude, i.e. 0.30 m and 0.60 m, with the result as presented on Fig. 3, which shows that wavelength from a wave with wave amplitude 0.30 m is longer that wavelength of a wave with wave amplitude of 0.60 m.

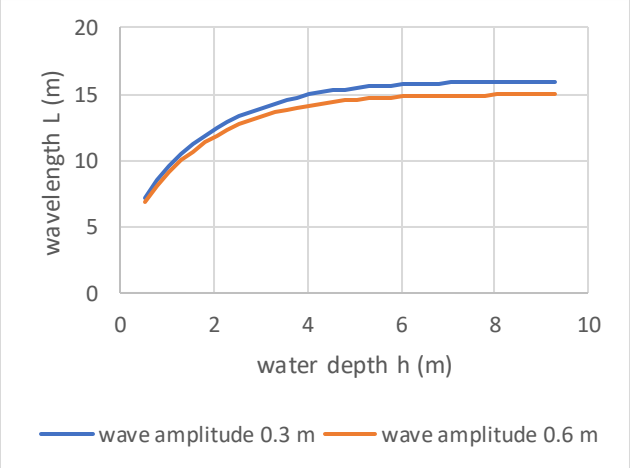

Fig.3: Wavelength (38) with different wave amplitude A

VII. CONCLUSION

This research concludes that at a space and time function, there is a time scale coefficient at total change or total acceleration. For a function $f(x,z,t)$ with the main direction of change at axis $-x$ direction, the total acceleration coefficient has a value of 2.483. The application of total acceleration equation with time scale coefficient at wavelength analysis produces wavelength that fits with the one exists in the nature.

There are 3 factors affecting wavelength, i.e. total acceleration equation, wave number conservation law and wave amplitude. However, the main factors are the first and the third factors. Total acceleration plays a role in determining wavelength as a whole i.e at deep water and shallow water, wave number conservation equation plays a role in the transformation of wavelength at the change of water depth at shallow water. With the presence of wave amplitude effect on wavelength, the correct wavelength analysis is if it is performed together with shoaling analysis.

Convective acceleration term at the momentum equation is shortening wavelength although it is relatively small. For practical purposes dispersion equation formulated without taking into account convective acceleration can be used.

Wavelength research with physical model has never been done before. Considering that the truth of a wave theory is also shown by the produced wavelength, therefore the availability of wavelength data as the result of physical model is highly needed.

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Comparative Anatomy of Abdominal Aorta in Coati (*Nasua nasua*)

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***Abstract*—** *Anatomic studies about Coati (Nasua nasua) are an interesting area, since the contribution to knowledge and development of biological system from this specie that is geographically distributed almost every South American continent, including Brazil. Coati is popularly known as coati, quati, quati-mundéo and quati of stick (terminology attributed with the shape of its nose similar to a trumpet), which belongs the carnivorous order and Procyonidae family. The Nasua gender comprises two species, Nasua nasua and Nasua narica, however only Nasua nasua occurs in Brazil, in the cerrado biome. The present work aimed an anatomical and comparative study of abdominal aorta to verify the structural organization of this vessel on the body and its adaptations to physiological and evolutionary processes, even as possible inherent adaptations to alimentary and reproductive habit. For this, two male and two female specimens obtained from accidental death on the roadsides of Brazilian Southeast of Goiás was used. The arterial system was dissected and inject with Latex Art Glue, colored with red pigment Wandalar, through the femoral artery. Subsequently was made a fixation with aqueous 10 % formaldehyde solution to conservation. The preparation of anatomical pieces was performed under consecrated techniques in Macroscopic Anatomy. The present study demonstrated that in Coati, the anatomic standard of aorta abdominal part and the respective collateral branch shows a similar template to mammalian animals and the detailed analysis of these abdominal vessels reveals particularities to this specie in small arteries as the Phrenic-Abdominal, Suprarenal and Deep Circumflex Iliac.*

Keywords*— *Coati, Anatomy, Abdominal Aorta and Mesenteric branches.

I. INTRODUCTION

The development of anatomic studies about coati shows an interesting area, since it contributes to the knowledge of the biological system from this specie, geographically distributed almost every South American continent. Anatomy, an oldest biomedical science, is an important tool to resolves doubts about the biology and evolution of species, especially in relation to the interaction of habitat environment, feeding and reproduction adaptations. In addition, morphology of anatomical structures reveals the natural history of an individual or specie. Coati (*Nasua nasua*), popularly known as coati, quati, quati-mundéo and quati of stick (terminology attributed with the shape of its nose similar to a trumpet), is widely distributed in the South American continent, including Brazil, which belongs the carnivorous order and Procyonidae family **[1]**. The *Nasua* gender comprises two species, *Nasua nasua* and *Nasua narica*, however only *Nasua nasua* occurs in Brazil. This specie is apparently adapted to Brazilian cerrado biome, were lives and reproduces in small forests and sometimes in communion with humans **[2]**. Forest and Cerrado represents its habitat, where this animal exhibits a semi arboreal behavior, constantly rising and descending in trees, trunks, etc **[3]**.

Coati shows anatomic similarities with domestic carnivores **[4]**, which represents evolutionary proximity to Carnivorous Order **[5]**. An important anatomical segment of all animals is the circulatory system, since the significance efficiency mean of transport and movement of the blood and other substances essential for survival. In this context, the study and description of abdominal aorta anatomy represents an important investigation area, since this vessel is responsible for all blood supply of the abdominal viscera and most abdomen wall, pelvis and pelvic members.

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The abdominal aorta, in dogs, arises caudally from diaphragm to centimeters above its bifurcation, nearly the edge of the minor pelvis. It supplies visceral and parietal branches, which the main are: The *celiac trunk*, *mesenteric cranial a.*, *phrenic abdominal a.; Lumbar A.a.*, *suprarenal a.; Renal A.a.*, *gonadal A.a.; External iliac A.a.; Internal iliac Aa.* and *finally medium sacral a.* which is the direct caudally continuation of aorta **[6]**. *Celiac trunk* – The celiac trunk arises from ventral superficies of abdominal aorta part, which is the first large visceral branch. Together with its origin, the diaphragmatic pillars are closely associated. *Celiac trunk* ends in: *hepatic a.*, *splenic a.*, *left gastric a.*, and divided into three branches, nevertheless, eventually *left gastric a.* and *splenic a.*, could arises from a common short trunk. *Cranial mesenteric artery* – The *cranial mesenteric a.* is the largest visceral branch of abdominal aorta. It is a unique branch and arises from the front of the aorta below the origin of the celiac trunk. *Cranial mesenteric a.* supplies small and the largest intestine. *Cauldal mesenteric artery* – The *caudal mesenteric a.* arise from the ventral front of aorta, cranially to *external iliac A.a.* and tail-ventrally, in left mesocolon, supplying the final part of cervix. *Renal arteries* – The *renal a.* arises asymmetrically from *aorta* the lateral surfaces. The *right renal a.* arises cranially in relation to the *left renal a.*, in accordance with the more cranial position of the right kidney. *Renal arteries* provide two or three branches to each one adrenal gland. Nearly to the renal hilum, it divides into a dorsal a ventral branch. Christensen in Miller *et al.*, (1964), proposed that *renal arteries* can be divided into two, four or seven branches, before entering the kidney or may not divide. In the left side, the *renal arteries* can particularly double. *Phrenic abdominal artery* – The *phrenic abdominal a.* is a pair of arteries and divides into *phrenic a.* and *cranial abdominal a.*. According to Marthen, cited by Christensen in Miller *et al.*, (1964), it arises from *aorta* lateral surface, between the *mesenteric cranial* and *renal arteries*. The *right phrenic abdominal a.* occasionally arises from the corresponding renal vessel, and the phrenic or abdominal parts could arise apart the *aorta* or *renal artery*. *Suprarenal arteries* – In dog, *suprarenal a.* usually arises from aorta, in a common trunk with *phrenic abdominal a.* or directly from the *renal a.*. Ljubomudrov cited by Christensen in Miller et al (1964) show that could have 30 or more arteries for each adrenal gland. Flren's cited by Christensen in Miller et al (1964) reports that *phrenic a.* and accessory *phrenic* represent the phrenic part of *phrenic abdominal a.* while the lumbar branch is the abdominal part. *Gonadal arteries (Testicular and Ovarian)* – The arteries that supply testicles and ovaries arise from the ventral face of aorta in the middle lumbar region. The right artery usually arises little cranial, in relation to the left. *Lumbar arteries* – The *lumbar arteries* branches of abdominal aorta are in a number of five pairs. It arises on the dorsal surface of the abdominal aorta. Each pair can appear through a common trunk. The fifth lumbar artery branch of the aorta differs from the others, as it may appear as a common trunk from the terminal part of the aorta or the *median sacral a.*. *Deep circumflex iliac artery* – The *deep circumflex iliac a.* is a pair and arises from the lateral surface of the aorta, cranially to the origin of *external iliac artery*. The right artery generally appears little more cranial, in relation to the left. *External iliac arteries* – The *external iliac a.* are the pair of major parietal branch of abdominal aorta. It arises from the lateral surface of the aorta and throws tail-ventrally to pelvic member. *Internal iliac and medial sacral arteries* – The *internal iliac a.*, together with *medial sacral a.*, constitute the terminal branches, that is the direct continuation of aorta. *Median sacral artery* – The *medial sacral a.* is the direct continuation of the aorta, caudally, after the origin of the internal iliac arteries.

Culau, Azambuja & Campos (2008) affirm that *Myocastor coypus* abdominal aorta, arises as first visceral branch the celiac trunk, which in turn trifurcates *hepatic a.*, *left gastric a. and lineal a.*. *Cranial mesenteric artery* arises in a ventral aspect of the aorta, caudally to the celiac trunk and irrigates almost small and large intestines. *Renal arteries* originates laterally and caudally to the *cranial mesenteric a.* They are generally asymmetric, where *right renal a.* is cranial, relative to the *left renal a.*, but eventually arises cranially as unique or eventually a double branch. The *adrenal A.a.* arises from *phrenic abdominal A.a.* or eventually as a *renal a.* branches. The *caudal mesenteric a.* arises from the final segment of aorta in the ventral surface, nearly to the bifurcation in *common iliac A.a.* and eventually arises from others branches, as *iliac* or *cranial mesenteric*. The terminal branches of abdominal aorta are internal *iliac A.a.* and *middle sacral a.*, while in coati, this branches arises dorsally before the *common iliac A.a.* separation.

Getty in Sisson & Grossman (2008), show that abdominal aorta of domestic carnivores animals is a descending aorta part that penetrates abdominal cavity after crossing the aortic hiatus of the diaphragm and along its abdominal path arises the following collateral branches: a) *Parietal branches* and b) *Visceral branches.*

The *parietal branches* are: *Abdominal phrenic a.*, which is a pair, and arises from aorta, between *mesenteric cranial a.* and *renal a.*. The *phrenic abdominal a.* initiation is relatively constant, while the right artery is variable and eventually arises from right *renal a.*. It arise branches to adrenal glands. The *lumbar arteries* are present in abdominal aorta on each body side. The five

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lumbar arterioles arise from dorsal surface of abdominal aorta. The fifth right and left lumbar arteries could form a common trunk that arises from the terminal part of aorta, median sacral a. or internal iliac a.. The *deep circumflex a*. of ileus arises briefly before the terminal aortic branch, at the same level as caudal mesenteric a. Eventually it arises from the *external iliac a.*. The *external iliac arteries* arise from the lateral aspect of the caudal segment of abdominal aorta and flow obliquely in laterocaudal direction, to the cranial border of the pubic bone, where depart abdominal cavity after through the femoral annulus. The *internal iliac arteries* arises from the final part of abdominal aorta, caudally to external iliac, together the medial sacral constitute the terminal branches of aorta. The *internal iliac a.* ends when divides into *gluteal caudal a. and internal pudendal a.*. The *medial sacral a.* is the caudal continuation of aorta abdominal part in the sacrocaudal region. It arises between the two internal iliac arteries.

The visceral branches of abdominal aorta are: The *celiac trunk*, a short vessel arising from the ventral face of the abdominal aorta, at aortic hiatus of diaphragm. It usually divides into *gastric left, hepatic and lineal arteries*. The *left gastric a*. and *splenic a*. eventually arises from a common short trunk. The *cranial mesenteric a*. arises closely and caudally to celiac trunk, from ventral surface of abdominal aorta.

The *caudal mesenteric a.* is small and arises from ventral face of abdominal aorta, cranially to *external iliac arteries*. The *renal arteries* are paired, and arise asymmetrically from lateral surfaces of abdominal aorta, caudally to the origin of *cranial mesenteric a.*. The *right renal a*. is in a cranial position to the corresponding left artery localization. The *right renal* is divided in dorsal branch and ventral branch, closely to ileum. These branches could divide into several interlumbar arteries, or not divide, before penetrate the renal wire. The adrenal arteries arise from different and variable ways, from *phrenic abdominal a., lumbar a., celiac a., cranial mesenteric a.* or *renal a.*. The *gonadal arterioles* are small vessels that arise ventrally and laterally to abdominal aorta, between *renal* and *caudal mesenteric a.*. Their terminal branches have an emission of abdominal aorta branches destined to supply pelvic cavity organs and enteral pelvic limbs, in the different species of domestic animals **[7,8]**.

Silva et al. (2011) describe that in *Saimiri sciureus,* the aorta is named *abdominal aorta* after cross the aortic hiatus. It arises in the abdomen between diaphragm pillars and then emits its first branch, the celiac trunk, which divides into *hepatic, left gastric and lineal arteries*. The next branch is *cranial mesenteric a.*, a large vessel that arises ventrally and irrigates the intestines. The renal arterioles are unique on each side and originate laterally. The *caudal mesenteric a.* is a small branch that originates ventrally, near aortic branch in *iliac A.a*. The *gonadal A.a.* arises in a ventral aspect, cranially to the *caudal mesenteric* a.. The terminal branches of aorta are common *iliac A.a.* and *medial sacral*, representing the continuation of aorta.

Macedo et al. (2013), investigating aorta anatomy of *Tamandua tetradactyla*, describe the *phrenic caudal A.a.* and three pairs of lumbar arteries as parietal branches of abdominal aorta, and visceral branches, the celiac trunk that divides in *hepatic a., left gastric a.* and *lineal a.*, eventually *hepatic a.* arises in a common trunk with *cranial mesenteric a.*. The *cranial mesenteric a.* that origins caudally to celiac trunk can arises in common trunk. The caudal *phrenic A.a.* and *adrenal A.a.* originate from aorta, between the celiac trunk and cranial mesenteric and eventually form a common trunk. The *adrenals A.a.* origins are variable, arising directly from aorta or renal arteries, individually or forming trunks. Further to *adrenal a.*, several small branches arise from renal and penetrate in suprarenal gland. The *renal A.a.* originate ventrolateral and caudally to *cranial mesenteric a.*, which the *right renal a.* cranially localized in relation to *left renal a.*. *Renal arterioles* divides before enter in renal wire. *Renal A.a.* emerges *gonadal A.a.* and eventually an *accessory phrenic a.*. The *caudal mesenteric a.* origin in the ventral face of aorta, nearly to *external iliac A.a.* division. It origin is relatively higher in females. The *gonadal A.a.* arises from renal artery near to renal wire. The caudal part of aorta emits *external iliac A.a.*, laterally and follow small until emitting *internal iliac A.a.*. *Median sacral a.* is generally originated from the left internal Iliac.

Bavaresco, Culau and Campos (2013), described in collateral-visceral of rabbit abdominal aorta, the Celiac Trunk; *cranial mesenteric a.*; *renal a.*; *gonadal a.* and *caudal mesenteric a.* as directs branches of aorta. *Umbilical* and *Adrenal arteries* is described as indirect branches. The *celiac trunk* is described as the first visceral branch of abdominal aorta and divides *in hepatic a. left gastric a.* and *lineal a.*. The second branch of abdominal aorta is *cranial mesenteric a.* that arises caudally to celiac Trunk, in the same ventral face of aorta. The third branch is *renal arerioles* that arises laterally, originating the *right renal A.a.* more cranially than *left renal A.a.*. The *renal A.a* can emerges as collaterals, *phrenic abdominal a.* and eventually *adrenal a.*. The *gonadal A.a.*, that generally originate cranially to *caudal mesenteric a.* and eventually caudally. The *mesenteric caudal a.*, is unique, but, eventually can be double. The *suprarenal arterioles* frequently arises from *phrenic caudal a.*. These branches vary from 6 to 7 small arteries that originate from

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different sources. The *median sacral a.* is the last collateral of abdominal aorta and originates from the dorsal surface, cranially to *common iliac A.a*. The terminal branches of abdominal aorta are common *iliac A.a.*, which divides into *external* and *internal iliac*. Pinheiro et al., (2014) describe the abdominal aorta of Jaguatirica (*Leopardus pardalis*) as the continuation of descending aorta after it crossing the aortic hiatus of diaphragm. It emits as first branch the *celiac trunk*, which divides into *hepatic a.*, *left gastric a.* and sequentially to *cranial mesenteric a.* as the largest branch of abdominal aorta. The *right* and *left suprarenal A.a.*, originate from the aorta, caudally *cranial mesenteric a.*. Then *renal arterioles* arises, were right renal a. is lightly cranial to the left in males, while in females the opposite occurs. Both emit small branches for peri and pararenal fat. The *gonadal arterioles* arises from the ventral aspect of aorta, with some distancing between them, were the *left gonadal a.* is lightly more cranial. Then *caudal mesenteric a.* arises, closed to the terminal part of aorta. The abdominal aorta emits some parietal branches, were the *phrenic-abdominal a.*, which is pair, arises between *cranial mesenteric* and *renal arteries*. The *left phrenic-abdominal* arises laterally while the right ventrally. Six *lumbar arterioles* are present in Jaguatirica, which arises from the dorsal surface of abdominal aorta. It also originates from abdominal aorta, laterally to *profound iliac circumflexes* and then *external* and *internal iliac arterioles*. They are the terminal branches of aorta, with *median sacral a.*.

Based on anatomical comparative observations to the development of anatomic studies and considering that the anatomy of abdominal part of aorta of Coati (*Nasua nasua*), were not until described and will contributes to the knowledge of the biological system, the present study was designed to dissected and describe these abdominal vessels of this specie distributed almost every South American.

II. MATERIAL AND METHODS

The present paper is a descriptive anatomical study with two male and two female specimens of Coati (*Nasua nasua*), obtained from accidental death on the roadsides of Brazilian Southeast of Goiás, under authorization of SISBIO nº 37072-2. Considering the descriptive approach of this work, statistical analysis is not necessary. All procedures were conducted in accordance with ethical principles and were approved by the Institutional Ethics in Research Committee at the Federal University of Uberlândia (CEUA/UFU nº 067/12).

The study was made in the research laboratory of human and comparative anatomy from the Federal University of Goiás – RC, were the arterial system was dissected and inject with Latex Art Glue, colored with red pigment *Wandalar*, through the *femoral artery*. Subsequently was made a fixation with aqueous 10 % formaldehyde solution to conservation. The preparation of anatomical pieces was performed under consecrated techniques in Macroscopic Anatomy. For this, after trichotomy of anterolateral abdomen region, an incision was made along *Linea Alba*, from xiphoid process to cranial extremity of the pubic symphysis. Other incisions were performed laterally, accompanying costal border of each side and inguinal region approximated of inguinal ligament. The abdominal wall was laterally open to visceral exposure, then all abdominal part and digestive system secluded, exposing the dorsal wall of abdomen. With an anatomical forceps, the adipose tissue and other tissues were removed to expose abdominal aorta artery and its branches.

The Sony Cyber® digital camera was used to the photographical documentation and the description nomenclature adopted is the standard of *Nomina Anatomica Veterinaria* (2012) **[9]**, elaborated by the International Committee on Veterinary Gross Anatomical Nomenclature.

III. RESULTS

The *Abdominal Aorta* begin is called as the part of *aorta artery* that crosses the diaphragm through the aortic gap and between diaphragmatic pillars, at about the level of *T. V. 12*. It descends cranially to caudal on the median sagittal plane and deviates slightly to the left along dorsal wall of abdomen. The *abdominal aorta* descends two important large groups of branches that can be classified as *visceral* and *parietal branches*.

Visceral Branches

The first visceral branch of *Abdominal Aorta* is the *Celiac Trunk*. It arises through the ventral aspect of aorta, between diaphragmatic pillars and partially covered by these pillars. The *Celiac Trunk* is divided into three main arteries: *splenic*, *left gastric left* and *common hepatic arteries*. The second large visceral branch of *Abdominal Aorta* is *cranial mesenteric a.* that is the largest visceral branch of *abdominal aorta* and also arises in ventral aspect of *abdominal aorta*, caudally to *Celiac Trunk*.

The *cranial mesenteric a.* supplies blood to small intestine and most of large intestine. Close to it, caudally, arise on each side of *abdominal aorta*, a large artery destined for renal supply, the *right* and *left renal arteries*. Both in the same level and caudally originate the origin of *cranial mesenteric a.*. The *renal A.a.* enter in the kidney without large branches, however, emits small branches to suprarenal gland nearly to the kidney. Caudally to *renal*

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A.a. origin, arises from the ventrolateral face, the *gonadal A.a*., were the left artery is larger and relatively caudally in comparison to the right. Along the path, they emit small branches to adjacent tissues.

Then, on ventral side and close the origins of *external* and *internal iliac arteries*, emerges the *caudal mesenteric a*., a small branch in relation to *cranial mesenteric a*., and arises in the caudal-ventral direction irrigating descending and sigmoid parts of the colon.

Parietal Branches

Along the trajectory of *abdominal aorta* in abdominal cavity, it emits six pairs of *lumbar arteries*, which emerges from dorsal wall of aorta and supply the dorsolateral structures of the of abdomen wall, where produces the irrigation of structures of that region. The first pair of lumbar arteries arises at the same localization of *celiac trunk* origin, between the diaphragmatic pillars. The second pair arises in the eminence of renal arteries and the other pairs arises between the origin of external and *internal iliac A.a*..

The male specimens, in the left antimere, there is no evidence of *phrenic abdominal a*., but a *phrenic caudal a*. that origin in ventral aspect of aorta and follow to ipsilateral diaphragmatic pillar, without collateral emission in its course. On the other hand, in the right antimere, there is a *phrenic abdominal a*. that emerges in the cranial face of *renal ipsilateral a*. and emits collateral branches to suprarenal gland, abdominal wall and diaphragm. In contrast, females specimens, the *left phrenic abdominal a*. is present on the ventral-lateral face of aorta, slightly caudal to *cranial mesenteric a*. origin and in a shot space divides into *phrenic*, *abdominal* and *adrenal branches*.

Caudally to *caudal mesenteric a*. origin, arises the *left deep circumflex iliac A.a*., while the *right* arises from *external iliac a*. in a distal origin.

The largest branches of abdominal aorta are *external iliac A.a*., which arise from the lateral side on the terminal segment of aorta asymmetrically, and follow caudal-laterally to pelvic limb. The first branch of *right external iliac* is the *deep circumflex iliac a*. and the *left deep femoral*.

After *external iliac A.a*. origin, the aorta is slight thinner and follows caudally in the sagittal plane in a short interval until emits the terminal branches represented by *internal iliac A.a*. and *median sacral a*.

IV. DISCUSSION

Anatomical studies on wild animals have a considerable importance to the contribution and knowledge of species biology, since the body morphology structures reveal the natural history of the individual, including diet, reproduction and survival. Herein, we present the novelty of description of abdominal aorta branches of Coati (*Nasua nasua*), performed on dissection technique and comparative anatomical observations, contributing to the knowledge of the biological system from this specie.

The analysis of the anatomical material dissected in Coati reveals that descending aorta crosses diaphragm through aortic hiatus in agreement with the literature compiled in domestic and wild animals (Miller *et al*., (1964) in dog [6]; Culau *et al*., (2008) in *Myocastor coypus* **[10]**; Getty in SISSON & GROSSMAN (2008) in carnivorous domestic animals **[11]** ; da Silva *et al*., (2011) in *Saimiri sciureus L.***[12]**; Macedo *et al*., (2013) in *Tamandua tetradactyla* **[13]**; Bavaresco *et al*., (2013) in rabbit **[14]** and Pinheiro *et al*., (2014) in *Leopardus pardalis* **[15]**). This literature also shows the same parietal and visceral branches of abdominal branches dissected on the specimens of this study.

The first visceral branch of abdominal aorta is the *Celiac Trunk*, which leaves aorta through the ventral side, between diaphragm pillars, a similar condition described in dogs by Miller et al. (1964). The *Celiac Trunk* of Coati is divided into *hepatic a*., *left gastric a*. and *lineal a*.. The three arteries exhibit individual origin, in agreement with Culau *et al*., (2008) descriptions in *Myocastor coypus*, da Silva et al., (2011) in *Saimiri sciureus L. and* Pinheiro et al., (2014) in *Leopardus pardalis*. On the other hand, are reports of common trunks formation between branches of *Celiac Trunk*, as Miller *et al*. (1964) and Getty in Sisson & Grossman (2008) that showed in dog, a common trunk that eventually establishes between the left *gastric a*. and *lineal a*.. Macedo *et al*., (2013) demonstrated in *Tamandua tetradactyla*, that sometimes *hepatic a*. can arises from *cranial mesenteric a*., a condition not observed in Coati.

The second visceral branch of abdominal aorta in Coati is the *cranial mesenteric a*. that arises in the ventral face of aorta, caudally *Celiac Trunk* origin, supplying small and large intestines. This finding unanimous corroborate the compiled authors (Miller *et al*., (1964) in dog **[6]**; Culau *et al*., (2008) in *Myocastor coypus* **[10]**; Getty in SISSON & GROSSMAN (2008) in carnivorous domestic animals **[11]**; da Silva *et al*., (2011) in *Saimiri sciureus L.* **[12]** and Macedo *et al*., (2013) in *Tamandua tetradactyla* **[13]**).

Close and caudally to *cranial mesenteric a*., arises from the lateral side aorta, a renal artery in each side. The right renal a. appears more cranially than it contralateral. The right enters in the kidney without branching, whereas the left bifurcate in ventral and dorsal branches before enter in the kidney and sometimes emits small branches in its pathway, mainly for suprarenal

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gland. The observations in this research are in accordance with Miller *et al*., (1964) when they mention that in dog the *renal A.a*. origin are asymmetric, where the right is slight cranial in relation to the left, however the affirmation that each *renal a*. provides two or three branches to suprarenal gland, is not a condition observed in Coati. Other discordant affirmation is that each *renal artery* divides in dorsal and ventral branch, since this occurrence is present only in the left antimere of a specimen, therefore, is not a rule. Christensen in Miller *et al*., (1964) affirm that *renal A.a*. can be divided into seven branches before enter in the kidney, even as, in dog the *left renal A.a*. can be double.

The *Myocastor coypus renal A.a*. are asymmetric, where the right is cranial in relation to the left, although eventually the left could be cranial. They are generally unique but can be doubled **[10]**. Getty in Sisson & Grossman (2008), affirms that *renal A.a*. of domestic carnivores are asymmetrical, the right is more cranial and can be divided into dorsal and ventral branch, however in Coati such occurrence in the left antimere is verified only once. Macedo *et al*., (2013) affirm that in *Tamandua tetradactyla* both renal arteries divides before enter in the kidney. Pinheiro *et al*., (2014) describe that the *right renal A.a*. in male *Leopardus pardalis* is cranial in relation to the left, but the opposite occurs in females.

Coati *gonadal arteries* originate from the ventral aspect of abdominal aorta, between *renal A.a*. and *mesenteric caudal A.a*., where the left is more caudal in relation to the right. These observations are in agreement with Miller et al. (1964) in dogs; Getty in Sisson & Grossman (2008) in domestic carnivores; da Silva et al., (2011) in *Saimiri sciureus L.*; and Bavaresco *et al*., (2013) in rabbit. Meanwhile, Macedo *et al*., (2013) shows that *gonadal A.a*. of *Tamandua tetradactyla* originate from *renal A.a*..

The *caudal mesenteric a*. in Quati is a small vessel that arises in ventral face of abdominal aorta nearly *external iliac A.a*. origin and is intended for the final part of descending and sigmoid colon, in accordance with Miller *et al*., (1964) in dog; Getty in Sisson & Grossman (2008) in domestic carnivores; da Silva *et al*., (2011) in *Saimiri sciureus*; Macedo *et al*., (2013) in *Tamandua tetradactyla*; Pinheiro *et al*., (2014) in *Leopardus pardalis*. On the other hand, Bavaresco *et al*., (2013) cited that the rabbit *caudal mesenteric a*. is in rule single but eventually double, when in Coati this branch is every unique.

For Getty in Sisson & Grossman (2008), in domestic carnivores; Miller *et al*., (1964) in dogs; Culau *et al*., (2008) in *Myocastor coypus*; Bavaresco *et al*., (2013) in rabbit; and Pinheiro *et al*., (2014) in *Leopardus pardalis*, the *phrenic-abdominal* have eclectics origin and distribution, which can originate from *aorta*, *celiac trunk*, *cranial* or *renal mesenteric*, but frequently arises from aorta. Its ramifications is variable although commonly ramify into *phrenic caudal a*. and *cranial abdominal a*., apart from provide branches to suprarenal gland and adjacent tissues. Coati dissections and analysis reveal consistent data with the literature.

Regarding Coati *suprarrenal A.a*., are also observed a variable origin and distribution, since it arises from aorta, *phrenic-abdominal* or *renal A.a*., corroborating the compiled literature citations **[6, 10, 11, 12, 13, 14, 15]**.

The parietal branches of Coati abdominal aorta are *lumbar A.a*., in a number of six pairs. The first pair arises from dorsal face of aorta together the *celiac trunk*. The second, third and fourth pairs arises in regular distances along the aorta and the sixth pair arises between the external and internal *iliac A.a*., all then in individual branches, without trunk formation. Miller *et al*., (1964) describe that *lumbar A.a*. in dog are five pairs, where arises from a common trunk and the last can arises from a *sacral median a*.. Getty in Sisson & Grossman (2008), describe that carnivorous animals also have five pairs of *lumbar A.a*., Where the last pair can arises from a common trunk of *aorta*, *internal iliac* and *sacral median*.

The *deep circumflexes A.a*. of ileum are small vessels intended for dorsolateral wall of abdomen. The left circumflex arises from the lateral aspect of the aorta, cranial or caudally to the origin of caudal *mesenteric a*., while the right arises in the dorsal face of the *external iliac* near to *mesenteric a*. origin. Miller *et al*., (1964) state that dog *deep circumflex of ileum a*. arises from *cranial aorta* and *caudal mesenteric*, while Getty in Sisson & Grossman (2008) on domestic carnivores and Macedo *et al*. (2013) shows that in *Tamandua tetradactyla* this artery can arises from *external iliac*.

External iliac A.a. are the largest branches of abdominal aorta of Coati and arise asymmetrically from each lateral face and follow caudal and laterally to pelvic limb, without emerges other collateral branches in their path, in addition, *deep circumflex a*. of the right ileum and *deep bilateral femoral a*. that are its branches. Miller *et al*., (1964) in dogs and Getty in Sisson & Grossman (2008) in domestic carnivores animals shows concordant affirmations that corroborate the observations of Coati, except in relation to *deep circumflex iliac a*. that the authors refer arises from aorta. Culau *et al*., (2008) in *Myocastor coypus* and Bavaresco et al., (2013) in rabbit, affirms that a *common iliac* occurs before divides in *external* and *internal*, arising *sacral median a*. direct from aorta, on its dorsal face, cranially to iliac origin. Pinheiro *et al*., (2014) affirm that in *Leopardus pardalis*, the terminal branches of aorta are *external iliac a*., *internal*

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iliac a. and *median sacral a.* that represents a trifurcation of the aorta.

To Miller *et al.*, (1964) in dog and Getty in Sisson & Grossman (2008) in domestic carnivore animals, after arises *iliac A.a.* the abdominal aorta is begin slight and laterally divides in *internal iliac A.a.* continuing as *sacral median a.*, corroborating to Coati observations. Summarizing the present study demonstrated unpublished data about Coati anatomy and particularities specifications of the abdominal part of aorta, thus contributing to biological sciences development and description of important vessels on a comparative anatomical observation.

V. CONCLUSION

In conclusion, the present study demonstrated that the anatomic standard of abdominal part of aorta and the respective collateral branches in Coati, shows a similar template to mammalian animals and the detailed analysis of these abdominal vessels reveals particularities to this specie in small arteries as the *Phrenic-Abdominal*, *Suprarenal* and *Deep Circumflex Iliac*. Our findings contribute to the description and knowledge of a specifically important vessel in biological system of Coati.

CONTRIBUTORS

Marcos Paulo Batista de Assunção and Thalles Anthony Duarte Oliveira were responsible for acquisition, analysis and interpretation of data.

Thiago Sardinha de Oliveira and Lanussy Porfiro de Oliveira were responsible for preparation and revision of the manuscript.

Roseâmely Angélica de Carvalho Barros, Daniela Cristina de Oliveira Silva and Zenon Silva were responsible for concept and design, and for preparation of the manuscript.

All authors read and approved the final version of manuscript.

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CONFLITS OF INTERESTS

The authors declare no conflicts of interest associated with this manuscript.

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FIGURES

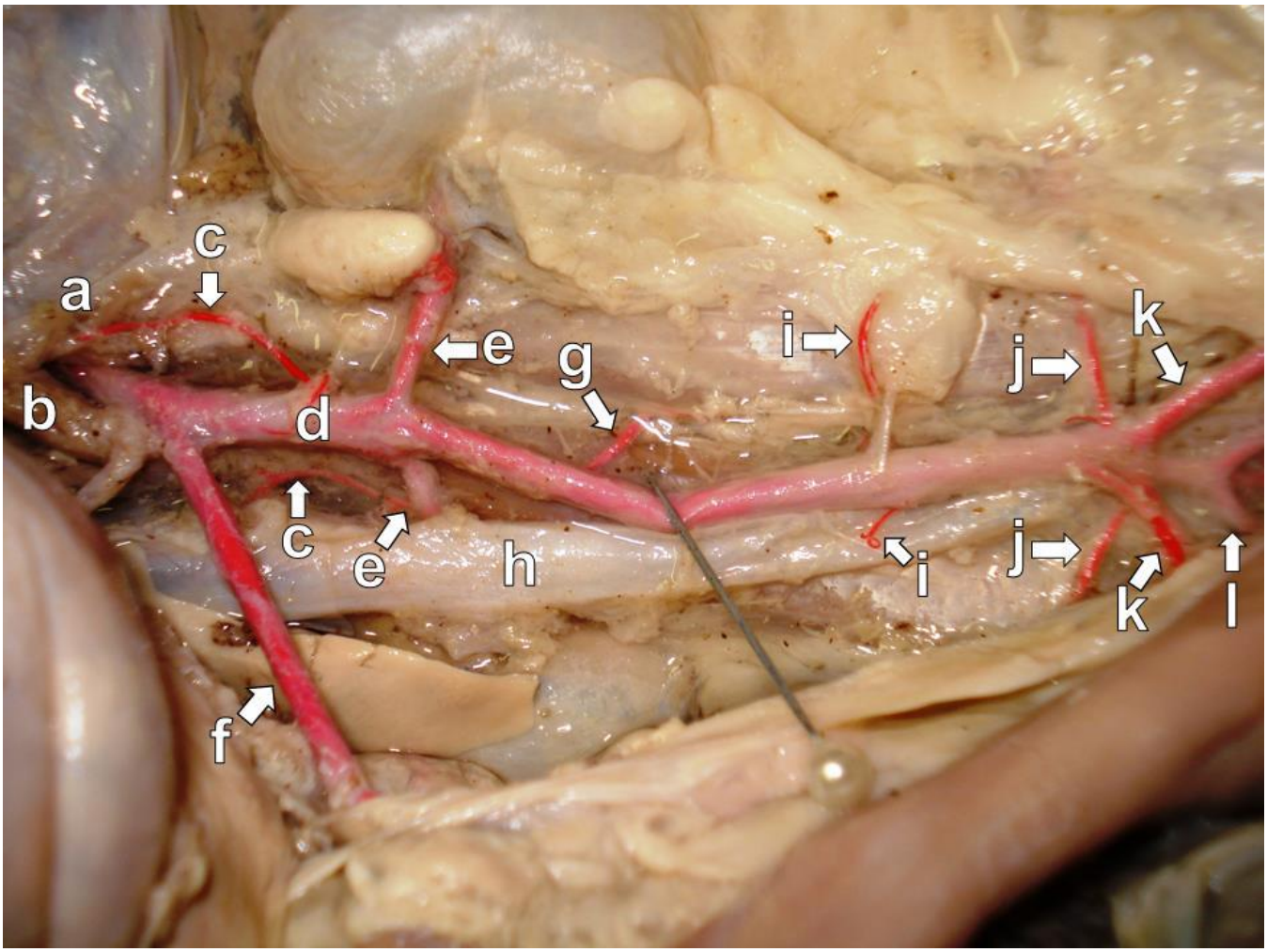

Fig.1: Ventral vision of dorsal wall in the abdominal cavity of Coati (Nasua nasua). a) left diaphragmatic pillar; b) right diaphragmatic pillar; c) right and left phrenic a.a.; d) abdominal aorta a.; e) right and left renal a.; f) cranial mesenteri c a.; g) lumbar a.; h) caudal cava vein; i) right and left ovarian a.a.; j) right and left circumflex abdominal a.a.; k) right and left external iliac a.a.; l) right and left internal iliac a.a..

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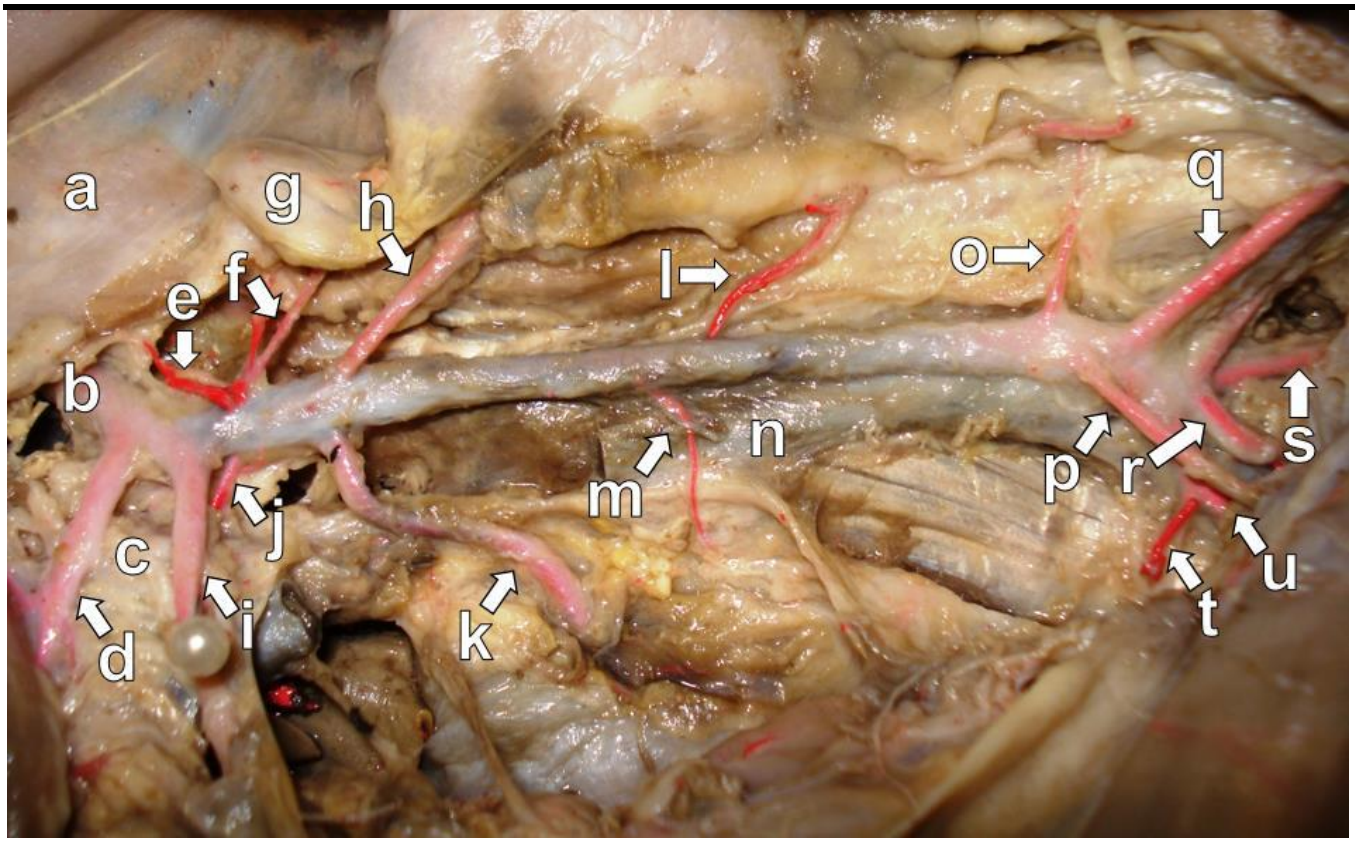

Fig.2: Ventral vision of dorsal wall in the abdominal cavity of Coati (Nasua nasua) (Second picture). a) left diaphragmatic pillar; b) abdominal aorta a.; c) right diaphragmatic pillar; d) celiac trunk; e) left phrenic a.; f) left suprarenal a.a.; g) suprarenal gland; h) left renal a.; i) left ovarian a.; j) right phrenic a.; k) right renal a.; l) left ovarian a.; m) right ovarian a.; n) caudal cava vein; o) left circumflex iliac a.; p) caudal mesenteric a.; q) left external iliac; r) right internal iliac; s) median sacral a.; t) right circumflex iliac a.; u) right external iliac.

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Evaluation of the Impacts of the Macrodrenagement Works of the Tucunduba River: Case Study of the Community of Pantanal - Belém, Brazil.

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Abstract*—This research investigates the social and sanitary situation of the Pantanal community located in the city of Belém, Pará. The methodology used sought to identify, in a quantitative and qualitative way, the positive and negative impacts of the macro drainage works of the Tucunduba watershed. Data collection was carried out by means of a semistructured questionnaire with an evaluation character, with the purpose of performing a Socioeconomic and Environmental Regressive Analysis (SEA), making a comparison before and after the beginning of the works. The result shows a social and sanitary improvement of the community, however there are caveats regarding changes in the execution and delays in the works that generated several disorders to the community.*

***Keywords*—Environmental sanitation,Hydrographic basin, Macrodrain.**

I. INTRODUCTION

Throughout the process of urban occupation of the city of Belém, areas of flooded land were occupied by an impoverished population that found in these lands, economically devalued, a housing solution near the main nucleus of the city (PENTEADO, 1968). These are floodplain or floodplain areas known as "plains," officially used by the government in the 1970s to designate irregular and poor occupations.

The main strategies for intervention in lowlands carried out by public authorities have been through macrodrainage projects with the objective of reorganizing and integrating these areas in the "formal" city and that would allow the expansion of infrastructure for the real estate market (ABELÉM, 1980). In this context, there is the macro drainage project of the Tucunduba stream that aims to interrupt the flood and structure the area.

Based on these meanings, this article aimed to investigate the socioeconomic and sanitary situation of the pantaneiro complex located on the banks of the Tucunduba river and to identify the positive and negative impacts of macrodrainage work, making a comparison since the beginning of the first. interventions for the year 2018, based on Socioeconomic and Environmental Regressive Analysis (SEA).

II. MATERIAL AND METHOD

The research consisted of a mixed, qualitative and quantitative research approach, through bibliographical and field research. Regarding the objectives, the research was descriptive and evaluative, since it was intended to describe and evaluate the environment in transformation in recent years, giving special attention to community health issues and to the positive and negative changes during the Tucunduba macrodrainage works.

In the field surveys, different data collection instruments were used, based on in situ observations, informal conversations, image capture and application of a questionnaire to residents of the Pantanal community in Belém - PA, on November 10, 2018.

The semi-structured questionnaire was constructed with the objective of performing a Socioeconomic and

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Environmental Regression Analysis (SEA) on the positive and negative impacts of the Tucunduba macrodrainage work. As a reference, the period used for the regression analysis of the SEA was 20 years, between 1998 and 2018, since it comprises the period of time in which the project was implemented.

The evaluation instrument worked in four dimensions: socioeconomic, basic sanitation conditions, macrodrainage impacts and vision of the future. Each attribute was evaluated by the following scores: 01 (very low); 02 (low); 03 (average); 04 (high); and 05 (very high), making a comparison between the period analyzed above. After assigning the scores on the different attributes, calculations were made to measure the indices of advancement and / or regression of each dimension, in order to perform the Regressive Analysis. The calculation of the indices was performed by the sum of the scores assigned to each attribute, divided by the sum total of the scores 05 (very high), ie $i = e1 / 5 + e2 / 5 + e3 / 5 + \cdots$. Thus, the calculated indices could go from zero to one (0-1), and the closer to one (1), the better the index, so the better the dimension was evaluated. On the other hand, the closer to zero (0), the worse the index, the less well evaluated was the dimension. The resulting indices allowed for quantitative assessments, in each dimension, if there were advances or setbacks.

Historical contextualization of the tucundubamacrodrenage project

The Tucunduba Basin covers the neighborhoods (University, Terra Firme, Guamá, Canudos and Marco) of three Administrative Districts (DAGUA, DABEL and DAENT). It has an approximate population of 161,499 inhabitants. Historically, the occupation process has advanced on the institutional areas belonging to the Union (UFPA, FCAP, EMBRAPA, Emílio Goeldi Museum). In these areas, occupations were carried out by low-income population. All of them were marked by urban land conflicts centered on the struggles for the right to housing, intensified mainly in the 1980s, over river beds.

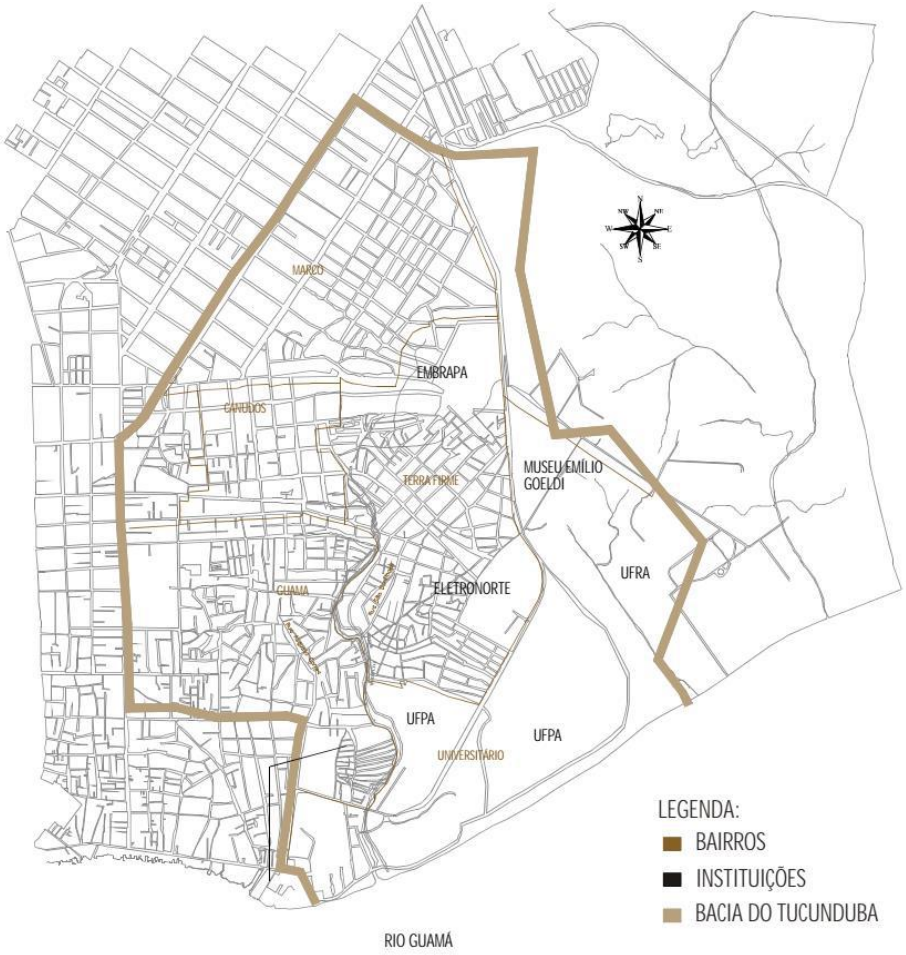

Fig 1. basin of the Tucunduba River.

It is an area historically occupied by "stilt houses" constructed in waterways, where basic sanitation services do not exist or are insufficient. The situation of poverty is characterized by unemployment, underemployment, high levels of violence and crime, and is therefore responsible for the creation of an urban environment of low sustainability, compromising living conditions that make socioeconomic inclusion unfeasible.

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In these areas, the first actions were carried out by the residents themselves, opening streets, landing with wood sawdust and açaí stones, but this was insufficient to solve the problems of floods and floods. Faced with these difficulties, the popular neighborhood movements were consolidated, which began to denounce the precarious conditions of life in these urban spaces. Among these popular movements is the community of Pantanal, consolidated in the area since the beginning of the occupations.

The first drainage works in the basin began in 1993, with the macro drainage of the canals of the Angustura, Leal Martins, Timbó and Vileta junctions in Marco neighborhood. However, these interventions were timely and were being carried out according to the availability of funding.

In 1998, after the re-evaluation of the projects, the Tucunduba Project was developed, involving partnerships between the Federal Savings Bank, the Federal University of Pará, nongovernmental entities and leaders representing the interests of the population residing in the area. The general objective of the project is to "revitalize flooded areas of the Tucunduba Basin through: physical and environmental interventions, social inclusion of residents, generation of work and income, encouraging the permanence in the place, and creating management participatory in the maintenance of the public good "(PMB, 1999, p.3).

The Tucunduba Project appears as a proposal for urban intervention based on local economic development and urban environmental management, prioritizing the recovery of degraded areas, located in the outskirts of the city of Belém (BARBOSA, 2003). This project is part of the Program "Management of Urban Rivers: City of Belém dos Rios". Initially, the project was financed with 73% of the FGTS loan proceeds, managed by the FGTS Curator Council and CAIXA, with a counterpart of 27% of PMB's own resources.

Every two years, CAIXA promotes the choice of 20 Best Practices in Local Management, articulated with the "Best Practices and Local Leadership Program" (BLP), conducted by UNCHS / HABITAT. In 2001, the Tucunduba Project was one of the practices awarded by the CAIXA Best Practices Program for Local Management (BARBOSA, 2003).

The project was divided into three stages; the first phase would cover 1,250 meters of the igarapé, between Av. Perimetral and Rua São Domingos, corresponding to a third of its route; the second phase, between Rua São Domingos and Av. Gentil Bittencourt, with an extension of 1,100 meters; the third phase, between Av. Ponte Gentil Bittencourt and Vileta, 1,000 meters long, the first phase being executed in the early 2000s and completed in 2004 in the project project (LEÃO, 2013).

The macro-drainage work of the Tucunduba basin was resumed in 2016, after twelve paralyzed years, beginning the second stretch with changes in the initial project, disregarding the revitalization of the ciliary forest and concreting the banks of the igarapé transforming it into a canal.

According to a state government website, the works should include "the opening and paving of new runways, the construction of pedestrian walkways, bicycle paths, drainage and dredging of the canal and the construction of three concrete bridges and a metal walkway." The second stretch is scheduled to be completed in April 2019.

III. REGRESSIVE SOCIOECONOMIC AND ENVIRONMENTAL ANALYSIS (SEA): THE BEFORE, THE NOW AND AFTER THE MACRODRENAGE WORKS OF THE TUCUNDUBA.

With the beginning of the works many families were relocated, this process was initially intended to transfer people to places close to the intervention area with the concern of setting them in places with access to infrastructure and the continuity of their activities. However, it was difficult to find nearby areas, and the Municipality of Belém (PMB) adopted new strategies by relocating the families to outlying settlements in Tucunduba or by purchasing dwellings pointed out by the residents.

In 2001 PMB created a complementary project to the Tucunduba project, the Local Development Plan (PDL) RiachoDoce and Pantanal, communities located in the intervention area of the first phase of the macrodrainage. This PDL emerged as an attempt to correct the distortions that occurred in the Tucunduba project, especially in the disrespect for housing and living conditions of the population (LEÃO, 2013).

The Pantanal set, a research site, was built with the objective of contributing to the improvement of the quality of life of families, through land regularization actions, urban infrastructure, housing improvements, environmental education, work and income generation BARBOSA, 2003).

It can be observed in graph 01 that the attributes evaluated in the socioeconomic dimension suffered a great variation. The index rose during the analyzed period. This growth can be attributed to the constant interventions that the area has undergone in the last 20 years. Although the works are in trouble and still leave many residents unsatisfied, the area has already had important advances, such as building a school in the neighborhood and a health post. Today, the place has trade shows and a variety of trade.

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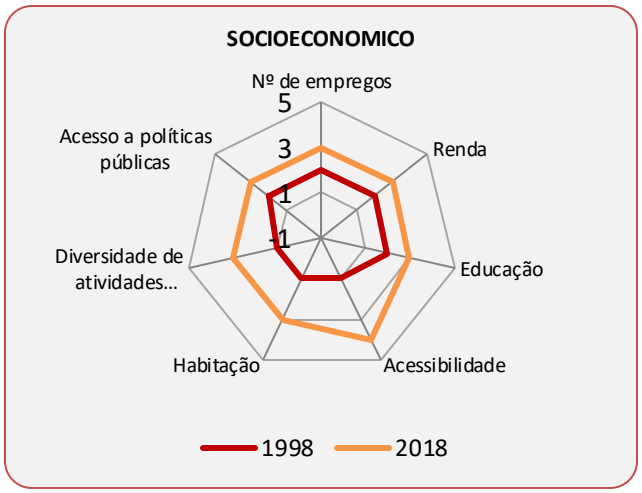
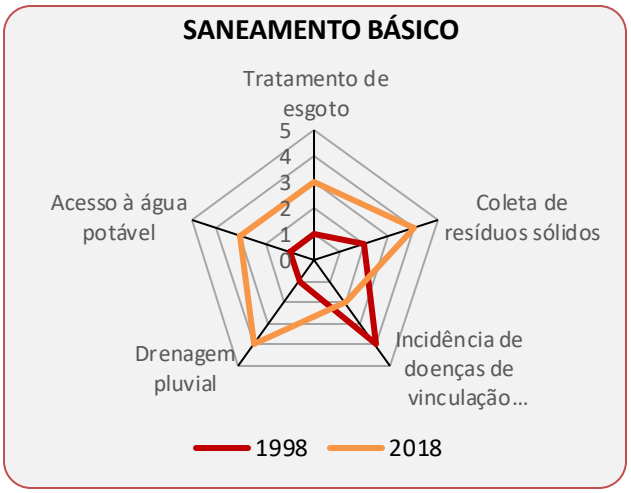


Graph 1. Socioeconomic analysis.



Graph 2. Basic sanitation.

Basic Sanitation Conditions

The basic sanitation index had a positive jump, but in a subtle way, taking into account the years since the Tucunduba Project. The treatment of sewage had an improvement considering that before the PDL the dwellings were style stilts, without a suitable bathroom, with direct eviction in the igarapé. All the Pantanal houses have septic tank, but there is no collection for a sewage treatment plant, another problem is the irregular occupation installed in the riverbank that spills untreated sewage.

The PDL RiachoDoce and Pantanal brought to the community drinking water supply, a service provided by the Companhia de Saneamento do Pará (COSANPA), which structured the entire Pantanal complex. With the long stalling of macrodrainage works, new irregular occupations were made in areas that had already been vacated with the relocation of families, which caused clandestine connections in the Pantanal's supply network interfering with water pressure and quality.

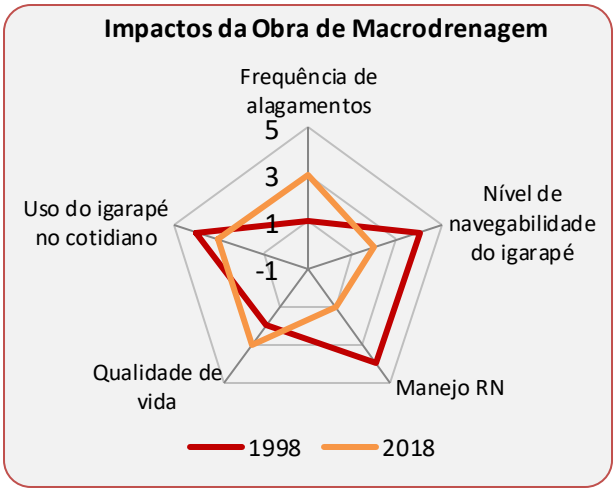
The collection of solid waste is done daily, but the community has serious problems with the irregular dumping of rubble. Despite the leadership of the group community in trying to raise public awareness, actions are isolated and of low effect.

As a result of improved sanitation conditions, the incidence of water-borne diseases has declined. According to reports from older residents, it was common for children and adults to have intestinal pain, diarrhea and even schistosomiasis, and there was no health clinic in the locality. Currently, in addition to access to drinking water, this situation has improved, residents consume mineral water and there is a medical center to serve the community. In the chart below we can see in a general way the variation of the evaluated scores.

Impacts of macrodrainage work

The first Tucunduba project planned to recover the entire riverbank, maintain its navigability and adequate conditions for community subsistence was executed only in the first stage, which competes from the voice to Rua Santo Domingos at around 1,250 meters. A part of this area is inside the UFPA and one can see a navigable stream with ciliary forest and without pollution.

With the re-evaluation of the initial project, the second stage is being carried out transforming the river into a canal, discarding the possibility of revitalization of the stream and maintenance of local community customs for subsistence use. Before the interventions, the river was wide, containing large vessels with goods circulation. Currently, the use of the river for trade and navigation is practically non-existent, only small boats known as "rabeta" can circulate.



Graph 3. Impacts of macrodrainage work.

IV. CONCLUSION

The Tucunduba Project was thought to be an innovative structural intervention associated with the socioeconomic-cultural development of the city of Belém, whose objective

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was the mobilization of a globalizing productive territoriality. However, with the redesign of the project, the innovative idea of river revitalization, port implementation and a new urban river management model, which made the project nationally recognized, did not materialize.

The macro drainage of the Tucunduba Basin no longer fulfills its sustainable role from the beginning of the second stage. Being implemented only as a physical intervention, the project stops implementing actions such as participation and social control and to carry out education and environmental management control campaigns.

Given what was observed in the field and in an interview with the residents of the Pantanal complex, it can be seen that access to basic sanitation services improved considerably compared to the situation prior to the project. However, it is still not ideal, the community goes through problems of water supply and irregular dumping of solid waste. The river still has stretches with its irregularly occupied bed and untreated sewage dump, a situation that could have been avoided with the continuity of the works within the initially planned schedule.

Thus, it can be concluded from this research that the Tucunduba Project brought structural and socioeconomic advances in the accomplishment of its first stage. However, the long years of work stoppage and the restructuring of the initial project caused negative impacts on the population. The low involvement of the community in the decisions and, mainly, the lack of complementary actions of social control and environmental education causes the river to continue being occupied in an irregular and polluted way.

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Evaluation of Acoustics in the built Environment, Mapping and Estimation of noise in the Stamping Sector of a Metallurgical Industry

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Abstract**—** *In this work a study of the acoustic problem in a metalworking industry of the Industrial Pole of Manaus, Brazil is carried out. The aspects related to the industrial environment such as the constructive aspects and the machineries in an area of stamping were analyzed. A mapping of the entire area of interest was carried out and the noise measurement points were selected at three different times, morning, afternoon and night. The results of the statistical analysis performed using statgraphics software demonstrate that there are no statistically significant differences between the noise levels achieved in different work shifts and that this condition is met for the case where the machines are working or not. The study considered to determine the areas that have the greatest noise affectation, proving that the average value achieved does not differ statistically between the different internal areas of the stamping process. All the information obtained serves as a guide for the company to establish the control measures, it is estimated that there will be a reduction of the levels of Sound Pressure Levels (SPL) emitted by machinery from the printing industry to the environment, guaranteeing a better quality of life for workers during the industrial working day.*

Keywords**— Assessment in Acoustics in the Built Environment, Occupational noise, Stamping industry, Metallurgical industry.**

I. INTRODUCTION

The industrial environment provides several problems related to acoustics and its construction. Observing the aspects of comfort, it is seen that the architectural projects assign greater relevance to the thermal, ergonomic and lighting aspects, to the detriment of the aspects directed to the acoustic treatment [1, 2]. This can be attributed to the fact that the assessment of the level of sound by the human ear is different from the evaluation of the distance by the eyes or the weight by the arm [3]. In this way, the negative acoustic interferences of the environment are not always easily perceived by the user.

Within the industry landscape, the issue of acoustic comfort usually does not receive the relevant concern it deserves. To control exposure to high levels of SPL, Individual Prevention Teams are traditionally used – IPE (Individual Protection Equipment), which act as palliatives, causing little intervention in the sources of noise emission (machinery), and minimal or no concern with the built environment, which justifies the relevance of studying the propagation of sound in indoor environments, since the machinery, the largest source of noise, is also a key component of factory productivity. Concerns about solutions to problems related to the comfort of industrial buildings have been increasing in Brazil [4].

The discussion of control of the problem of occupational noise also addresses factors that may be responsible for the worsening of the real condition, such as the use of constructive materials unfit for sound absorption and the lack of acoustic comfort guidelines that make it difficult to control SPL in the environment [5].

In order to better characterize and create effective proposals for the noise problem in the industrial environment, we intend to create an integration relationship between two physical space evaluation tools: the formal and systematic process of Post-Occupancy Assessment – POS and the physical space management process, seeking the real scenario of the environmental

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conditioners through a management system that allows the detailing of the investigations [6].

For the Brazilian Association of Technical Standards - ABNT (1987), the concept of noise is the mixture of tones whose frequencies differ from each other, due to the value inferior to the discrimination (in frequency) of the ear.

There is also classification according to the variation of noise according to the standard IS02204/1979, also in the standard NBR 10152 [7].

• Continuous - noise with variations of negligible levels (up to ± 3dB) during the observation period;

• Intermittent - noise whose level continuously varies from an appreciable value (greater ± 3dB) during the observation period;

• Impact or impulse noise - that which presents in acoustic energy peaks lasting less than one second. The waveform of this type of noise is often described by amplitude and duration, the amplitude being measured at the maximum peak, and the duration is the time the wave takes to drop 20 dB from its normal level.

He asserts that the main reactions and behavior of the wave are: transmission, absorption, reflection and diffraction. These reactions depend on the characteristics of the material that compose the incident obstacle of the spherical wave [8], according to figure 1.

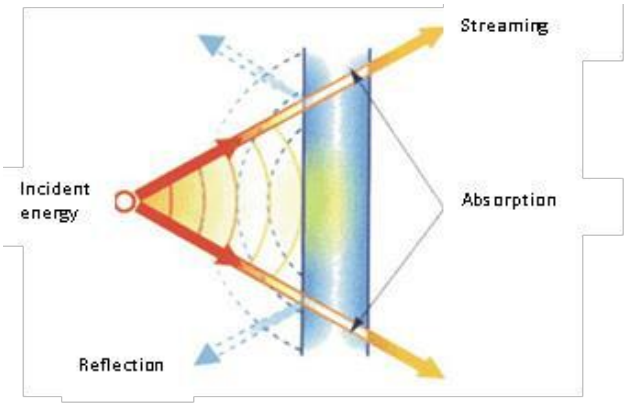

Fig.1: Scheme of the behavior of the wave incidence. Source: [8].

1.1 Industrial noise

The issue of industrial noise is directly related to the use of machines that are the tools of production, [8] describes the origin of industrial noise as the vibrations of the equipment in operation, which excite several parts of the equipment itself or parts attached to it.

For the characterization of the acoustic condition of an environment to be studied, it is necessary to understand that the architecture and the sound are inseparable, since the space by itself already presents certain loudness.

For [8] industrial noise originates from machines operating in industry and, as it should not be, comes from the vibration of bodies, surfaces and machines, which are caused by the movement of moving parts of machines, utensils and any objects that are excited by such vibrations.

According to [9], the mere existence of closures in an enclosure gives rise to reflected sounds and implies the emergence of 'reverberating intensity'. From the acoustic point of view, it will always be desirable to sound and reverberation. The basic points to be considered in this regard are the acoustic characteristics of building materials.

They argue that the result of these collections can be transposed to a graphical representation called acoustic map, which are charts that represent the noise actually existing in a given area, and can be obtained through measurement and / or through computational instruments [9]. The map allows to visually identify the critical areas of an environment, determining the priority points for the intervention, characterizing all physical space according to the sound levels.

The general noise regulation and the definition of the ceiling of SPL that are acceptable according to the activities carried out are defined by some institutions that specify the limits [7].

Therefore, the objective of this work was to evaluate the non-machinery and non-ambient noise levels (stamping sector) of a metallurgical industry, to diagnose the problems of the built environment and to identify areas with greater SPL.

1.2 Sound spectrum

The sonorous spectrum is an approach little explored in general terms of the concern with the selection of hearing protectors, the characteristic that distinguishes between serious sounds and acute sounds is called height, which is a function of frequency [10].

The set of infrasounds, audible sounds and ultrasound is called the sound spectrum. Infrasounds have a frequency less than 20 Hz. Audible sounds for humans have a frequency of 20 Hz to 20000 Hz. Ultrasound have a frequency above 20000 Hz. waves of lower frequency and of greater length while ultrasound have higher frequency and lower length [11].

II. MATERIALS AND METHODS

The methods for the results to be obtained in the intervention project in the stamping PLOTAM da Amazônia LTDA were organized as follows:

2.1 Survey of physical aspects:

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It was developed through photographic record, in loco measurements, quantification of the area occupied by material, reporting on the physical aspects of the production line.

a) External composition:

The building presents a diversified characterization of building materials. The front, bottom and sides of the industrial building is constructed of concrete masonry and complemented with galvanized plates, according to Figure 2.

Fig.2: Zinc Plates and Concrete Masonry.

b) ***Detailing of materials:***

1→Galvanized sheets 2→Masonry wall (concrete block).

c) Internal composition:

The internal composition of the industrial building does not differ from the external characteristics of the absorption coefficient because it has the predominant material, both in the structure of the building and in the covering and in all the machinery of the production, according to Figures 3 and 4.

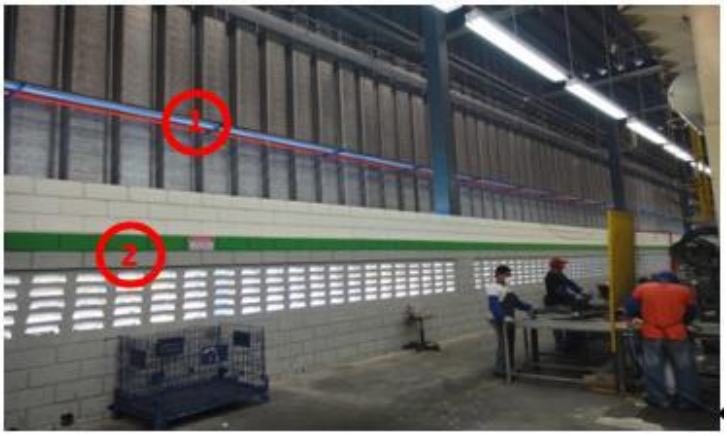

Fig.3: Metal structures and roofing with zinc and polycarbonate tiles.

d) Details of materials:

1→Zinc sheets 2→Masonry wall (concrete block).

Fig.4: Organization of internal space.

e) Materials:

- Galvanized sheets
- Masonry wall (concrete block)
- Metal structure
- Metal elements

f) Survey of Sound Pressure Levels - SPL:

It was used the GERGES methodology [12] and NHO [13], with the brand decibel meter: INSTRUTHERM Model: DEC-416, calibrated by INSTRUTHERM CAL 1000; the measurement data was collected on the four sides of each machine, according to Figure 5.

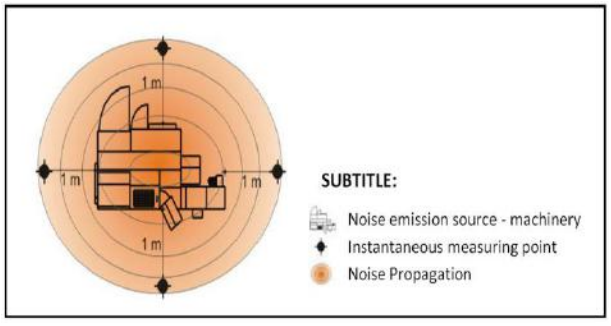

Fig.5: Instant measurement collection.

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A total of 45 sources were mapped (Figure 6) and 180 measurements were performed at three different times, being 9:30 p.m., 3:30 p.m. and 8:30 p.m. This step determined the priority sources of SPL emission within the production line and checking which schedule is noisier.

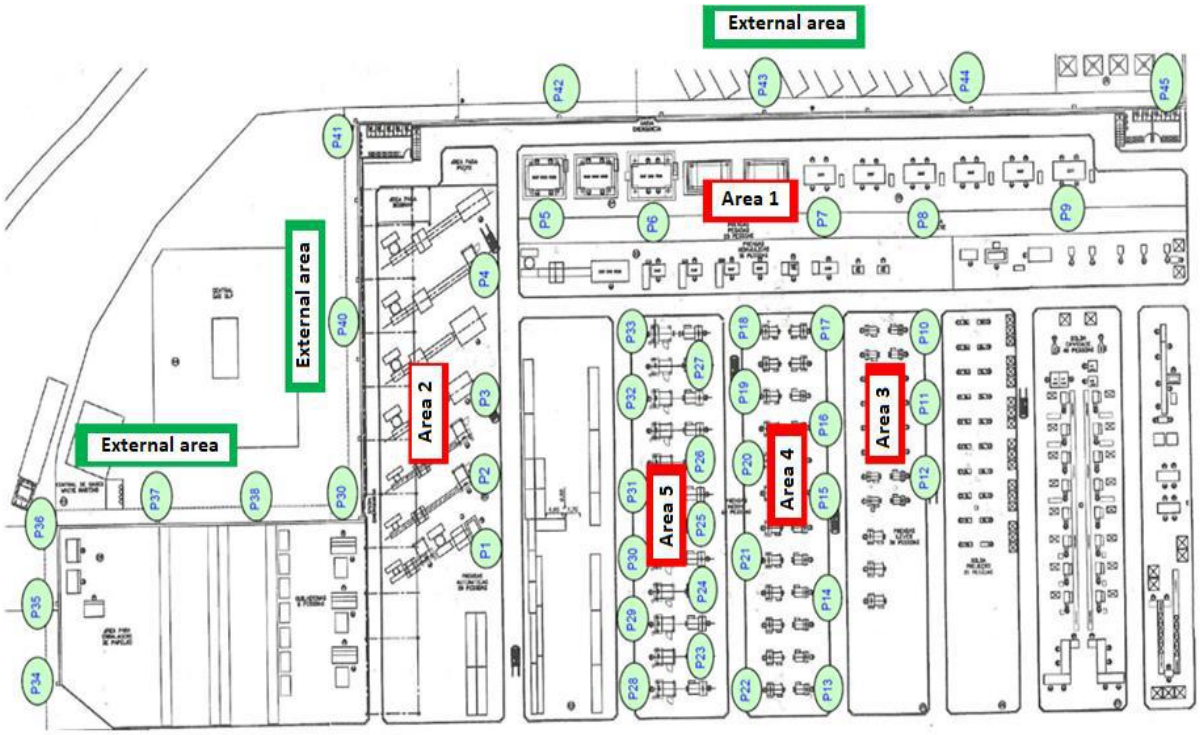

Fig.6: Stamping Sector - Font Map.

g) Statistical analysis of data.

Where:

Sample 1: MED 1 Measurements at 9:30 with machines running.

Sample 2: MED 1 No Measurements at 9:30 am the machine is not running.

Sample 3: MED 2 Measurements at 15:30 with machines running.

Sample 4: MED 2 No Measurements at 3:30 p.m. not working.

Sample 5: MED 3 Measurements at 8:30 PM with machines running.

Sample 6: MED 3 No Measurements at 8:30 PM on machines not working.

The software Statgraphics Plus v. 5.1 was used in Spanish to analyze the noise measurement data from the PLOTAM production process in Amazonia, in three different working hours and with or without operating conditions of the process machines.

We used the option of comparing multiple data samples and obtained numerical and graphical options, such as; Tabular Options: Procedure Summary

Statistical summary; ANOVA Table (Analysis of Variation); Table of Averages; Multiple Row Contrast (LSD); Contrast of variation; Tests of Kruskal-Wallis and Friedman [14];

Graphic Options: Scatter plot; Chart of Averages; Box and Mustache Graphics; Residue in front of the Exhibition; Waste versus Predito; Residual against the observed Average Analysis Chart (ANOM).

The process was divided into 5 work areas A1 through A5; and compared the noise levels between the areas for the same working hours.

Where, according to the attached plan of procedure:

Area 1: p1-p4

Area 2: p5-p9

Area 3: p10-p12

Area 4: p17-p22

Area 5: p23-p33

Ext. Area: p34-p45.

III. RESULTS AND DISCUSSION

3.1 Survey of physical aspects:

As the presses machines presented SPL in a range of 85.3 - 94.1dB were identified as due to the electric motor being coupled directly to the metallic body of the machine's sealing and control which, when vibrating, causes resonance to further aggravate the noise initially generated by the motor, according to Figure 7. This condition is repeated in several machines within the production line

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Fig.7: Partial view of the motors and general of the metal body of the presses.

The presses presented SPL in a range of 88.2 - 89.1dB, although they did not have continuous use. When connected, they generate high SPL due mainly to impact noise and, because it is an old machine, vibrates and transmits this vibration to the floor and adjacent equipment.

One aspect observed was the impossibility of total insulation of the motors of the presses due to their physical composition and to the interference in the operability of the production, which further aggravates the acoustic conditions of the environment as a whole.

Although all the presses already have vibration dampers, some of these need to be replaced because they do not present any more functionality in the operation, as shown in Figure 8.

Fig.8: Vibration damper with low efficiency.

The compressed air nozzles used for the cleaning of the metal chips, both of the parts and of the workers themselves, have a very variable time of use, but required several times during the working day, have SPL in the house of 110dB at each moment of use and in certain points this is used continuously, according to Figure 9.

Fig.9: Air nozzle without proper nozzle.

Fig.10: Storage boxes without lining.

It was observed that the carriages of transport of pieces, storage boxes and tables of support to the process do not have lining in its interior. (Figure 10).

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It was observed that the carriages of transport of pieces, storage boxes and tables of support to the process do not have lining in its interior. (Figure 10).

3.2 Calculation of Reverberation Time

Survey of physical aspects of the production line, such as building design, construction characteristics, photographic record, graphic representations of the building configuration, application of the Sabine formula for the frequencies of 125Hz, 500Hz and 2000Hz.

The Reverberation Time Calculation was designed for the company's production line environment in the frequencies 125Hz, 500Hz and 2000Hz. Using the absorption coefficients of the existing materials in the physical configuration of the building from the NBR–10152 [15] e [16], the Real Reverberation Time (TRR) can be found through the Sabine Formula, according to Annex 1, and the correction is made for the frequency of 125Hz, also according to the recommendation of the NBR –12179 [17].

The existing building materials in the evaluated environment have predominantly reflective characteristics to the sound, such as metal plates and structures, masonry walls, zinc tiles, among others. All the metallic machinery and the ambient volume of 18,000 m^3 are significant for the propagation of noise, making the difference from the ideal to the real, as can be observed in the results shown in Table 1 between the comparison of the calculated TOR and the recommended TOR in the NBR-10152 standard.

Os materiais construtivos existentes no ambiente avaliado possuem características predominantemente reflexivas ao som, como chapas e estruturas metálicas, paredes de alvenaria, telhas de zinco, entre outros. Todo o maquinário metálico e o volume do ambiente de 18.000m^3 são significativos para a propagação do ruído, fazendo a diferença do ideal para o real, como pode-se observar nos resultados demonstrados na Tabela 1 entre a comparação do TR calculado e o TOR recomendado na norma NBR-10152 [15].

Table 1: Comparison between Calculation of TR found and TOR recommended.

Frequency	125Hz	500Hz	2.000Hz
TR Calculated (s)	5,77	5,72	7,1
TOR Recommended (s)	2,45	1,69	1,69

The result showed a very marked difference between the TR found and the TOR recommended by the standard. There was no concern regarding the acoustic quality of the industrial environment, both as regards the architectural design and the choice of the elements that compose the noisy environments.

The high noise is due to machines, equipment and tools existing in the production line, built of predominantly metallic components, generating noise due to their own conditions, and also due to the advanced life of the equipment.

INTERNAL MEASURES IN THE PROCESS OF INDUSTRY

As the presses machines presented NPS in a range of 85.3 - 94.1dB were identified as priority because the electric motor is coupled directly to the metallic body of the machine's sealing and control that, when vibrating, causes resonance aggravating even more the generated noise initially by the motor, according to Figure 7. This condition is repeated in several machines within the production line.

The presses presented SPL in a range of 88.2 - 89.1dB, although they did not have continuous use. When connected, they generate high SPL due mainly to impact noise and, because it is an old machine, vibrates and transmits this vibration to the floor and adjacent equipment.

One aspect observed was the impossibility of total insulation of the motors of the presses due to their physical composition and to the interference in the operability of the production, which further aggravates the acoustic conditions of the environment as a whole.

Although all the presses already have vibration dampers, some of these need to be replaced by not be more functional in the operation, according to figure 8.

The compressed air nozzles used for the cleaning of the metal chips, both of the parts and of the workers themselves, have a very variable time of use, but required several times during the working day, have SPL in the house of 110 dB at each moment of and in certain points it is used continuously, as figure 9.

3.1 Statistical analysis of data.

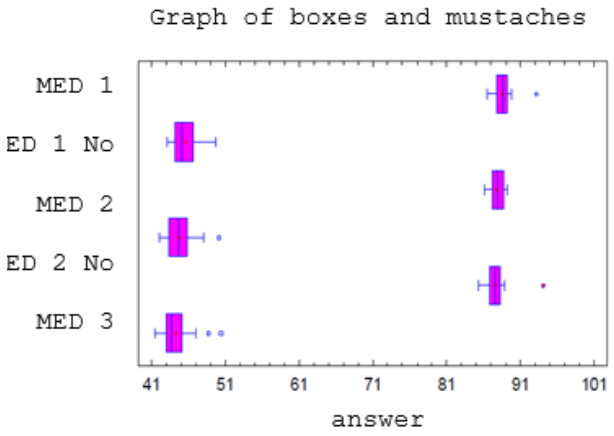

Fig.11: Graph of boxes and mustaches.

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In Multiple Queue Tests, Least Significant Differences (LSD) are used to determine the means that are significantly different from each other, as shown in Table 2.

Contrast Múltiple de Rango					
Method: 95,0 percentage LSD					
Frequency.			Average	Homogeneous group	
MED 3	No	33	44,2697	X	
MED 2	No	33	44.7606	X	
MED 1	No	33	45,5727	X	
MED 3		33	87,5485	X	
MED 2		33	87,8212	XX	
MED 1		33	88,5242	X	
Contrast				Differences	+/- Limits
MED 1 - MED 1 Não				*42,9515	0,75346
MED 1 - MED 2				0,70303	0,75346
MED 1 - MED 2 Não				*43,7636	0,75346
MED 1 - MED 3				*0,975758	0,75346
MED 1 - MED 3 Não				*44,2545	0,75346
MED 1 Não - MED 2				*- 42,2485	0,75346
MED 1 Não - MED 2 Não				*0,812121	0,75346
MED 1 Não - MED 3				* - 41,9758	0,75346
MED 1 Não - MED 3 Não				*1,30303	0,75346
MED 2 - MED 2 Não				*43,0606	0,75346
MED 2 - MED 3				0,272727	0,75346
MED 2 - MED 3 Não				*43,5515	0,75346
MED 2 Não - MED 3				* - 42,7879	0,75346
MED 2 Não - MED 3 Não				0,490909	0,75346
MED 3 - MED 3 Não				*43,2788	0,75346

* indicates a significant difference.

The asterism that is next to the 12 pairs indicates that they show statistically significant differences at a 95.0% confidence level. At the top of the page, 4 homogeneous groups are identified according to the alignment of the sign X in the column. within each column, levels that have sign X form a group of means between which there are no statistically significant differences.

As can be seen in the table, there are significant differences between the noise levels measured in the process when the machines are running or not, for any working time (column pairs of values: MED 1-MED 1 No; MED 2- MED 2 No, MED 3-MED 3 No).

The differences between noise levels for running machines are not significant between morning and afternoon measurements (MED 1-MED 2) and between afternoon and evening (MED 2-MED 3). The differences are significant but in a low fly between the measurements performed in the morning and at night (MED 1-MED 3). There are also no significant differences between mean levels of noise between the afternoon and evening hours (MED 2-MED 3).

That is, average noise levels at any time are around 88 dB, which is high according to Standard NR 15.

The comparison of two samples of noise measurement values at the same time but with the machines running and not running (Example MED1-MED1 No) reflects the following:

Sample 1: MED 1

Sample 2: MED 1 No

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Contrast Múltiple of Range					
Method: 95,0 percentage LSD					
Frequency			Average	Homogeneous groups	
MED 3	Não	33	45,5727	X	
MED 1	Não	33	45,5242	X	
Contrast				Differential	+/- Limits
MED 1 - MED 1 Não				*42,9515	0,73583

The asteristic that is next to one of the pairs indicates that it shows a statistically significant difference at a 95.0% confidence level.

That is, there are significant significant differences in noise levels when the machines are running or not. The graph of Figure 12 shows the mean values achieved and typical intervals of the measurement values with respect to the average morning noise levels.

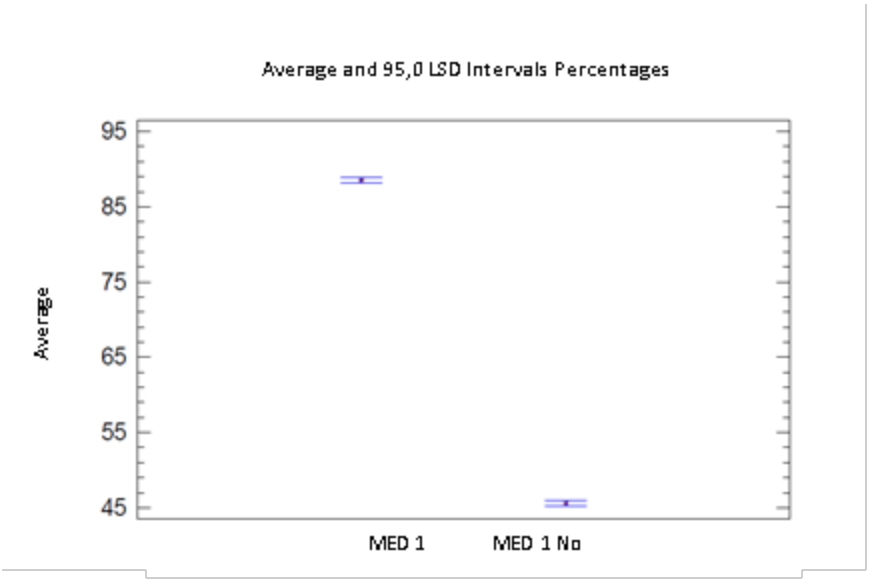

Fig.12: Averages and percentages of LSD intervals

Comparison between work areas for the same working time with machines running. For the morning time (MED1).

STATISTICAL SUMMARY

	Frequency	Average	Variance	Typical deviation	Minimum
Area 1M1	4	88,725	2,86917	1,69386	86,7
Area 2M1	5	88,82	2,357	1,53525	87,6
Area 3M1	3	88,2667	10,2933	3,20832	85,2
Area 4M1	6	89,1667	2,82667	1,68127	87,3
Area 5M1	11	88,3091	0,560909	0,748939	87,2
Total	29	88,6276	2,2085	1,4861	85,2
	Maximum	Range	Typical asymmetry	Typified Curtosis	
Area 1M1	90,7	4,0	-0,0621196	-0,185936	
Area 2M1	91,3	3,7	1,27327	0,605122	
Area 3M1	91,6	6,4	0,26265		
Area 4M1	91,5	4,2	0,228867	-0,683066	
Area 5M1	89,8	2,6	0,672859	0,202606	
Total	91,6	6,4	0,737913	0,30049	

The average noise values are above Standard NR 15 in all work areas and the measured minimum values also exceed the value of 85.

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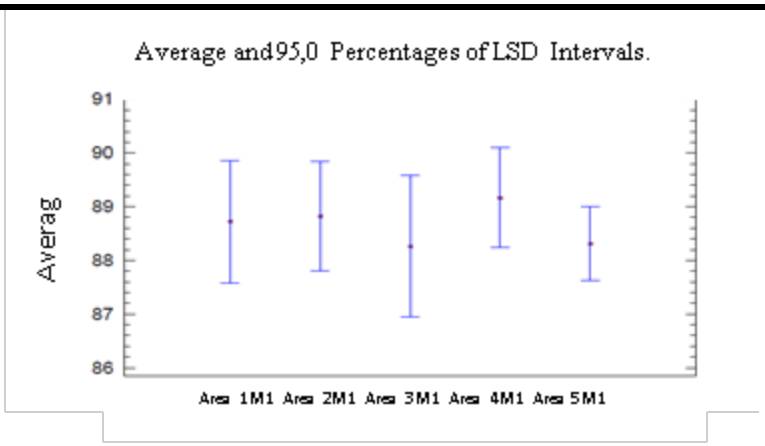

Fig.13: Average and percentages of LSD intervals.

Contrast Múltiple de Range				
Method: 95,0 percentage LSD				
Frequency			Average	Homogeneous groups
MED 3M1		3	88,2667	X
MED 2M1		11	88,3091	X
MED 1M1		4	88,725	X
MED 3M1		5	88,82	X
MED 2M1		6	89,1667	X
Contraste			Differential	+/- Limits
Area 1M1 – Area 2M1			-0,095	2,15906
Area 1M1 – Area 3M1			0,458333	2,4582
Area 1M1 – Area 4M1			-0,441667	2,07756
Area 1M1 – Area 5M1			0,415909	1,87922
Area 2M1 – Area 3M1			0,553333	2,35049
Area 2M1 – Area 4M1			-0,346667	1,94892
Area 2M1 – Area 5M1			0,510909	1,73595
Area 3M1 – Area 4M1			-0,9	2.27585
Area 3M1 – Area 5M1			-0,0424242	2,09636
Area 4M1 – Area 5M1			0,857576	1,63347

* indicates a significant difference.

As can be seen, there are no significant differences between the noise levels in the different work areas for the measurements performed in the morning hours.

Noise levels were compared in the same area for different working times and machines operating or not.

For example, in Area 3:

Contrast Múltiple of Range				
Method: 95,0 percentage LSD				
Frequency			Average	Homogeneous Groups
Area3 M3		3	88,5333	X
Area3 M2		3	88,0667	X
Area3 M1		3	88,2667	X
Contraste			Differential	+/- Limits
Area 3M1 – Area 3M2			0,2	3,98246
Area 3M1 – Area 3M3			0,733333	3,98246
Area 3M2 – Area 3M3			0,533333	3,98246

* indica uma diferença significativa.

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EXTERNAL NOISE MEASUREMENTS IN THE IFER PROCESS:

External noise levels are compared with machines running at three different working times.

STATISTICAL SUMMARY

	Frequency	Average	Variance	Typical deviation	Minimum
Ext MED1	7	82,5714	42,3557	6,50813	68,7
Ext MED2	7	84,0143	8,5681	2,92713	78,6
Ext MED3	7	73,3143	28,8014	3,20832	66,8
Total	21	79,9667	47,5153	5,3667	66,8
	Maximum	Range	Typical asymmetry	Typified Curtosis	
Ext MED1	88,2	19,5	-2,1799	2,48351	
Ext MED2	87,2	8,6	-1,2013	0,503909	
Ext MED3	79,8	13,0	-0,0494558	-1,19699	
Total	88,2	21,4	-1,52957	-,0586752	

Contrast Múltiple of Range					
Method: 95,0 percetage LSD					
Frequency			Average	Homogeneous Groups	
Ext MED1		7	73,3143	X	
Ext MED2		7	82,5714	X	
Ext MED3		7	84,0143	X	
Contraste				Differential	+/- Limits
Ext MED1 – Ext MED2				-1,44286	5,78914
Ext MED1 – Ext MED3				*9,25714	5,78914
Ext MED2 – Ext MED3				*10,7	5,78914

* indicates a significant difference.

That is, there are significant differences, as reflected in the previous table, between the average levels of exterior noise between the morning and evening hours (MED1-MED 3)
and those of the afternoon and evening (MED2-MED 3), influenced by internal noise levels. Between morning and afternoon there are significant but minimal differences (-1.44286).

Outdoor measurements with or without running machines for different working hours.

STATISTICAL SUMMARY

	Frequency	Average	Variance	Typical deviation	Minimum
Ext MED1	7	82,5714	42,3557	6,50813	68,7
Ext MED1 Não	7	46,3571	4,83286	2,19838	43,1
Total	14	64,4643	374,869	19,3615	43,1
	Maximum	Range	Typical asymmetry	Typified Curtosis	
Ext MED1	88,2	19,5	-2,1799	2,48351	
Ext MED1 Não	50,2	7,1	0,566466	0,710728	
Total	88,2	45,1	0,186408	-,0586752	

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Contrast Múltiple of Range					
Method: 95,0 percentage LSD					
Frequency			Average	Homogeneous Groups	
Ext MED1 Não		7	46,3571	X	
Ext MED1		7	82,5714	X	
Contraste				Differential	+/- Limits
Ext MED1 – Ext MED1 Não				*36,2143	5,65705

* indicates a significant difference.

For the rest of the working hours the graphic results are shown (in all cases there are marked significant differences):

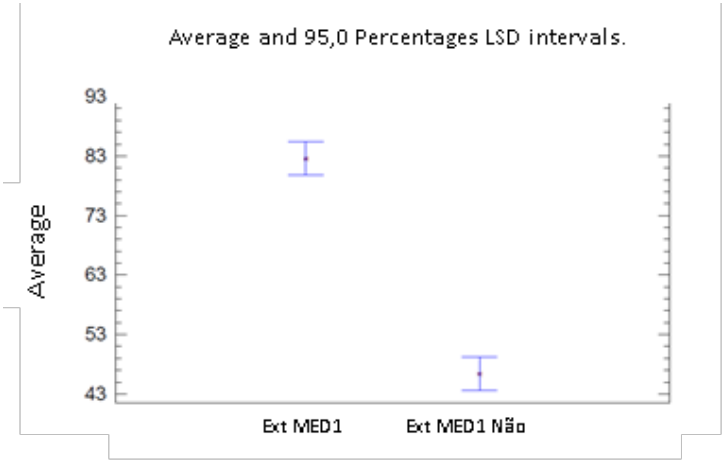

Fig.13: Average and percentages of LSD intervals.

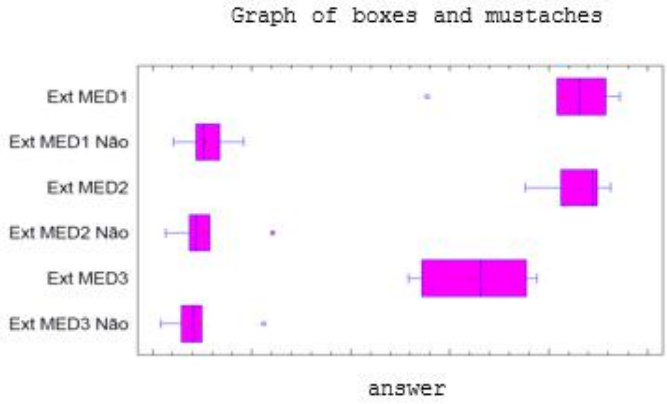

Fig.14: Mean and percentages of LSD intervals.

To sum up, for all external measurements with or without the operation of the machines in the interior, it is observed that there are significant differences between the average levels of noise outside when the machines are working or not and for the different working hours. The mean values of noise at night are lower, possibly affected because the non-inherent contribution to the process is lower.

It is also observed that in the evening hours the average noise levels are lower, with or without the machines running.

V. CONCLUSION

The noise present in the work environment studied is above the level of action and therefore requires the adoption of preventive measures. The relationship between man and the environment involves physical and functional aspects that contribute to a symbiotic harmonization. In industrial environments, quality of life is a fundamental item and directly influences the productivity of the individual. Thus, the performance of the environment from the physical point of view should favor the metabolism of the individual in order to provide adequate conditions to their physical requirements and, from a functional point of view, should contribute to the activities being developed with quality and efficiency. Environmental comfort provides this, and each of its aspects - thermal lighting and acoustics - must be in line to achieve the appropriate environmental quality. The

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acoustic comfort, object of this work, is one of the most important and relevant aspects in the quality of life of users, as well as for industrial productivity. It was concluded that the architectural features do not contribute positively to acoustic comfort; the noise sources generate high SPL that are aggravated by the high reverberation time coming from the physical characteristics of the environment. Therefore, there is a need for acoustic treatment and insulation at some critical points. It was also identified the need to deepen the SPL survey, with differentiation of frequencies, the functionality of the environment, the necessary conversation between workers and dosimetry. The statistical treatment reflected that there are no significant differences between the averages of the measured noise values at different working hours. In addition, it is found that the average levels achieved do not differ from one area to another within the stamping sector.

It is suggested ways of reducing machine noise, such as total or partial enclosure that completely covers down noise sources. The noise control by enclosure is a practical and feasible solution for noise reduction of a machine that is already installed and in operation, but each case must be studied looking for the best alternative, as suggested for the transport cart, boxes storage tables, support tables, electric motors and compressed air nozzles.

VI. ACKNOWLEDGEMENTS

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The Application of UBS has to Reduce due to Influencerainfall Extreme in the A.Y Patty Street Ambon City

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Abstract**—** *In the last 20 years there is often an extreme climate phenomenon that causes high rainfall and flood impact in Maluku. A.Y Patty Street is one of the locations in Ambon, the capital city of Maluku that often experience the inundation. In facing this phenomenon, the extreme value theory becomes the right solution where based on the theory, the value of extreme rainfall is known asymptotically and it will converge following the distribution of GEV (Generalized Extreme Value) which is an extreme value in a certain period.To overcome the extreme climatic problems on urban drainage system, the under drain Box Storage (UBS) filling hole is used as an environmentally friendly drainage concept. With the implementation of UBS, the drainage system can reduce 43.36% the inundation that occurred on the area of A.Y Patty street for the 5th return period and 30.99% for 10th return period.,or51.25% of the volume of water capable of being impregnated into the soil.*

Keywords— extreme climate, GEV, UBS, drainage, Ambon city.

I. INTRODUCTION

In the past 20 years in Maluku, extreme climate phenomena often occur which cause high rainfall and flooding everywhere. Rain with high intensity will cause inundation at some locations in Ambon, one of them is at AY Patty Street. The inundation is caused by several factors; they are high rainfall, natural factors and human factors. People tend to discharge a lot ofgarbage into waterways, as the result the canal becomes shallow then the flow of water becomes obstructed, overflows and stagnates. One other reason besides above factors is the lack of absorption of soil against water because the soil has been covered by pavement (asphalt) and buildings that are clearly translucent, cause the increasingof surface volume water which entering the drainage canal.

Some problems that arise here are (1) how to determine rainfall, extreme distribution and return period ?, (2) how is the drainage system used?

To overcome extreme climate problems and city infrastructure in this case roads and buildings that cover waterways or water absorption, an environmentally sound drainage system is needed with the basic principle of controlling excess surface water so that it can be run in a controlled manner and have more opportunities to seep into the ground. This is intended so that groundwater conservation can well take place and the structure of the drainage building dimension can be more efficient. In contrast to the old principle of drainage, which is to drain rain water into the receiving water body as soon as possible, environmentally-friendly drainage works by attempting to slow down runoff flow.

The principle of filling holes under the drainage channel (under drain box storage) is to hold rainwater that falls and seeps into the ground. This is done considering the lack of groundwater supplies and the high rate of water extraction. Development of environmentally sound drainage is shown to manage surface runoff by developing facilities to withstand rainwater. This concept is what wants to change the old paradigm in the construction of drainage, especially in urban areas.

II. STUDY OF LITERATURE

2.1 Concept of Underdrain Box Storage (UBS)

Underdrain Box Storage (UBS) is an environmentally friendly drainage concept. The technical concept is that rainwater is flowed through open channels where the bottom is given holes arranged serially along the channel as a function to fill the storage space, where the bottom of the shelter is related to the ground. The UBS concept consists of rainwater drainage channels, vertical drain holes, storage boxes and domestic waste disposal channels (sewerage

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systems). Rainwater drainage channels function to receive surface runoff due to rainwater lighting. Vertical drain holes function to continue rainwater runoff into the storage box. Whereas the storage box which is functioned as a long storage which holds rainwater runoff then absorbs water naturally into the soil. In this system, domestic sewage channels are placed separately from rainwater channels. In general the requirements of the construction of the drainage concept are as follows:

1. Rainwater channels are placed separately from the sewage channel.
2. This construction is made of precast reinforced concrete or a combination of masonry and precast reinforced concrete.
3. The main channel is given a round hole at the bottom.
4. In its application, maintenance is needed on a scale to keep it functioning properly.

2.2 Extreme Value Theory

Based on the theory, it is known that asymptotically the extreme value of rainfall will converge the following distribution of GEV (Generalized Extreme Value) which is an extreme value in a given period. Suppose we have a free random variable x1, x2, ... xn each variable xi has the same distribution function, namely F (x) then consider the maximum value Mn = max (X1, X2, Xn) as written as the equation below;

$$F(x)=\begin{cases}\exp\left(-\left[1+\xi\left(\dfrac{x-\mu}{\sigma}\right)\right]^{\frac{1}{\xi}}\right), & \xi\neq 0\\ \exp\left(-\exp\left[-\left(\dfrac{x-\mu}{\sigma}\right)\right]\right), & \xi=0\end{cases}$$

The parameter form ξ determine characteristic of the distribution tip if ξ < 0 then the chance function has a finite right end and if ξ ≥ 0 the chance function will have an infinite right end. The extreme value distribution introduced by Jenkinson, is a combination of three types of limited distribution for extreme values into one single form as derived by Fisher and Tippet, the three singular forms referred to are Gumbel distribution,

2.2.1 Determination of Extreme Values

Determination of extreme values can be done in two ways:

1. By taking maximum values in a period, for example weekly or monthly periods, observations of these values are considered extreme values.
2. By taking values that exceed a threshold value, all values that exceed the threshold are considered extreme values.

2.2.2 Return Level

In practice, the quantity that is concerned is not only directed at estimating the parameters themselves but in quintiles which are also referred to as return levels of the GEV. The estimated rate of returned on maximum rainfall.

$$x^k = F^{-1}\left(1-\frac{1}{k}\right)$$

If F is the distribution of the maximum value for observing the same period, then the rate of return will follow the following equation where $F^{-1}$is quintile function of the function of distribution*F, k*is the period of time and p is the period. The return period value is the maximum value that is expected to be exceed once in the period k with period p, or in other words in the time period k, the rainfall will reach the maximum value once after the expected parameter μ,σ dan ξ can be substituted with the equation below.

$$x^k=\begin{cases}\hat{\mu}-\dfrac{\hat{\sigma}}{\hat{\xi}}\left(1-\left[-\ln\left(1-\dfrac{1}{p}\right)\right]^{-\xi}\right) & ;\xi\neq 0\\ \hat{\mu}-\hat{\sigma}\ln\left[-\ln\left(1-\dfrac{1}{p}\right)\right] & ;\xi=0\end{cases}$$

III. RESEARCH METHODOLOGY

The research location is in Ambon with an elevation from the sea level 10.47 m at the coordinates 3°.41 'LS - 128°.31'BT. As seen at picture below.

The population and sample are all objects in this study which are located on the A.Y Patty street; geometry and channel dimensions, building infrastructure, soil type and rainfall data for 29 years. Meanwhile the research variable is used in the identification process based on the study of theory. Variables used in this study include: Existing conditions of drainage systems, land use, rainfall data and soil permeability

Data collection methods used in this study include; Observations include observation of catchment area, topography of the region, inundation area, land use and land permeability, meanwhile the data analysis method used is descriptive method which is classified as analysis of basic physical conditions including topographic analysis, rainfall analysis using extreme theory, permeability analysis soil and analysis of filling holes in the reservoir under the drainage canal.

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Fig1.Research Site

IV. RESULTS AND DISCUSSION

4.1Descriptive Rainfall Statistics in Ambon City

Rainfall analysis in Ambon City uses the maximum daily rainfall data from 1989-2017 which consists of 324 data. Descriptive statistics of rainfall in Ambon City are presented in Table 1.

Table.1: Descriptive Statistics of Rainfall in Ambon City

Variable	N	Mean	Min	Max	SD	CV	CS	CK
CH	324	60.33	0	455	57.37	95.1	2.85	13.02

4.2 Selection of Distribution

From the rainfall phenomenon that occurred for 28 years (1989-2017) in Ambon, it can be concluded that the rainfall occurring in extreme categories. This pattern reads that most of the data is on the left side, while in others it is of extreme high value with the appearance of '*'. The characteristics of asymmetrical data with a greater proportion of data on the left side, it is assumed that rainfall data will follow the distribution of generalized extreme values such as Figure 2 and distribution analysis in table 2.

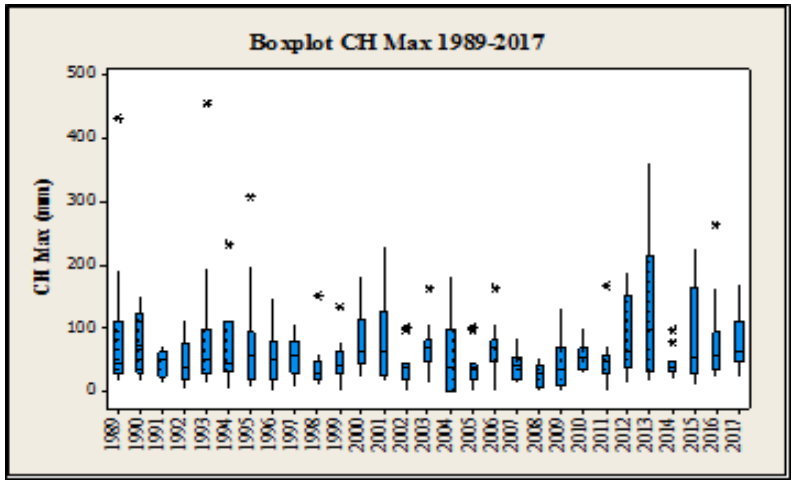

Fig 2. Boxplot Graph- data 29 year rainfall data

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Table.2. Analysis of Distribution Models With Several Methods

Parameter	Distribution			
	GEV	Gumbel Max	Lognormal	Weibull
α				1.2224
β				66.776
σ	29.172	44.733	0.9608	
μ	34.199	34.505	3.7649	
ξ	0.2465			

In the Distribution Compatibility Test the Smirnov Kolmogorov test is used to test the horizontal direction deviation and the Chi-Square test to calculate the vertical direction deviation and Anderson-Darling used to measure the suitability of the data distribution shown in the table below.

Table.3: Distribution Compability Test

Disribution Test	Parameter	KS			AD			Chi Kuadrat		
		Sample	Probabilty	Rk	Sample	Probabilty	Rk	Sample	Probabilty	Rk
Distribution	**GEV**	324	0.035	1	324	0.417	1	324	3.291	1
	Gumbel Max	324	0.115	4	324	7.989	2	324	47.495	4
	Log Normal	324	0.073	2	324	23.383	4	324	21.173	3
	Weibull	324	0.086	3	324	20.187	3	324	12.169	2

From the results of the hydrological analyst, according to the hypothesis GEV distribution where the value of the parameter $\xi \neq 0$ is used as a rainfall plan with a certain return period to determine runoff discharge, which can be seen in table 4.

Table.4: Rainfall recurring period analysis

Parameter			Distribution Function		
			K	5	10
σ	μ	ξ	P	0.2	0.1
29.172	34.199	0.246	Xk	87.14	121.94

4.3 Analysis of the database with underdrain box storage (UBS)

Environmental-friendly drainage analysis with underdrain box storage (UBS) in the area of A.Y Patty street, Ambon city produces values:

1) The average slope of the channel (S) is 0,0036
2) Time of concentration (Tc) = $0.0195L^{0.77}*S^{-0385}$according to Kirpich produces a concentration time 30.84 minutes or 1850.49 seconds
3) The amount of rainfall intensity (I), using the Manono be equation, where the 5year return period is 78.19 mm/hour and for 10 years it is 101.30 mm/hour.
4) The mangnitude of the average land use cooficient($C_{rata-rata}$) at A.Y Patty street is 0,68
5) The channel storage coefficient (Cs) is 0.752
6) The magnitude of the design discharge (Q) for 5 years 1,06 m^3/second, 10 years 1,48 m^3/second.
7) Calculation of infiltration by using Horton method results in a soil permeability value of K =$6*10^{-6}$Cm/second.
8) Calculation of dimensions for draians using existing conditions (existing channels) because the existing dimensions are changed into rectangles with a semicircular base. The dimensional model can be seen as shown in Figure 3 below.

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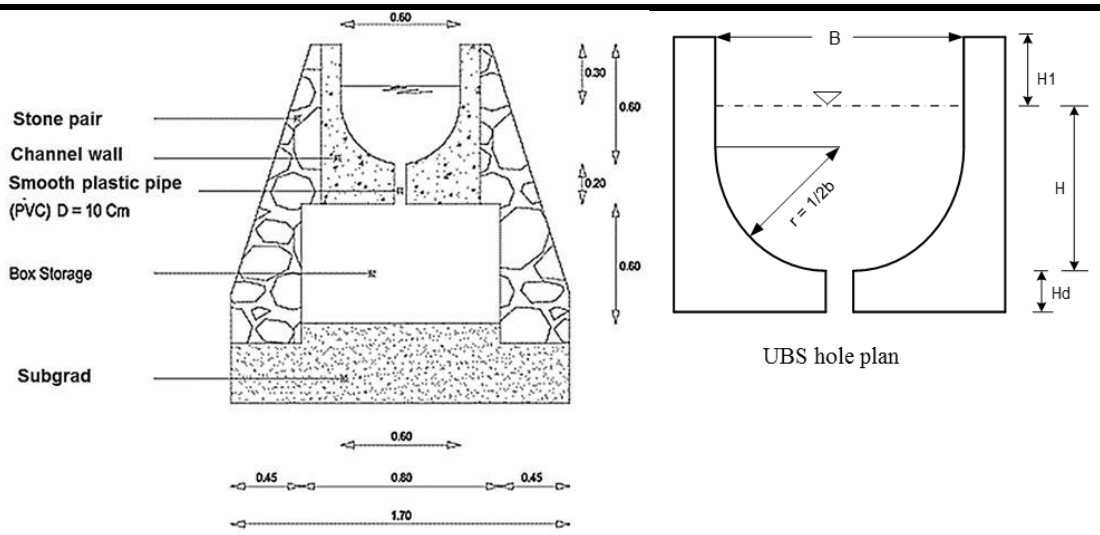

Fig3.Underdrain box storage design

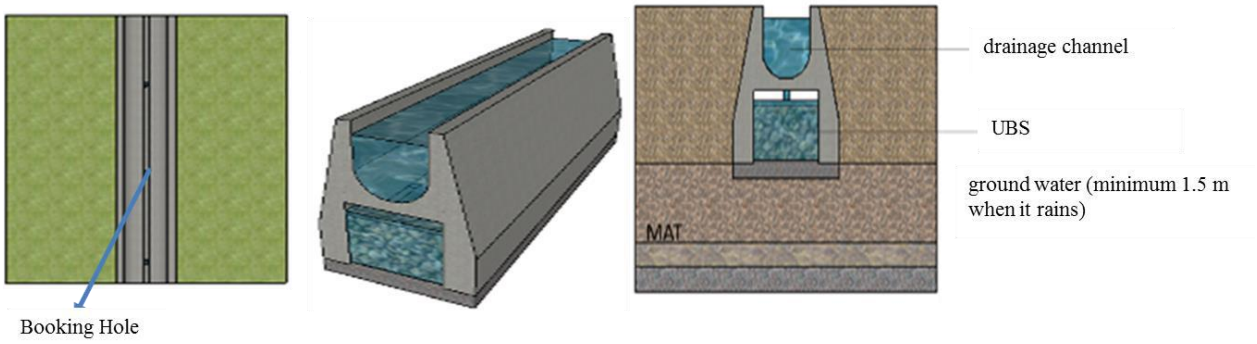

Fig 4. UBS plan details

From the results, the plan debit analysis which is using the rational equation is greater than the channel debit which results in runoff. Comparison of the two debits can be seen in table 5.

Table.5: Percentage of storage

Tr Thn	Qr m3/det	I mm/jam	Qdr m3/det	Qrunoff m3/det	Presentase	
5	1.06	78.20	0.89	0.17	8.72	91.28
10	1.48	101.72	1.15	0.33	12.55	87.45

4.4 The diameter planning of the filling storage

In this study using dimensionless variable parameters to determine the hole diameter of filling the pool using the Froude number.

$$Fr = \frac{v}{\sqrt{g.h}}$$

$$Fr = \frac{1,41}{\sqrt{9,81.0,6}} = 0,581$$

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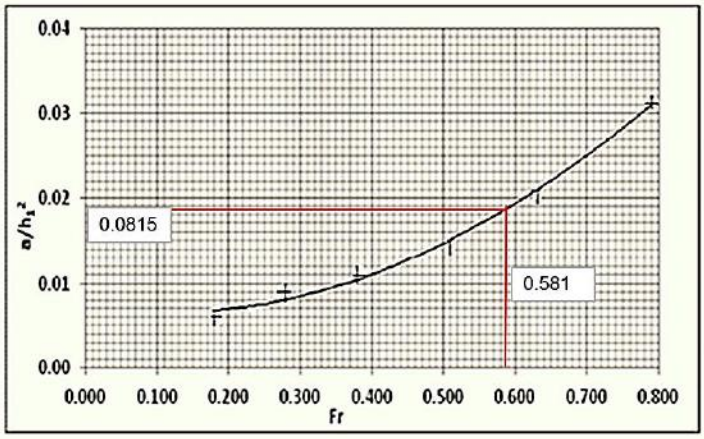

Fig.5. Relatiohship between Fr and a/h^2

For Fr = 0,581 produces a/h^2 =0,0185, IfFr = 0,581 it includes in sub critical flow A = 0,0067 00 0. 0,007 m^2after obtaining the UBS filling hole, found a hole diameter of 10 cm or 3 inches. With a total of 57 holes.

Table.6: Planning for a number of holes

Box	Distance (m)	Long (m)	Σhole (Pc)
1	15	258	17
2		165	11
3		164	11
4		270	18

4.5 Planning of Storage Space (Box Storage)

Besides absorbing rainwater in order to reduce runoff in the main drain, Box Storage also functioned to accommodate the volume of water to be absorbed slowly. The following are the dimensions of the storage box design::B=0,8 m ; H_2=0.6 mdan H_1=0.3 m

Table.7: Volume of storage space (box storage)

Box	b (m)	H2 (m)	L (m)	Volume UBS (m3)
1	0.8	0.6	258	123.84
2	0.8	0.6	165	79.2
3	0.8	0.6	164	78.72
4	0.8	0.6	270	129.6
Total				411.36

With the value of soil permeability (K) = 6 * 10^{-6} Cm / det and duration / peak time (t) = 30.84 minutes or 1850.49 seconds the recharge volume can be seen in Table.9

Table.8: Percentage of accommodation has been done by storage

Tr	Volume			(%)
	Channel	Runoff	Leftover	
(Year)	(m3)	(m3)	(m3)	
5	435.72	1960.68	1524.95	22.22
10		2743.76	2308.04	15.88

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Table.9: Percentage of storage/shelter after there is a storage box

Tr	Qd	Tc	K	Volume					(%)
				Channel	UBS	Infiltraton	Runoff	Leftover	
(Year)	(m3/sec)	(Sec)	(cm/sec)	(m3)	(m3)	(m3)	(m3)	(m3)	
5	1.06	1850.49	6*10^-6	435.72	411.36	3.148	1960.67	1110.45	43.36
10	1.48						2743.76	1893.53	30.99

CONCLUSION

1. The phenomenon of rainfall in Ambon city includes extreme rainfall so that this problem can be solved by extreme value distribution. From several distribution methods used, the GEV method is a method that can provide solutions to extreme rainfall conditions.
2. With the UBS method in implementing environmentally friendly drainage systems, the drainage system can reduce waterlogging that occurs in A.Y Patty area for a 5 year return period of 43.36% and 10 years 30.99% or 51.25% of the volume of water that can be absorbed into the soil.

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