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## **About the Journal**

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## Editorial

### Dear authors, reviewers, and readers

It has been a month since I was given the privilege to serve as the Chief Editor of the International Journal for Innovation Education and Research (IJIER). It is a great pleasure for me to shoulder this duty and to welcome you to **THE VOL-9, ISSUE-02 of IJIER** which is scheduled to be published on **1<sup>st</sup> February 2021**.

International Journal for Innovation Education and Research (IJIER) is an open access, peer-reviewed and refereed multidisciplinary journal which is published by the International Educative Research Foundation and Publisher (IERFP). IJIER aims to promote academic interchange and attempts to sustain a closer cooperation among academics, researchers, policy makers and practitioners from a wide range of disciplines, which contribute to state of the art in science, education, and humanities. It provides a forum for the exchange of information in the fields mentioned above by welcoming original research papers, survey papers, and work-in-progress reports on promising developments, case studies, and best practice papers. The journal will continue to publish high-quality papers and will also ensure that the published papers achieve broad international credibility.

The Chief Editor, appointed by the Associate Editors and the Editorial Board, is in charge for every task for publication and other editorial issues related to the Journal. All submitted manuscripts are first screened by the editorial board. Those papers judged by the editors to be of insufficient general interest or otherwise inappropriate are rejected promptly without external review. Those papers that seem most likely to meet our editorial criteria are sent to experts for formal review, typically to one reviewer, but sometimes more if special advice is needed. The chief editor and the editors then make a decision based on the reviewers' advice.

We wish to encourage more contributions from the scientific community to ensure a continued success of the journal. We also welcome comments and suggestions that could improve the quality of the journal.

I would like to express my gratitude to all members of the editorial board for their courageous attempt, to authors and readers who have supported the journal and to those who are going to be with us on our journey to the journal to the higher level.

Thanks,

**Dr Eleni Griva**

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# **ADVOCACY COMMUNICATION AND THE CHILD TRAFFICKING SITUATION IN KENYA: THE CASE OF MATHARE CONSTITUENCY PRIMARY SCHOOLS**

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## **ABSTRACT**

*Child trafficking is one of the leading crimes in Kenya. The purpose of this study therefore was to look at the efficacy of advocacy communication when it comes to addressing the complications of child trafficking in society. The study focus was Mathare constituency in Nairobi County. This is because there are many child trafficking cases from Mathare constituency that have been reported over the years causing a number of humanitarian organizations, who work with schools and community groups, to step in and address the issue. A purposive sample of 240 teacher respondents and 16 facilitators was selected as per Yamane's formula while convergent parallel mixed methods design was used for data collection and analysis. The study established that videos and pictorials were the most popular advocacy methods used, with a 100 percent respondent rate while 98 percent observed that through advocacy, humanitarian organizations were making a difference in countering child trafficking. The study established also that all (100%) of the facilitators agreed that the stakeholders directly involved with children did contribute to the fight against child trafficking. The study concluded that integrated communication was adopted by facilitators and that the advocacy communication methods used were effective. The study recommends involvement of key stakeholders' right from the planning stage for effectiveness. A recommendation of the study is that further investigations be done from the viewpoints of the children, parents and the local administration.*

**Key words:** child trafficking, advocacy communication, facilitators, countering

## **1. Introduction**

Child trafficking, an offence to human dignity, typically involves violations of several fundamental child rights. Trafficked children face a series of threats to their health, development, welfare and in some extreme cases, their lives (Beyrer, 2004). A further observation is that child trafficking is morally wrong and inhumane and therefore should not come as a surprise that it has generated outrage and the need for advocacy. Such involves the need for creating awareness by multiple sectors who seek to advocate for human rights. As argued by Gardner (2015), conservation of human dignity and eradication of social injustice has always been achieved through campaigns and advocacy initiatives that seek to be the voice of the voiceless hence enabling advocacy to play a critical role in the fight against vices in society. Even

though those advocating for the rights of those considered lesser or vulnerable in a society has been laced with confrontational tendencies, Breitrose (2012) argues that advocacy does not have to be confrontational especially if proper planning that will prompt tactical skills so as to avoid conflict are adopted. Advocacy is a process that depends on many approaches ranging from campaigns, lobbying, awareness- raising, and mass mobilization to sharing and providing information thus provoking action. This involves working well with other people with an aim of addressing a particular issue (Onyango, 2014).

Additionally, for effective advocacy work, there is a need for effective communication to take place so that the intended message for the target group can be passed. In advocacy work, communicating effectively can include doing entertainment education (edutainment), coming up with messages that address the need to fight for the course believed in (among others). This is because as argued by Coulby (2010), advocacy is all about impelling and urging individuals as well as institutions in order to bring about social justice and in this case, to the children most vulnerable to trafficking. This cannot be achieved unless one is able to communicate his or her ideas and bids effectively.

According to a Save the Children (2016) report, sub-Saharan African children are commonly trafficked for domestic and farm labour as well as profitable sexual exploitation like prostitution, pornography and underage sex tourism trade in pedophile rings. This shows that there is a desperate need to report and address the vice meticulously. For instance, in Nigeria, one of the advocating acts that was witnessed in December 2017 is where all the nuns of the Africa Faith and Justice Network (a faith based organization doing advocacy works across the country) took to the streets in the cities and villages of Nigeria as they were convinced that human dignity especially for children was being violated and abused through child trafficking. Reportedly, Nigeria experiences more than 10,000 indigenous people getting trafficked (Africa Faith & Justice Network, 2018).

Despite many efforts by different humanitarian organizations to end child trafficking, Kenya still remains a major source, transit and destination in the Central and Eastern Africa region (National Crime Research Centre, 2015). In their view, Kenya is accommodating over 350,000 refugees especially from South Central Somalia and as a result, has been recognized as the focal point for human trafficking with many of these refugees becoming vulnerable to various forms of exploitations and abuse.

Some of the efforts made in Kenya to fight child trafficking are as demonstrated by Trace Kenya, a national counter trafficking in persons Non-Governmental Organization (NGO) based in Mtwapa, on the outskirts of Mombasa, Kilifi County. The organization specifically works with refugee children, the internally displaced and street children. They endeavor to create awareness among the youth, women, children and personnel with infirmities who are the most vulnerable populations in Kenya due to the risk of being trafficked for the purposes of forced labour, street begging and in extreme cases, sexual exploitation (Trace Kenya, 2018). There is also Movement Against Child Trafficking (MACT), a community based non-profit organization that works in collaboration with the relevant government departments and other Civil Society Organizations (CSOs) with the aim of averting and shielding children from trafficking and sexual

exploitation. In order to achieve results, advocacy communication especially in schools has become an effective tool of reaching out to vulnerable children.

## **2. Literature review and theoretical Underpinnings**

According to Petty and Cacioppo (1986), it should be obvious that understanding one's audience is dire when choosing the appropriate route and that it is also very vital to understand the audience when creating an elaborated argument. In other words, one must consider how the audience will likely react to the quality and arrangement of the arguments that are being presented (Dainton & Zelley, 2005).

Elaborated arguments can be measured as either strong, neutral or weak where strong arguments create a positive rational response in the minds of receivers while also positively bringing into line the receivers' opinions with those views of the persuader (Petty & Cacioppo, 1986). Strong arguments create long-term attitude change that easily lead to predictable behavior. As argued by Dainton and Zelley (2005), repetition is thought to boost the persuasive effect of strong arguments while interruptions weaken their effectiveness. That is why it is very important to consider how advocacy communication messages on child trafficking are presented to the children, for instance through simplification so that understanding can be easy. Repetition ensures that the intended message sinks in and comprehension is at a much deeper level.

### **2.1 Child Trafficking in Kenya**

Child trafficking is a development issue because it is an exploitation that has hostile effects on efficiency and equity. Economic theory as exemplified by Koettl (2009) defines exploitation of labour, be it consensual or nonconsensual, as situations where wages are below the fringe value product of labour due to a dominant power of employers. Moreover, the ultimate result for this is an economic inadequacy due to an unproductive resource provision in production of goods and services and underutilization of labour when compared to the social prime (Koettl, 2009). What this means is that wages and employment levels for unskilled labour are ineffectually low thus resulting in high levels of poverty. This is ultimately a major reason for child trafficking. Child trafficking provides cheap labour and due to high poverty levels, the traffickers take advantage of some of these children's parents and guardians promising them a better future for their children. More often than not, this is usually not the case and so sensitizing children through advocacy, would contribute to eradication of the vice.

A report by Humanium (2011), an organization that fights for the rights of children that are victims of trafficking reveal that the business of trafficking particularly for women and children has a profit that reaches up to 10 billion U.S dollars per year. The victims are usually silenced through being subjected to immoral activities brainwashing, physical and psychological violence as well as conditioning so that they obey their traffickers (UNICEF, 2003). Language barrier and geographical isolation more often than not strengthens the power and control that traffickers have on their victims who are unable to escape (Humanium, 2011). Various reasons have been reported by many humanitarian organizations to be the cause of the continuously thriving child trafficking business.

According to UNICEF (2003), reasons for this situation include: poverty, humanitarian crises and ignorance. Reportedly, poor families abandon their children in search of greener pastures, leaving them vulnerable to traffickers. Ignorance is also blamed for the huge escalation in the number of street children and orphans, a situation that leaves them vulnerable and fending for themselves. Due to this, they become ultimate victims for traffickers who are quick to promise these unsuspecting children better living and working conditions. Similarly, Humanium (2011) observes that child trafficking is very conspicuous in areas struck by natural disasters as well as where there is lack of information. In such circumstances, these vulnerable groups are not even aware of their rights and therefore do not even realize when these rights are violated. The situation is compounded by an absence of birth registration amongst most of these children as observed by Save the Children (2016). Thus, international adoptions which lead to children being solicited more by dishonest adoption agencies that do not have a hard time finding potential clients such as desperate couples in need of a child and traffickers (UNICEF, 2006).

A number of organizations advocating for eradication of the vice of Child trafficking operate in Mathare Constituency in Kenya. This area as noted by Terres des hommes (2014), is highly vulnerable to trafficking cases due to high levels of poverty and ignorance. Many of these advocacy initiatives in this area work very hard as attempts to counter the vice. Such organizations include: Childline- Kenya, Awareness Against Human Trafficking- Kenya (HAART- KENYA), African Network for the Prevention and Protection Against Child Abuse and Neglect (ANPPCAN), Movement Against Child Trafficking (MACT) and Save the Children organization. They work closely with schools and community initiatives in their effort to create awareness among children and society members.

## **2.2 Role of Advocacy**

Works in advocacy can be divided into two broad types depending on the size of the group being advocated for (Coulby, 2010). These types are case advocacy and systematic advocacy otherwise known as structured advocacy. According to Dalrymore (2004), case advocacy deals with small groups such as a family unit while systematic or structured advocacy deals with organizations or even larger groups with the goal of exerting pressure on authorities so as to influence policy. Other types include professional advocacy which basically involves informing policy makers, governments and the public on specific development issues in the professional's area of specialization. Citizen advocacy involves defending and standing up for the rights of people that are considered vulnerable in a society such as those living with disability (Martin, 2004). Media advocacy on the other hand involves the media defending and confronting injustices found in the society by using the platforms provided by media.

Sharma (2012) describes advocacy as a tool for putting a problem as part of the main agenda, providing solution to that problem and providing a platform meant to act on both the problem and the solution. Sharma expounds in her argument that even though most times advocacy is defined as speaking on behalf of others, its main goal among many, must be to raise public's consciousness about a particular issue. She also says that advocacy is a phenomenon that encompasses social change as the main process that affects attitudes, social relationships and power relations thus strengthening civil society and opening up democratic spaces



(Sharma, 2012). Additionally, for it to be able to fulfil its aspirations, advocacy requires efforts coordination, communication, outreach, mobilization, strategic information among others.

Given the reason that has been defined broadly, advocacy is one concept that has continued to be surrounded by several myths and misconceptions. Among these is that advocacy is only for professional lobbyists, advocacy is walking down the streets rioting in a demonstration, advocacy is the same as fundraising and has nothing to do with initiating social change, advocacy consumes a lot of time, advocacy is all about politics meant to achieve politics gain. While actually, as argued by Quarry and Ramirez (2009), advocacy offers voice to the marginalized and disregarded populations thus promoting an active participation in certain issues that affect their lives. Advocacy also provides platforms where different individuals and groups contest interpretations of various problems and proposed solutions (Ciztek, 2017).

One important lesson learnt in trying to combat child trafficking in the recent years is that it is not only what organizations and individuals do to combat trafficking of children that matters, but also how they do it. This is where the concept of advocacy comes in because in the context of trying to counter child trafficking, advocacy is a means of helping individuals and groups know what they need to do exactly in order to contribute much effectively to the anti-trafficking efforts (ILO, 2009). In this context as noted by ILO (2009), such efforts may range from helping a child know what he or she can do when it comes to self-protection, to helping relevant government bodies appreciate how best to allocate resources in order to ensure that a budget allocation has maximum impact in countering child trafficking.

Just like any other phenomenon aimed at influencing both attitude and behaviour change, advocacy also has to be planned. ILO (2009) suggests the following questions as a guide in this process:

Who? That is, whom you want to influence.

What? Be clear on what the who (s) need to be prompted to do.

How? Spelling out the best way through which the who(s) can be reached in order to prompt change in the long run.

When? Be clear on the timelines. That is, when things should be done and objectives achieved.

The message? The message intended to reach the target audience is very important as this is what will determine the channels that will be used in order to make this possible.

Given that advocacy entails influencing people towards behaviour and attitude change in different context, one needs to consider what will influence the target audience in order to make the right choices with regards to what they do (ILO, 2005). This will thus be a key element of one's advocacy message in identifying the form of action one wants his or her advocacy initiative to follow. That is, will it be a public campaign, a media event, a publication or a one on one meeting with the target audience whom the message targets?

According to Salamon, Hems and Chinnock (2000), advocacy is one approach that international organizations, non-governmental organizations and individuals that share a common concern for social justice often use so as to encourage social change and increase accessibility of resource. For example,

when dealing with victims of violence, advocates and organizations trained to provide trauma-informed services are very essential because they are better equipped to provide culturally- sensitive services. They are also in a better position to empower those survivors so that they reach their own personal goals (Briere & Jordan, 2004; Sullivan & Bybee, 1999). Research shows that when women who have undergone various forms of exploitation are aided by community-based advocacy interventions, they tend to gain greater access to community resources, consistent social support and overtime heal faster than women who have not received any advocacy services (Sullivan & Bybee, 1999). As argued by Houston, Odahl-Ruan and Shattell (2015), advocates assist survivors in steering the complex systems they come across in the process of seeking help or pursuing justice. Therefore, advocates are chiefly important in helping survivors of child trafficking through attaining access to resources, navigating the complex social provision systems usually put in place and by raising awareness about the issue to service providers and the general public (Houston, Odahl-Ruan & Shattell, 2015). This in a way will ensure that the relevant assistance for those survivors will be geared towards them. Relevant resources directed towards assisting them will also be allocated in budgets so as to ensure that they are never in lack.

### **3. Methodology**

Data was collected in Mathare constituency of Nairobi County. This is one of the largest informal settlements in the county. The constituency is divided into 6 administrative units referred to as wards. A sample of 240 teachers out of a total target population of 597 were selected for the study using Yamane's (1967) formula. Likewise, the formula enabled a selection of a random sample of 17 facilitators, from different CSOs that carry out advocacy activities in the primary schools in Mathare. The study used the convergent parallel mixed methods approach which required that the researcher collects both the qualitative and quantitative data, analyze them independently, then compare the results to find out if they approve or disapprove one another.

The researcher used questionnaires to collect data. This was administered to the respondents through the help of a research assistant who was familiar with the terrain of the region. The procedure of data analysis was guided by the objectives of the study while the data collected was both qualitatively and quantitatively coded and analyzed. The Statistical Package for Social Sciences (SPSS) was used in the analysis of the quantitative data while thematic analysis technique informed analysis of qualitative data. Thematic technique provides essential skills for steering a qualitative analysis (Braun and Clarke, 2006).

### **4. Results and Discussion**

The findings of the study and the discussion of these results are discussed in this section. The main focus being advocacy communication and how it is employed in schools with a view of countering child trafficking.

According to UNICEF (2003), children are usually smuggled across international borders or trafficked internally within their home countries (mostly from rural areas to urban areas) where they are sold like

commodities and suffer brutality on their dignity and safety hence the need for advocacy. Victims of child trafficking are usually taken away from their families and forced to do unspeakable things that undermine their dignity and rights as children. It is one of the fastest growing criminal industries (U.S Department of state, 2016) costing an average of \$ 80,000 to purchase a child. Many children from Africa and the less developed states where poverty is a real problem, become victims of trafficking easily as they are enticed by the promise of education and a more thriving life that is better compared to the life they lead in their homes.

#### **4.1 Advocacy Communication in schools**

Most of the advocacy methods adopted by schools as established from findings of the research involve communication methods that are interesting and captivating enough to capture the attention of students. These advocacy methods range from use of videos and images to use of games with the ultimate goal of passing across the intended message (Christian, 2014). Advocacy in schools also comprises of involving the teachers and parents who are the major stakeholders in this community. Involving these two parties ensures that they play a role in attitude and behaviour of the children who are the main beneficiaries of this message. This is due to the fact that teachers and parents spend a lot of time with children and thus can work towards ensuring that the message of security and protection when it comes to child trafficking has been considered.

Encouraging students to openly address the issue of child trafficking by reporting cases they come across to either their teachers or caregivers so that the necessary precaution of reporting these cases to the authorities with the aim to arresting the perpetrators can be taken. Some of the illustrations on how advocacy is done in schools as gotten from the respondents in this research and study include:

“Posters addressing the issue, forwarding reported cases to the relevant authorities, talking about this issue even with parents, and having the topic being addresses in clubs like the debate club” (*Respondent 116*).

“Taking part in advocating against this vice during school events, allowing and inviting organizations addressing child trafficking to teach our children on the topic, reporting cases, rescuing children susceptible of being victims, and doing follow ups with the children to ensure that each is comfortable at home” (*Respondent 178*).

“Allowing organizations fighting this vice to create awareness in our school, working in partnership with these organizations in order to address this issue, and reporting and following up cases forwarded to us by the children” (*Respondent 137*).

#### **4.2 Role of advocacy in countering child trafficking**

Advocacy promotes social reforms (Sharma, 2012). This is because it empowers and encourages citizen participation where the citizen themselves act like watchdogs of government programs. It gives the underprivileged citizens a chance of being involved directly in the decision making processes. Thus with advocacy, behaviour and attitude change among the children with the aim of ensuring they protect themselves more by avoiding strangers and always reporting, can be achieved.

Advocacy helps in enhancing the success of government programmes. That is, it aids in enlightening public representatives such as senators about what will work at the local level and what will not. As Sharma (2012) explains, advocacy places persistent pressure for unrelenting support and funding since support and funding for successful programmes that are well documented is not assured if advocacy is not practiced. In this case, unrelenting support into ensuring that the issue of child trafficking has been addressed accordingly and awareness creation against it done relentlessly.

Advocacy contributes to democracy by having an influence on government policies (Sharma, 2012). That is, helps the government develop good public policies while at the same time guaranteeing that the nation is accountable to its citizens. It helps mobilize citizens so as to participate in nation building ordinarily perceived as a key to developing a democratic culture.

Advocacy helps in representing people's interests given the fact that sometimes public representatives are not sufficient to fully represent their local residents. The main aim at this point as Sharma (2012) argues is to ensure people's needs are put at the forefront. For this to happen, relentless advocacy work is required. In this case, the needs and rights of children are put at the forefront so as to fight child trafficking.

At the end of the day, advocacy plays a huge role in attitude change among recipients of a particular message. It helps in addressing the problem at hand head on and search for solutions so as to make effective and relevant decisions. This is as backed up by the responses some of the respondents who helped inform this study gave.

“Taking part in advocating against this vice during school events, allowing and inviting organizations addressing child trafficking to teach our children on the topic, reporting cases, rescuing children susceptible of being victims, and doing follow ups with the children to ensure that each is comfortable at home” (*Respondent 178*).

“Forwarding reported cases to the relevant authorities, allowing institutions or organization addressing this issue into our school, continuing to teach the children about child trafficking and urging them to take the necessary precautions, talking to their parents during parents' meetings so that they too can take care of their children” (*Respondent 122*).

#### **4.3 Efficacy of the Various Advocacy Communication Methods Used in Countering Child Trafficking**

This refers to the various dimensions of advocacy communication efficacy such as stakeholder participation in the countering of child trafficking, their satisfaction with the advocacy work by various organizations, their appreciation of the need for education on the subject of child trafficking, facilitator's ability to communicate with children and the ability of the children to understand communication messages, the perceived difference humanitarian organizations are making to address child trafficking and stakeholder ownership of the combat against child trafficking.

### 4.3.1 Stakeholder Participation in the Combat against Child Trafficking

In Kenya, various stakeholders have taken part in addressing child trafficking and ensuring that relevant laws pertaining to child trafficking have been laid across so that perpetrators can be arrested and face the law accordingly. One such government body that addresses issues of trafficking is the National Crime Research Centre. This body seeks to create awareness against child and adult trafficking and even educate law enforcers on what these phenomena are all about so as to deal with it accordingly. Additionally, there are various national and international organizations based in Kenya who also address the issue of child trafficking and even help a lot in reporting cases they come across. Such organizations include: Awareness Against Human Trafficking (HAART-KENYA), Movement against Child Trafficking (MACT), Save the Child, the UN under the anti-terrorism branch and among many others.

Moreover, facilitators, a target population for this study were asked whether stakeholders directly involved with children contributed to the fight against child trafficking. Figure 1 below presents the results.

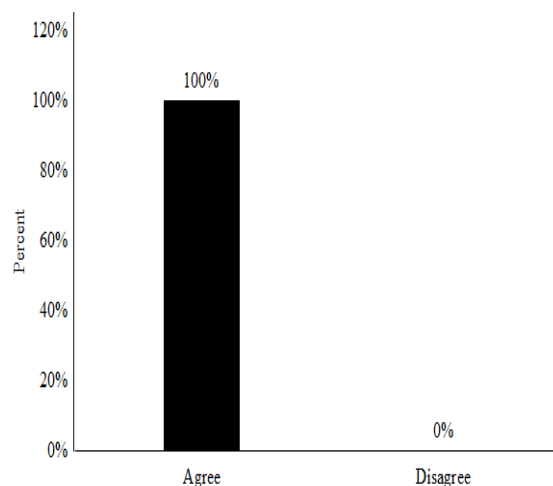


Figure 1: Stakeholders contribution to the addressing of child trafficking

The figure shows that all (100 percent) of the facilitators agreed that the stakeholders directly involved with children did contribute to the fight against child trafficking. This implies that there was stakeholder participation and ownership of the fight against child trafficking which (HAART, 2015) argues is one effective way of addressing trafficking of children.

Another important aspect is the stakeholder Satisfaction with the Advocacy Work by Various Organizations whose findings are captured in the figure below.

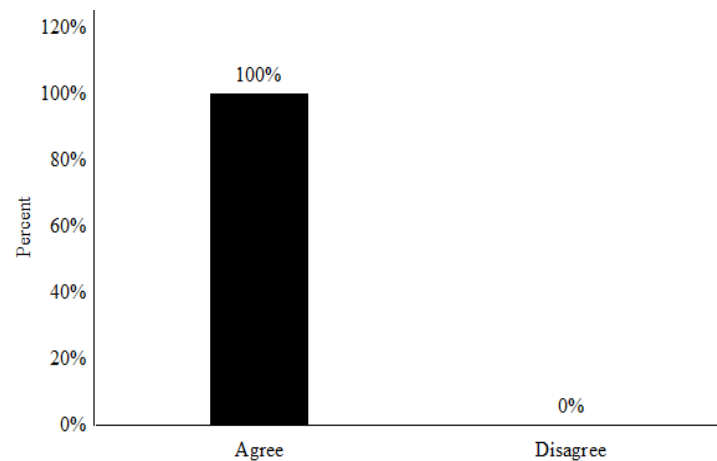


Figure 2: Stakeholders appreciate advocacy communication work

The views of facilitators were sought as to whether the school community appreciated the work being done by organizations that create awareness against child trafficking and even recommend more of awareness initiatives to be conducted. Results are presented in Figure 2 above. The figure shows that all (100 percent) of the facilitators agreed that the school community was grateful for the advocacy communication programmes and recommended even more awareness creation. This means that members of the school community embraced the campaign and took ownership of the processes of advocating against child trafficking campaign. This is in line with Gardner's (2015) argument that eradication of social prejudices and inequalities in any given community can be achieved through advocacy campaigns.

#### 4.3.2 Stakeholder Appreciation of the Need for Education on the Subject of Child Trafficking

The study sought to establish the views of the teachers on whether the aspect of educating children on issues relating to child trafficking was necessary in the region. Figure 3 below presents the findings.

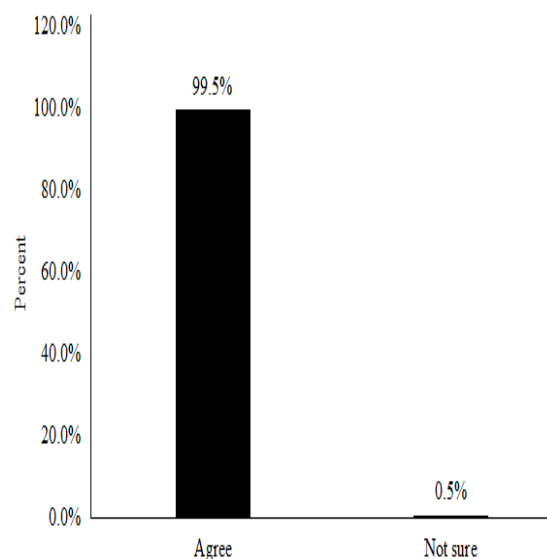


Figure 3: Educating children on issues relating to child trafficking is necessary



The findings indicate that 99.5 percent of the respondents agreed that it was necessary to educate children on issues related to child trafficking whereas some 0.5 percent of the respondents were not sure. This means that respondents recognized the importance of children as stakeholders in advocacy communication against child trafficking (Christie, A., Nott, T., Capezzuoli, S., Smith, J., Wedden, P.V & Jaenicke, H. (2014).

#### 4.3.3 Facilitator's Ability to Communicate with Children

The teachers were asked to evaluate whether the facilitators were able to communicate with the children. Figure 4.4 below shows the findings.

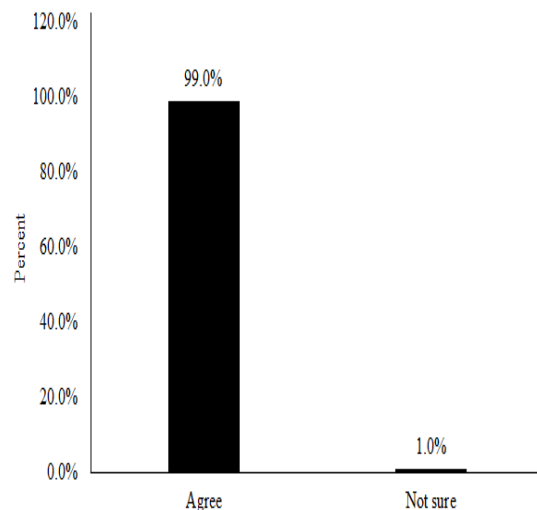


Figure 4: Facilitators ability to communicate with the children

As per the finding in figure 4.4 above, 99 percent of the respondents agreed that facilitators were able to communicate with the children and only 1 percent were not sure. This finding implies that advocacy communication to children in addressing child trafficking was effective because as argued by (Sharma, 2012), the ability and effectiveness of a communicator communicating with his or her audience lies on the communication channels used which is what this finding found out.

#### Ability of the Children to Understand Communication Messages

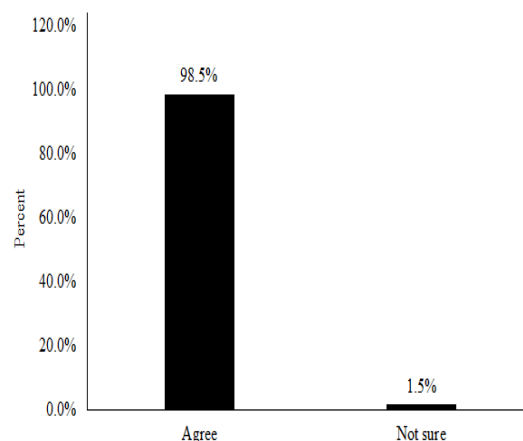


Figure 5: Children ability to understand messages on child trafficking

The teachers were asked whether the children have the ability to understand the message on child trafficking. Figure 4.5 shows that 98.5 percent of the respondents agreed and 1.5 percent of the respondents were not sure. The results suggest that in the evaluation of teachers, the children were able to make sense of advocacy communication messages. This potentially enhanced the effectiveness of the methods and tools used to advocate against child trafficking in the study area.

Concerning how respondents were able to tell that children have understood the message of child trafficking whenever explained to them, five themes were recurrent. These were: the children's increased ability to voice their rights, detect and report cases of child trafficking, engage in discussions on the subject of child trafficking, being more inquisitive about child trafficking so as to have a depth of understanding and take precautions to protect themselves against becoming victims. As argued by (UNICEF 2003), self-protection is necessary and can be achieved when one understands the content and context of achieving that. This is evident in the following verbatim samples;

“Asking questions for clarification with regards to the topic, avoiding contact with strangers and reporting cases they have heard or come across” (*Respondent 30*).

“Lively discussion relating to the topic they have after every training, precautions they start taking after the trainings towards protecting themselves from perpetrators who mean them harm, reporting cases they come across either at home or school and asking questions in relation to the topic so as to have a better understanding of the phenomenon” (*Respondent 34*).

“They are able to know the difference between a trafficker and a victim of CT thus offer the needed help if they ever come across one” (*Respondent 64*).

“They do not accept gifts and offers from strangers e.g. car lifts, they do not walk alone especially late hours in the evening e.g. when going back home after school, and they openly present funny behaviors they do not understand with people they know or don't know to parents and teachers for clarification” (*Respondent 71*).

“They repeat what they have heard and saw during different trainings, they start taking more precautions meant to ensure their safety, you find them discussing some of the topics covered among their peers and they ask questions where they need clarification and were a bit hesitant to ask during training” (*Respondent 122*).

#### **4.3.4 Perceived difference Humanitarian Organizations are making to address Child Trafficking**

The views of teachers were sought concerning whether facilitators from different humanitarian organizations addressing child trafficking in schools in the area were making a difference in the children's understanding of the concept.

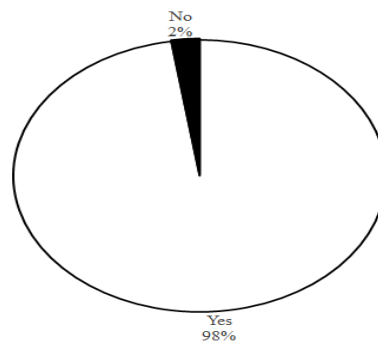


Figure 6: Humanitarian organizations making a difference in the fight against child trafficking

Figure 6 above shows that 98 percent of the respondents said ‘yes’ and 2 percent of the respondents said ‘no’. The themes of heightened levels of awareness and vigilance on the part of the children, as well as increased reporting of suspected cases of child trafficking were outstanding from the views expressed by majority of the respondents. The following are some of the verbatim examples;

“The children have been able to adopt the attitude of ‘better safe than sorry’ which means that they are quick to report and be on the lookout” (*Respondent 1*)

“Yes, they help create awareness which in turn has opened the eyes of both children and parents in this area thus the need to tighten security and being more careful” (*Respondent 4*).

“Yes, they have helped the children really understand this concept at a deeper level thus being more cautious and careful towards their security” (*Respondent 7*).

“Yes, even the community at large has become more aware that Child Trafficking is a problem and are taking part in addressing it” (*Respondent 13*)

“Yes, have helped in awareness creation in this area such that children even know who to contact if they ever fall as victims” (*Respondent 16*)

Yes, because after every facilitation, children can be able to cite incidents of having come across the vice. They also point out some other children’s homes that should be investigated because they think the children in that home are being exploited (*Respondent 20*).

Yes, they help them realize how grave CT is and how costly it can be to their lives. Also help them realize their rights and therefore when these rights are violated they know where and who to report to (*Respondent 23*).

From these verbatim examples, it can be inferred that most of the respondents associated increased vigilance and measures children took to protect themselves against child trafficking with the advocacy communication undertaken by the facilitators and the organizations that they represented. This agrees with UNICEF’s (2003) argument that indeed one way to vigilantly address any social injustice is by first offering protection to the victims and vulnerable groups identified.

#### 4.3.5 Role of the education system in curbing child trafficking

As per the findings of this study, it is very clear that the education system has a role to play in ensuring that cases of child trafficking subside and children get to be safe from the perpetrators. This is because a

large portion of these children's lives is spent in school and therefore their protection and ensuring they understand what the phenomenon is all about so that they can be cautious, is key.

As seen from the responses given by the targeted respondents, schools play a huge role in addressing child trafficking and creating awareness against it with the aim of protecting their students. Below is the finding gotten with regards to this.

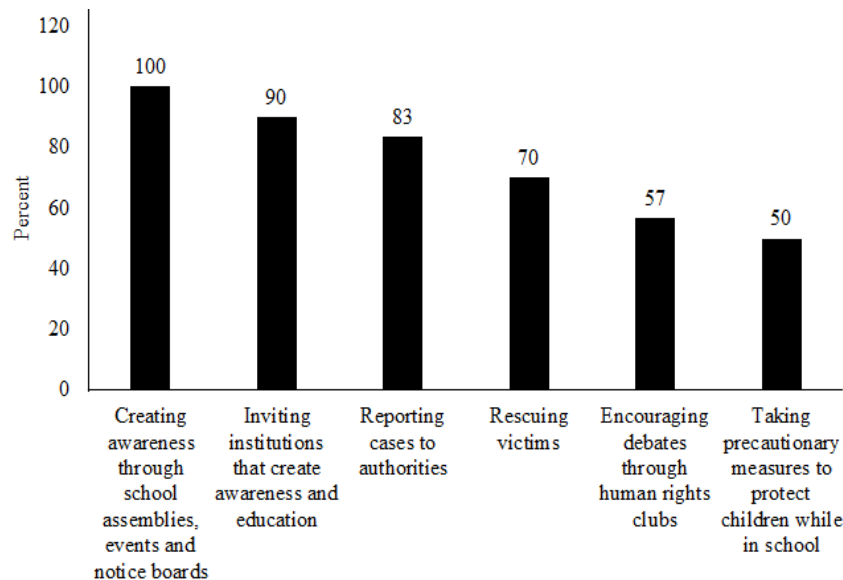


Figure 7: Ways in which respondents' institution addresses the issue of child trafficking

As a measure of effectiveness of child trafficking advocacy communication, the teachers were asked to list ways in which their institution has addressed the issue of child trafficking. The responses obtained revealed that most schools took multiple steps to address the issue of child trafficking as shown in Figure 7 above. The figure presents the distribution of responses by the respective ways from the most frequently mentioned. Additionally, the above mentioned methods are in agreement with what Christian (2014) identifies as effective advocacy methods and channels that come in handy in combating some of the social ills like child trafficking.

The findings in Figure 7 above show that awareness creation was practiced by all (100 percent) of the institutions, followed by inviting institutions that create awareness and education (90 percent), reporting cases to authorities (83 percent), rescuing victims (70 percent), encouraging debates through human rights clubs (57 percent) and taking precautionary measures to protect children while in school (50 percent). These results are reflected in the following verbatim comments;

“Taking part in awareness creation by having posters addressing the issue, talking to other stakeholders on the same among others, inviting institutions addressing the same to our school, and forwarding reported cases” (*Respondent 99*).

“Posters addressing the issue, forwarding reported cases to the relevant authorities, talking about this issue even with parents, and having the topic being addresses in clubs like the debate club” (*Respondent 116*).

“Forwarding reported cases to the relevant authorities, allowing institutions or organization addressing this issue into our school, continuing to teach the children about child trafficking and urging them to take the necessary precautions, talking to their parents during parents’ meetings so that they too can take care of their children” (*Respondent 122*).

“Allowing organizations fighting this vice to create awareness in our school, working in partnership with these organizations in order to address this issue, and reporting and following up cases forwarded to us by the children” (*Respondent 137*).

“Taking part in advocating against this vice during school events, allowing and inviting organizations addressing child trafficking to teach our children on the topic, reporting cases, rescuing children susceptible of being victims, and doing follow ups with the children to ensure that each is comfortable at home” (*Respondent 178*).

From the prior findings, it can be inferred that most of the schools in Mathare Constituency took part in advocacy communication programmes specifically addressing child trafficking, implying that they embraced the advocacy work geared towards countering child trafficking. On the basis of the above findings, this paper argues that all (100 percent) of the facilitators agreed that the stakeholders directly involved with children did contribute to the fight against child trafficking. This agrees with the observation made by Quarry and Ramirez (2009) that advocacy usually give voice to the marginalized population thus promoting an active participation in certain issues that affect their lives. The implication of this finding is that the children get more aware and knowledgeable on matters to do with child trafficking, which forearms them with the information about how to respond when under threat. This was further reflected in the subsequent finding which showed that 99.5 percent of the responding teachers agreed that it was necessary to educate children on issues related to child trafficking, which means that they recognized the important role that the children themselves would play in combating child trafficking in society.

It was also found that nearly all (99 percent) of the respondents agreed that facilitators were able to communicate with the children, which means that their advocacy communication techniques were effective. In the same vein, the results showed that majority (98.5 percent) of the responding teachers agreed that the children have the ability to understand the message on child trafficking, implying that they were able to make sense of advocacy communication messages relayed by the facilitators. This is line with ILO (2009) who see advocacy as a means of helping individuals and groups know what they need to do exactly in order to contribute much effectively to the anti-trafficking efforts.

Nearly all (98.5 percent) of the teachers agreed that they were usually present when the different humanitarian organizations conduct trainings addressing child trafficking in their school. This is an indication of high stakeholder participation and ownership of the move geared towards addressing child trafficking which is a measure of effective advocacy communication against child trafficking. This is potentially because they embraced the advocacy communication campaign against child trafficking as a

societal responsibility. This is resonant to the argument put forth by Feshbach and Feshbach (1978) that advocacy communication should involve the community for it to be effective as this will create a forum for community dialogue in an open and freer atmosphere. In this study, the notion of community participation was reflected in the results which showed that awareness creation was practiced by all (100 percent) of the institutions, invitation of facilitators and organizations involved in advocacy against child trafficking was practiced by 90 percent. Further evidence of high community participation was reflected in the findings which showed that 83 percent of the institutions reported cases to authorities, 70 percent rescued victims, 57 percent encouraging debates through human rights clubs and 50 percent took precautionary measures to protect children while in school.

Related findings revealed that all of the responding facilitators agreed that the school community appreciated the work being done by organizations that create awareness against child trafficking and even recommend more of awareness initiatives to be conducted. This means that advocacy communication programs implemented earned dividends in terms of community buy in, which is arguably a very important aspect of winning the war against child trafficking. This was reflected in the children's increased ability to voice their rights, detect and report cases of child trafficking, engage in discussions on the subject of child trafficking, being more inquisitive about child trafficking so as to have an in-depth understanding and take precautions to protect themselves against falling victims. These explain why almost all (98 percent) of the respondents believed that there was a positive difference that humanitarian organizations undertaking advocacy communication against child trafficking in Mathare Constituency.

These findings therefore concur with Petty and Cacioppo (1986) who advocate the importance of understanding one's audience when choosing communication methods and elaborated messages and how the audience members are likely to react to arrangement of arguments being presented. This will determine the efficacy of the methods put in place as they will have been selected carefully and deliberately.

## **5. Conclusion**

The use of appropriate advocacy communication methods in countering child trafficking can be effective. This in the study was indicated by a high level of community ownership, involvement and participation. As a result, members of the school community contributed to the combating of child trafficking in various ways. They embraced the advocacy campaigns, participated in awareness creation and recommended even more. They also reported cases of child trafficking to the authorities, encouraged debates through human rights clubs and took precautionary measures to protect children under their care. However, the prevalence of child trafficking in the constituency remains high meaning that there is still room for improvement. The study argues that the war against child trafficking can be won through use of advocacy communication strategies.



## 6. Acknowledgement

We are very grateful to every respondent who took their time to provide adequate data for this study. Without your input, finding relevant information that helped inform this study would not have been possible.

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# Craft based assignments of undergraduate textile design students:

## Multiple case study

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### Abstract

*Modern textile design education is based on skill and practice. To inculcate the required expertise, contemporary educators used craft-based assignments. Many designers and artists consider designing high-tech products to start with sketching and drawing, paper, and a pencil. The visualization of design is a broad idea. It involves the cognitive critical and technical thinking of the designer. The present study discussed different approaches to visualization and elucidation. Craft based assignment is the foundation of the design process, where undergraduate textile design students experienced design development. The present study is a multi-case study. Data were collected from three assignments in textile design education. It's a departmental case study where three cases were studied under the supervision of three textile design instructors. The outcomes demonstrated that, through craftsmanship training, the students found perception and explanation methods that were beforehand obscure to them and that they would not have thought of themselves. The study plan focused more on the thought and the outline sentiment than on the subtleties while applying the new strategies. The study shows that rough techniques seem to offer undergraduate textile design students a more robust visualization method and lower their creating threshold. The outcomes may be useful for teachers when planning craft projects that include a complete craft process that promotes undergraduate textile design students' own creativity and ideas. Through a well-planned craft project, it is possible to combine knowledge of different courses and promote essential skills in overall learning and education.*

**Keywords:** Craft based textile, Textile Design process, Design education design experiment craft process content analysis

### 1. Introduction

National College of Arts Lahore Pakistan (NCA) has a long tradition of requiring craft as a compulsory course for every undergraduate textile design student. As early as the 1900s, NCA advocated the importance of craft for a complete education also discussed by Virtamaa (1980) in context of Scandinavian education. Today, craft is taught as a compulsory course at every level of education. Craft as a course consists of working with both soft (textile) and hard (wood, metal, etc.) materials.

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In craft education craft is defined as containing the entire process from designing to producing the final outcome. No step in the process is seen as more important than another. However, in practice, either designing or producing may be emphasized and the work may concentrate more on one of these steps. For example, it may be essential to concentrate on producing to learn the skill of a particular craft technique, or designing may be the focus even to the extent that the final product is not produced at all. It is also possible that, if a teacher lacks the skills and ideas for teaching design, undergraduate textile design students are asked to use ready-made designs and models. The report on the evaluation of the course of craft in Textiles education shows that nearly half of the products produced in craft lessons are made from models introduced by the teacher. However, according to the national curriculum and the future needs of society, more emphasis should be placed on complete craft processes, i.e., processes that promote the use of undergraduate textile design students' own creativity and ideas, and not just pre-existing models.

Researchers agree that craft promotes various skills and has positive effects on undergraduate textile design students, both physically and psychologically (Garber 2002; Karppinen 2008; McLennan 2010; Huotilainen 2012). Making something by hand is constructive and empowering; craft enhances cognitive skills such as thinking and problem solving. It enhances bodily skills, fine motor coordination, hand-eye coordination and spatial conceptualization (Huotilainen 2012). Through craft, undergraduate textile design students gain positive experiences as they make artefacts with their own hands. What is more, craft-work advances skills in perseverance and group work. Theoretical and abstract phenomena of the surrounding environment may be brought into concrete practice through working with craft; it is also possible to combine knowledge of different courses and promote skills that are essential in overall learning and education.

A multidisciplinary approach and the integration of different courses has been debated and called for by authorities. The understanding of complete processes is enhanced when integrated teaching and learning is used (Anila 2009). However, Higher education Commission Pakistan (HEC) fragmented, and every design institution course is taught in its own lessons using course specific scheme of studies. This raises challenges for an undergraduate textile design student to perceive how the world fits together and how to understand entire processes instead of phenomenon separated from each other. Furthermore, there have been calls for the study of everyday phenomena of the surrounding world and topics that interest undergraduate textile design students (Anila 2009)

Sundass (2004) claim that meaningful and stimulating study modules increase students' motivation and improve learning results. They found that information is assimilated most profoundly in situations that are as close to real life as possible. Resolving real everyday problems makes learning more meaningful and improves learning. However, it seems that a lack of educational ideas diminishes integration in the design institution context.

This integration of everyday phenomena through craft-making can be explored in a number of ways. For example, the theme of using natural dyes was found to be a good way of integrating courses around phenomena that are familiar and interesting to teenagers, such as colors and textiles. It also offered a

platform of teaching certain topics mentioned in the national curriculum i.e. environmental issues and ecological values, materials, different separation techniques in chemistry, product design, and the cultural context of textiles and particular craft techniques. The curriculum of the Natural Dyes project contained the complete process from the collection of plants or fungi to the isolation, separation and characterization of pigments in chemistry, as well as from dyeing or printing with the pigment powder to designing and producing the craft product. At the end of the project, an exhibition was organized. It concretized the process and made the results visible to outsiders.

## **2. Research aim and methods**

This article presents research from one part of the Natural Dyes project. It focuses on the design part of the project in order to discuss different approaches to visualization and elucidation. The two research questions are

*What effect do the design process and the technique for elucidating an idea have on the final craft product?*

*What effect do the design process and the technique for elucidating an idea have on the undergraduate textile design students' conceptions of the designing and production process?*

The data were collected from three design cases in textile craft courses taught by three teachers with one group of seven or eight undergraduate textile design students each. Each case introduces one visualization technique: watercolor painting connected to window framing, which resulted in the rug technique slippers; quick sketching with watercolors, which resulted in printed wall hangings; and collage by cutting or tearing shapes from colorful papers, which resulted in a set of printed bags. Each design case consisted of both designing and producing the final product. The research data of the design and visualization process consisted of the teachers' written lesson plans, notes of the researcher's observations in the classroom and videos recorded from the craft lessons (800 minutes, approximately 260 minutes per teacher). There was 6×90 minutes teaching periods for each group. Discursive interviews with the teachers were carried out on the themes connected to the teaching tasks. A structured questionnaire with a five-step Likert scale was completed by the undergraduate textile design students who took part in both chemistry and craft lessons (N=14). The questionnaire consisted of fifteen statements that undergraduate textile design students answered with a five-step agree–disagree scale. In addition, undergraduate textile design students' statements and other qualitative data were obtained from videos. A data-based, qualitative content analysis was performed of the interviews, lesson curriculums, notes of the classroom observations and videos. The analysis categories covered statements connected to design, product and integration.

The permission for this research and publication of the photos taken during the project has been obtained from the Design department and the guardians of the undergraduate textile design students involved in the project.



### **3. The Natural Dyes project and the three design cases**

The Natural Dyes project was based on the multidisciplinary doctoral thesis ‘Anthraquinones from the fungus *Dermocybe sanguinea* as textile dyes’ by Räsänen (2002), in which simple methods were developed for the isolation and characterization of pigments from the fungi. The pigments were separated and analyzed by chemical means, after which the pigment powder was applied as dye for textile materials. Because the techniques used were simple and required little equipment, the idea of applying them at design institution in chemistry and craft lessons arose.

In cooperation with craft teacher education at the NCA, a public design institution in Pakistan, the Natural Dyes project was carried out three times within two years. Over 70 undergraduate textile design students participated in at least part of the project every design institution year. Some students were only part of the chemistry lessons (32, as two groups of sixteen undergraduate textile design students a year) or the craft lessons (32, as two groups of sixteen undergraduate textile design students a year), while some were in both (fourteen, as two groups of seven undergraduate textile design students in the first year and one group of seven undergraduate textile design students in the second year). Nearly half of the undergraduate textile design students were girls, and those who participated in the whole project, including both the chemistry and craft lessons, were all girls. Teachers, Khadija Hameed(Case 1), Tayab Subhani(Case 2) and Mubeen Ashraf(Case 3), laid out the visualization and elucidation ideas presented in this article. In each of the three design cases, the undergraduate textile design students were given the task to design and produce a particular craft object. The teacher introduced the idea of the object, but it was the task of the undergraduate textile design student to make his or her own design for the final product. The products were slippers, printed silk wall hangings produced as group work and bags, according to cases 1□3.

#### **3.1.Case 1: Watercolor painting and window framing**

In Case 1, the undergraduate textile design students were given the task to make slippers out of self-dyed yarn using a rug- making technique. The design for the covers of the slippers was accomplished using an aquarelle technique. Before the actual painting session, undergraduate textile design students were introduced to textile art accomplished with a rug-making technique and shown pictures of textile pieces. While watching, undergraduate textile design students were asked to describe their feelings about the particular art piece or the qualities or characteristics that the textile presented. These statements were recorded. The slide show and discussion took fourteen minutes. After that, undergraduate textile design students were encouraged to skim the pages of the books about Textiles rug culture and rug textile art. In the next stage, undergraduate textile design students took watercolors and were allowed to mix three to four colors that matched the previously self-dyed yarns. The teacher directed the undergraduate textile design students to paint freely on a sheet of A3 paper inspired by the expressions collected during the slide show; these expressions were shown on the whiteboard of the classroom. The undergraduate textile design students were encouraged to paint three different versions and try to accomplish them in a way that would ‘feel like the undergraduate textile design student’s own style’ (T1). The teacher suggested that the undergraduate textile design students think about the paintings ‘as surfaces’ and she guided them towards more ‘abstract composition’. She noted, ‘Do not draw hearts’ (T1). The painting session took 80 minutes.

When the paintings were finished, the design for the slipper was chosen by searching for an interesting area in the painting with a window frame, a hole in a paper.

The covers of the slippers were completed with a rug-making technique for which aquarelle painting was a very applicable strategy for visualization because the blending of colors and forms was smooth. In the rug-making process, it was possible to blend several differently colored yarns to produce one knot and to obtain the preferred outcome. In the final rug surface, accurate forms were not delineated, but colors were blended together. After the pieces of the covers were accomplished, the slippers were sewn together and completed.

### **3.2.Case 2: Quick sketching with watercolor's**

In Case 2, the undergraduate textile design students were asked to design and print silk materials to be wall hangings in the design institution hall. In the beginning, undergraduate textile design students were introduced to modern textile art by a ten-minute slide show. After that, undergraduate textile design students took a fifteen-minute tour in the design institution building to look for an appropriate place for the wall hangings. For the design, the undergraduate textile design students drew quick sketches of their dancing classmates with watercolors. The idea was to complete a figure quickly without thinking too much about the final appearance of the drawing. According to the teacher (T2), 'Watercolors make it impossible to draw in a too meticulous way. Drafts are supposed to be rough: great lines and simple forms are easier to work forward'. The teacher explained to the undergraduate textile design students why the drafts were made and why the shapes and forms were more important than the details. Undergraduate textile design students chose their favorite music. A group of undergraduate textile design students were dancing, and at the same time, members of the other group sketched their classmates. The watercolors did not allow detailed drawing, and the short period, only several seconds, forced the drawings to be produced with no more than a few lines /The drawing session took 30 minutes.

After the sketching, the teacher explained to the undergraduate textile design students the principles of printing design, including the enlargement and reduction of the pattern, rhythm and composition. The undergraduate textile design students were divided into groups of three to four and they selected a few figures from their drawings to be made into stencils. Undergraduate textile design students were briefed on how to use copy machines for enlarging and they were reminded that difference in size increases tension and can be used to make the print more interesting. The stencils for printing were prepared by cutting the figure out of a transparency film laid over the drawing. The silk materials were dyed with natural dyes, after which the figures were printed using the stencils. The undergraduate textile design students prepared the printing pastes made of natural colorants.

### **3.3.Case 3: Collage: Cutting or tearing shapes from colored paper**

In Case 3, the design for the textile printing was accomplished using a paper collage method. Teaching outside the classroom was included in this experiment; the inspiration for the shapes was obtained from Central Asian ikat coats that were part of an exhibition in a museum to which undergraduate textile design students made a 50-minute visit. In the museum, every undergraduate textile design student was given a

paper with four questions about the colors and forms of designs and patterns of the coats. Undergraduate textile design students were allowed to draw or write their answers. Afterwards, the undergraduate textile design students composed patterns for printing inspired by their excursion. They made a collage by tearing or cutting out shapes from colored paper. For printing, the undergraduate textile design students used such techniques as stencil, frame or tape-resist printing. At the end of the process, the printed fabrics were sewn into bags

## **4. Results and discussion**

The research aim was to discover what effects the designing process and the technique for elucidating an idea had on the undergraduate textile design students' conception of the designing and producing process and on the final product. Here the results are presented and argued in relationship with the literature on the course.

### **4.1. Visualization as a part of the design and craft process**

Visualization is an essential part of the craft designing process, because to ideate a novel product and to be able to discuss it with a teacher, an undergraduate textile design student must use some way of elucidation to show what he or she intends to make (Garner 2002). In particular, visualization assists in problem solving and handling diverse information (Seitamaa-Hakkarainen 2000: 172; Bilda et al. 2006). The importance of visualization was confirmed in this study. Classroom observations, teachers' statements on the video and the lesson plans showed that the teachers valued the designing and undergraduate textile design students' own ideas over any ready-made samples, because they felt that visualization was an important tool for communication and for them to understand the children's thoughts. As one teacher said, 'Otherwise I cannot know what you are thinking' (T1). The study showed further that the visualized design was also important for the undergraduate textile design students because it served as an instruction for them for the production process. The visualized design helped to concretize the way and order of working when using a particular craft technique (evident in all three Cases).

### **4.2. Communication through visualization**

Bilda et al. (2006) noticed that students learn to develop their ideas through sketching, i.e. unfinished rather quick drawings or paintings made as a preliminary study. They emphasized that design education required an intensive learning process through drawing, and thus it was important to learn how to think with sketches. When students learn how to sketch, they also learn how to develop ideas. Bilda et al. described sketching as a dialogue in which drawing is used to test and evaluate ideas. Some designers describe sketching as a language that is used to externalize a mental image, the idea and, like language, sketching can also be learned (Bilda et al. 2006). Similarly, Akalin and Sezal (2009), following Edwards (1979), maintain that drawing is important for designers as a tool for communication with others and that it helps them to see and understand the forms with which they work. Through sketching, students learn to think with illustrations, develop ideas and solve complex problems (see also Seitamaa-Hakkarainen 2000). Thus, the act of drawing seems to be intimately bound with thinking: illustration describes the mental

processes of internalized images and constructs an interpretation that the outside world can see and understand (Jung and Sato 2010).

It appears that the design process is not linear but rather iterative where repeated cycles gradually drive the problem solving towards a solution (Zeisel 1981). Because designing is time consuming as well as a challenge for teachers in content planning and instruction it is easily omitted in class sessions. The present study showed that the external constraints like the design institution and project timetables decreased the time for designing. In all cases 75–90 minutes were used for the designing processes: introducing the ideas (teacher as the main actor), working with the idea and visualization (undergraduate textile design student as the main actor), and preparing the final design for a product (P). The museum visit as a source of inspiration was excluded from the time calculations (Case 3). In this short period, undergraduate textile design students did not reach the state of iterative design cycles nor did they learn how to use their sketches consciously to develop their designs. Rather they produced a few alternatives from which they could choose one. Only in Case 2 did undergraduate textile design students develop their drawings further by enlarging and condensing sizes of the chosen figures, after which they searched the composition with several variations. However, in spite of the short time of designing, the outcomes showed that new stimuli and visualization techniques had an effect on the conceptions; thus, design is important in both pedagogy and actual creation. This conclusion was drawn against the previous class-room experience of the teachers, which had shown that, in designing, the undergraduate textile design students very eagerly followed ready-made images and forms like circles and hearts. This was revealed through the teachers' interviews and videos, while the undergraduate textile design students' statements revealed that they did not trust themselves in creating a fresh vision without stimulation: 'I would not have thought of such technique on my own'.

### **4.3. Stimuli for visualization and design**

Cotton and Haddon (1974: 20) have realized the influence of the surrounding visual environment on people and how they see their own illustrations. Western culture, which is dominated by photographic images, seems to value realistic illustrations, and thus raises the threshold for drawing and illustration. Cotton and Haddon claim that children often underestimate their ability to draw because their self-confidence is easily undermined and they doubt their skills to fulfil the unwritten expectation presented by pictures in books and magazines (Cotton and Haddon 1974: 20). Furthermore, investigation has shown that the majority of undergraduate textile design students as well as teachers agree that the appreciation of art lays in realistic representation. In the research data, this pattern of thinking of realistic representation appeared in the teacher's comment (T1) that forbids undergraduate textile design students to draw hearts or anything representational. In addition, in Case 2 the watercolour technique was chosen because it 'did not allow too detailed drawing' (T2). In both of these cases, the teachers had presentiments that undergraduate textile design students would draw realistic illustrations if they were not guided to visualize differently. Teachers preferred rough and simple lines to details because they were easier to work with towards printing designs than careful and detailed drawings done with sharp pencils. The other aspect of underestimating one's own illustration appeared in undergraduate textile design students' comments about their work. One student

stated, 'This looks awful', about a watercolour painting while another said, 'There is nothing nice here', when searching an area with the window frame (Case 2). According to the questionnaire, undergraduate textile design students agreed that designing was difficult or challenging.

How can the problem of undergraduate textile design students undervaluing their own skills of illustration be overcome? Thomas (1995) argues that drawing is not an easy skill to master. However, young children generally become more skilful as they grow older. According to studies, the principal sources of inspiration for most drawings can be traced to pictures that children have seen and adopted. Thus, they seem to learn drawing skills by copying pictures available in their environment. When children draw something that they have seldom, if ever, drawn before, they show more variability in illustrating than do children who follow well-practised procedures and familiar topics (Thomas 1995). It is more likely that children will draw from a fresh vision if they are presented with objects that are new to them and for which they have no schema. For example, minute objects seen through a magnifying glass or microscope or that can be held in the hand or be experienced in a haptic way provide intrinsic qualities and lead to unrestrained drawing. Such objects are interesting because of the associations they have for the observer (Cotton and Haddon 1974: 20). Both of these findings reinforce the argument that schemata, copied from past pictures or discovered and developed by trial and error, are the essential basis for picture-making. These also show that an apparent inflexibility may arise from habit rather than limits of cognitive capability (Thomas 1995).

This study confirmed the importance of unknown schemata for learning. Undergraduate textile design students showed variability in illustrating because they used familiar techniques in a new way; they discovered unknown topics and drew something they had never drawn before. Each teacher planned a different way to inspire undergraduate textile design students: there was a slide show of textile art accompanied by a discussion (Case 1), music with bodily action (Case 2) and a museum visit (Case 3). The rough illustration techniques that were introduced offered undergraduate textile design students a strong visualization method and a way to concentrate on forms rather than details. With regard to the design process, the majority of the undergraduate textile design students said that they learned new visualization and elucidation techniques that they would not have thought of on their own. As the undergraduate textile design students stated,

*The whole technique was great! The design was more artistic and different. I would have not thought of such technique on my own.*

*[Without the teacher's advice] I would have probably designed a simple figure like a circle.*

*It was fun to search for an interesting view through the hole [in the paper].*

However, the findings also show that a group of undergraduate textile design students lacked flexibility and would have liked to work from habit. The data obtained from questionnaires and video analyses indicated that one group of undergraduate textile design students favored the introduced new techniques,

whereas another group of undergraduate textile design students found the unconventional visualization techniques laborious and would have preferred the conventional ones, which they claimed to be easier. A student in this group noted,

*It would have been easier just to take a checked paper in the form of the slipper cover and color the pattern there with colored pencils. It would have been easier to design a simple figure, a circle or something.*

These statements also support the observations of Cotton and Haddon (1974) and Thomas (1995) that the principal sources of inspiration for the drawings can be traced to pictures and forms that children have seen and that most follow well-practiced procedures and familiar topics. This study showed that, through free and uninhibited techniques (aquarelle and collage), the undergraduate textile design students did not focus as much on what the sketches looked like, but on the idea and the feeling in the illustrations. This was possible because the technique did not allow detailed drawing and also the teachers' guidance towards non-representative imagery. One student suggested, 'The figures bear resemblance to the cave paintings!'. Furthermore, the usage of only part of the drawing in the design was new for the undergraduate textile design students; that is, the window framing technique made undergraduate textile design students think that the outcome was more artistic than they expected. One student noted, 'The thing [craft object] is nice as a bag, although it was not very nice in the beginning'

#### **4.4. The role of the teacher**

The basis of creativity is a feeling of confidence. For the undergraduate textile design student, this depends on the sense of personal security and self-estimation as well as the attitude of the teacher. Teachers and their enthusiasm have a large influence on undergraduate textile design students and particularly on the values present in classrooms (Cotton and Haddon 1974: 10–11). Cotton and Haddon (1974) point out that the teacher is the key person to lower thresholds to create. It is the teacher's duty to keep children's interest and confidence high, especially during the difficult periods during which they tend to reject their work. To that purpose, teachers may introduce rough techniques as a medium that offers the possibility to move beyond naturalistic work. The opportunities to explore and master the materials encourage new ways of expression (Cotton and Haddon 1974: 20–21, 22, 25).

In this study, the teachers' enthusiasm was seen and heard in their way of talking to the undergraduate textile design students, for example as a rising intonation, and how they encouraged undergraduate textile design students. Teachers had also put a lot of effort into their lesson plans. Of course, one needs to keep in mind that the lessons were the final teacher training assignments, and thus more time will have been spent in preparing them than in the case of a regular teacher preparing her or his lessons. All teachers encouraged undergraduate textile design students and gave them further advice and hints to continue with the chosen theme in situations in which undergraduate textile design students were unsure or underestimated their skills. For example, the following dialogue was observed: 'This does not look nice' (P, Case1). 'Yes, it does. You may try different greens [yarns]. Hmmm, this is very good. Several different greens over there' (T1, original emphasis).



Cotton and Haddon (1974) point out that it is important that undergraduate textile design students have the freedom to choose the technique appropriate for them and the task they are tackling. Before making a decision about technique, undergraduate textile design students need knowledge about different techniques and their potential for the visualization of an idea. Experience of materials of painting and drawing is an essential component of growth in creative work and the teacher should provide a range of materials and stimuli that provoke their use in an imaginative way (Cotton and Haddon 1974: 26). Similarly, Kopper and Power (2010), following Chappell (2007), emphasize the importance of the teacher's attitude in fuelling the creative process. Since undergraduate textile design students are accustomed to reproducing memories of pictures they have seen, the teacher's role is often to help the undergraduate textile design students to develop ideas derived from their own experiences (Cotton and Haddon 1974: 26). At the same time, giving undergraduate textile design students the freedom to visualize and elucidate their ideas does not mean that the teacher should never restrict their expression. Undergraduate textile design students would need a wider experience in order to choose the scale and technique from knowledge rather than habit (Cotton and Haddon 1974: 25).

The role of the teacher is to help the undergraduate textile design student gain the power to accomplish the task. The teacher should not be afraid to put new opportunities before undergraduate textile design students or to give them clear instruction on how to begin exploring the materials and ideas; if the teacher only provides a range of materials without teaching undergraduate textile design students how to use them, the undergraduate textile design students are very likely to experience frustration and continue to use those items with which they are already familiar. It is essential for the process to be taught in such a way that it opens up a range of possibilities and is not restricted to one result. There is not one right way to resolve a creative problem. The teacher's role is to focus the undergraduate textile design students' attention on the various aspects, and through discussion help to structure experiences in a way that they become manageable and can be expressed. In addition, it is important that the undergraduate textile design student realizes that he or she has a technique at his or her command that can be used in a variety of ways to suit his or her purposes and that it can be used in conjunction with other techniques. Thus, it is vital that the teacher, at least sometimes, deliberately restricts the undergraduate textile design students' choices so that they gain experience of a particular medium or process (Cotton and Haddon 1974: 8–9, 26) and actively encourage undergraduate textile design students to search for new ideas, to develop ideas further and not to be satisfied with the first solution.

In this study, the introduced rough illustration techniques offered undergraduate textile design students a visualization method they were not used to. With regard to the design process, the majority of the undergraduate textile design students said that they learned new visualization and elucidation techniques that they would not have thought of on their own. This not only stresses the importance of learning but also confirms the earlier (Cotton and Haddon 1974; Bilda et al. 2006) observations that the teacher has a central role in introducing new techniques and sources of inspiration and helping the undergraduate textile design students to execute their ideas in forms derived from their own experiences. In this study, undergraduate textile design students were stimulated by the museum visit, slide show and dancing.



The conceptual and concrete models used as tools for communication between students and teachers help students to improve their design ideas (Akalin and Sezal 2009). Therefore, when deciding on the most appropriate technique for elucidation, teachers must consider what idea needs to be expressed and what role concrete visualization has in the designing process.

The interviews of the craft teachers reveal that the teachers are sometimes unsure about their ability to guide the undergraduate textile design students in visualization and elucidation. However, the teachers were willing to learn more about different visualization and elucidation techniques and about possibilities and ideas for expanding on them in teaching. The interviews showed that teachers may not be able to put knowledge into practice if they are not taught how to do so. In addition, in their article, Kopper and Power (2010), following Alter (2007), expressed that the lack of confidence of a teacher in his or her own skills is an obstacle to effective teaching. Thus, it is important to teach the visualization and elucidation of ideas to teachers and to encourage them to use different techniques, not only sketching with a pencil and white paper, even though that method is easy, time saving and quick. Design is an important part of the craft process; thus, the visualization techniques used should be inspiring rather than obstructive. Similarly, teacher education should offer teachers tools for creating new knowledge and enthusiasm.

#### **4.5. Integration**

The research data collected from student questionnaires and teachers' interviews showed that the Natural Dyes project enhanced meaningful learning; the project was meaningful and interesting for both the majority of undergraduate textile design students and the teachers. All teachers agreed that it was meaningful to teach a project that integrated different courses and created a complete continuum even though the cooperation was challenging because of the exterior obstacles such as the design institution time table and class periods. The project was interesting to majority of undergraduate textile design students, because the learning was connected to phenomena, colours and textiles, important in the undergraduate textile design students' own reality and lives in a concrete way. At the same time, it is important to keep in mind that a minority of undergraduate textile design students did not see integration or working in a project as a method that was any better than the conventional ones. Thus, there seems to remain a challenge in reaching every student in a positive way towards new challenges and learning.

Through the Natural Dyes project, the individual courses of chemistry and craft were part of the greater entity as realized by the undergraduate textile design students, who made the following comments.

*Yes, I now understand the whole thing and not only what I see! [A statement said by a undergraduate textile design student when she understood why and how textiles were colorful.]*

*Because of combining the knowledge of chemistry and craft, I now understand better where the color of clothes comes from.*

*I have learned that there are different chemicals used to create color in textiles.*

These statements also reveal that the color phenomenon was understood completely: the undergraduate textile design students understood why and how textiles were colorful. This understanding also enhanced the meaning of the color and their own design of the craft object. One student noted, 'The final product was just as I designed it to be – personal. And I made everything by myself – the color, the material, the design – everything'.

The Natural Dyes project increased the teachers' cooperation at the design institution. Several studies have shown that it is difficult for teachers to find time for cooperation during the design institution day, and thus very little collaboration is undertaken (Sundas 2004: 65–66; Saima 2008: 51–54). It is important when laying out a project to reserve time for collaborative planning and to schedule meetings before-hand for the duration of the project. The time needed for planning is often underestimated, and time is reserved only for the actual activity, i.e. teaching and learning. However, the statements of the teachers' in this study revealed that well planned is more than half done and that it is easier to cooperate when there is communication.

## **5. Conclusions**

The first research question concentrated on finding out what effect the design process and the technique for elucidating an idea have on the final craft product. This study showed that the teacher has a significant role in guiding undergraduate textile design students to discover new ways of expressing themselves. Rough elucidation techniques seem to offer undergraduate textile design students a stronger experience of success and lower their threshold for creating. This leads to more gratification and better learning results. Also, the undergraduate textile design students described the outcomes as different and unconventional.

The second research question asked what effect the design process and the technique for elucidating an idea have on the undergraduate textile design students' conceptions of the designing and production process. Undergraduate textile design students realized that designing is difficult. However, when they learn new visualization and elucidation techniques, they become enthusiastic about them and this enthusiasm increases interest towards learning and finishing the project. Evidently, there is a group of undergraduate textile design students that lacks flexibility and would like to work from habit and this group sets challenges to the teachers.

The study showed that integration of different courses is not a self-evident truth and it meets obstacles. The habit of working in a conventional way is strong in design institutions; this appears for both teachers and undergraduate textile design students. It needs extra effort to break this schema. Teachers are the key persons and they need support and ideas on how to discover new ways of teaching and planning curricula. Investments in teacher education and training are usually rewarded with higher levels of student success. The number of people involved in the study was small and the results may not be generalized to a wider extent. In addition, the comments obtained from the teenagers were exiguous. However, the study gave other valuable information about the effects of teaching on the undergraduate textile design students'

conceptions and learning. This information may be utilized in teacher training when guiding craft teachers to look for their own teacher character and ways of teaching design tasks and cooperative learning projects. Furthermore, it is important to notice that creativity and interdisciplinary experimentation brings synergy into the design institution system's learning environment. Art and craft courses introduce new ways of exploring creativity and ingenuity, which are needed in learning within all design institution courses.

As a researcher I have tried to be as objective as possible. This research has been made in National College of Arts Lahore Pakistan in Textile design department and thus all statements are my translations into English, and they may have a different echo compared to the original statement said in Textiles. Finally, a study is always a researcher's interpretation of the events.

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# **PEOPLE, CULTURE AND CIVILIZATION: TROPICALISM AS RESISTANCE TO MILITARY DICTATORSHIP**

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## **Abstract**

*The political and economic crises faced today, evidenced by the manifestos of political parties and the texts published in social networks and in the press, point to Brazilian society the possibility of different directions, including that of an autocratic regime, with the return of the military to the public sphere. This article discusses the movements of acceptance and resistance to the military regime that was implemented in Brazil with the coup of 1964. It is observed that the military uprising received at that time the support of a large part of the Brazilian population, which sought ways to maintain its socioeconomic status to the detriment of a majority that perceived itself vulnerable in view of the forms of maintenance and expansion of power used by the regime. In this context, Tropicalism emerges as an example of a contesting movement. This text approaches the song "Culture and civilization" by Gilberto Gil, performed by Gal Costa, relating the ideas present in this composition with the understandings of politics and culture, in a multidisciplinary proposal, seeking to understand the resistance and counter-resistance movements that emerged in Brazil at the time.*

**Keywords:** Culture. Civilization. Dictatorship. People. Bourgeoisie.

## **Initial thoughts**

In the face of political and economic crises, violence, unemployment and other current social ills, it is observed that a significant portion of society has been occupying space in social networks, political parties and the media to ask for autocratic regimes. They seem to despise democratic values, while seeking someone to save them from the challenge of managing the public thing and thus their own lives. It is therefore important, in view of this situation, to reflect on the period of the Brazilian military regime, considering that "[...] history being the source of our problems is also the key to their solutions" (IAMAMOTO, 2006, p. 151).

Tropicalism, a cultural movement that emerged in the 1960s, especially with the song "Culture and civilization", the work of Gilberto Gil, in the voice of Gal Costa, provokes the challenge of thinking about cultural movements during the dictatorial period in Brazil. The song encourages us to understand, even in the face of the limitations of this work, how these concepts were constituted and what the meanings and intentions of the song lyrics would be. Why would Gal Costa sing "Culture and civilization to be unwell. Or not", in view of the sociocultural values instituted or sought to institute in the period? Considering tropicalism a protest movement, would it be isolated or would it compose a scenario of rebellion and resistance with several other segments of Brazilian social life? In the light of political theory, it will then seek to problematize the way in which the dictatorial regime, in the context of the April 1964 coup, sought its legitimacy or authorization, as well as the forms of social contestation produced in that period.

The dictatorial scenario is observed as conflicting and that the vision of culture is divided between cults and uncultured; whereas the former are defined as those who have access to classical arts in general and universities, while the others would be the working population limited to public schools, carnival and football; and that the objective of the regime may be to maintain this order as a form of economic development. For this qualitative and multidisciplinary analysis will be referenced some marxist critical theorists, especially Netto (2015) and Couto (2008), who will present the regime's strategies and the movements of rebellion and resistance. With Bauman (2012), Arendt (2015) and Freud (2010) we will shed light, considering the limitations of this space, on the movements of resistance and acceptance to the regime, as well as to the concepts of culture and civilization.

## **Culture and civilization in the brazilian context of 1964**

Men alone, with no others who oppose them, never have enough power to successfully use violence (Hannah Arendt).

In April 1964, with the Government Humberto Castelo Branco, there was the heyday of the dictatorial period with Institutional Act nº 5 (AI-5). The National Congress was closed, the dictatorial regime was legitimized in the country, and all constitutional guarantees were suspended. The scenario that was imposed was apprehension. People were tortured, exiled and others disappeared. The list is large and heterogeneous. Socialist deputy Rubens Paiva, who was described as "missing", was tortured, exiled and



subsequently killed in Rio de Janeiro; Geraldo Vandré, who had his song "Not to say I didn't speak of the flowers" censored, was also tortured and exiled. In addition to well-known names, also trade unionists, workers and students suffered from the authoritarian acts of the regime, among them "[...] the episode that occurred in March 1968 in Rio de Janeiro, when the student Edson Luiz was killed, after the invasion of the military police at a student restaurant" (COUTO, 2008, p. 123).

In this scenario, the regime propagated its ideal of prosperity with the intention of transforming Brazil into a world economic power. To this end, some populist practices gain strength. As an example, the Brazilian Legion of Assistance - BLA, founded in 1942, during the Vargas administration, stands out, which continued to control the working class, doing charity in order to ensure order by enabling the system's invalidated minimum necessary subsistence guarantee.

Also, the "S system": Social Service of Industry, Social Service of Commerce and National Service of Industrial Learning, which fed the factories with skilled labor. It is observed, therefore, that by force and persuasion, an autocratic State was sought to establish a culture of fear and work, associated with populism and clientelism, aimed to guarantee the subservience of the working class through the production, collective of an individualistic subjectivity where the foreign worker the reality that surrounds him assumes social ills for himself.

Also important was the institutionalization of working-class organizations and cultural manifestations. To this end, in 1966 the Federal Council of Culture (FCC) was created, through Law nº 74 of November 21, 1966. It would be up to this body, in the words of the then Minister of Education and Culture, Tarso Dutra, to formulate a national plan for culture (NETTO, 2015, p. 108). Article 2, which deals with the council's competences, point "a" "formulating national cultural policy", and, point "(c)" "deciding on the recognition of cultural intuitions" stand out. In this context, some political parties and trade unions lose legitimacy.

Law nº 4,330/1964 was also instituted, which regulated the right to strike. Law that implied the objective of hindering participation by defining who could or could not participate and the way in which this participation would take place, especially with regard to the way unions operate. Later, already in the Ernesto Geisel government, The Minister of Justice Arnaldo Falcão would create Law nº 6,339/1963, which went down in history as "Falcão Law", delegitimizing political parties and establishing bipartisanship, where the National Renovating Alliance (ARENA) and the Brazilian Democratic Movement (MDB) were the only authorized parties. Then, during this period, the ruling party and the authorized opposition have been allowed. The Communist Party of Brazil (PCdoB), founded in 1958, acted in the underground, but incisively composed the political scenario of the period.

As for the concept of culture, it is observed as hierarchically divided between the popular and the scholar. In one of the poles is the cultured person, who has access to the theater, cinemas, the paintings, the latest fashion trends, the jockey club and the universities. In the other, popular culture, which watches football, participates in the samba wheels, in the patios of candomblé. The knowledge of the first group is positively valued. There are the military and other bourgeois who held public office, the media and ran the banks. In the second group, the working population of factories and crops, as well as the intellectuals, organic, represented an emerging artistic class that was available through popular art to question the values of the system. In the words of Santos (2006, p. 30):



Culture can on the one hand refer to "high culture", to the dominant culture, and on the other to any culture. In the first case, culture arises in opposition to savagery, barbarism; culture is then the very mark of civilization. Or, the "high culture" emerges as a mark of the dominant layers of the population of a society; opposes the lack of mastery of the written language, or the lack of access to science, art and religion of those dominant layers. In the second case, one can talk about culture about any people, nation, group or human society.

Those who set up cults from the uneducated were the dominant class by placing themselves as a parameter for the whole society. In this context it is the nationalist civic values that establish the limits and differences between patriots, who value and love the homeland and the family, and others, the strange, dispatric, anti-patriot, who threaten these values. "The offense of the stranger consists of him not sharing [...] basic assumptions have called into question almost everything that seems unquestionable to the members of the group considered" (BAUMAN, 2012, p. 244). Communism occupied the place perceived as essential in the affirmation of the regime, it was the enemy to be defeated, and should constitute a common goal between the ruling class and the workers.

With the expropriation of the word and the right to vote, associated with unemployment and the growing distance between the worker and the result of his work, resistance and contestation movements gained strength. Small bourgeois, dissatisfied with the regime, added to the resistance. This is the case of the National Union of Students, the NUS, which will play a leading role in the fight against the regime through the most varied forms of demonstrations. In the case of Edson Luiz's death: "The day after his death, 50,000 people took to the streets to protest. Three months later, 100,000 students held a huge march in Rio de Janeiro" (COUTO, 2008, p. 125). Also the movements of workers within which the "Peasants' League that forced the creation of the Rural Worker Statute in 1966" (COUTO, 2008, p. 114), a period in which several unions were created, threatening the capitalist logic, especially in relation to landowners, who also had, in the period, about 50% of the population in the rural environment.

According to Arendt (2015), power and violence go together. The author distinguishes the concepts of power and violence, but using the conjunction "e" exposes the use of violence as a medium activity and as a maintainer, which composes with other forms of domination the framework of totalitarian regimes. Domino's strategy that is observed even if in a quick look at the story. By the force of armies, money and/or persuasion, places and roles are accentuated. Even in The Greece of Aristotle and Plato, the cradle of democracy, the roles were defined by the owners of power. The foreign peoples, the barbarians, served as beacons, accentuating the differences between civilized and uncivilized.

Later, Nazism in Germany did not hesitate to point out the Jews for the failure of their economy and as a solution to establish a single corporate model, closing in on foreigners. In contemporary times, the United States spread its armies around the world in order to ensure the continuity of the capitalist corporate model. The dictatorial regime that was lived in Brazil follows this same logic. Transforming Brazil into a world economic power means annihilating communists and controlling the working class, making it believe to be part of the creation process: "There has never been a government based exclusively on the means of violence. Even the totalitarian client, whose greatest instrument of dominance is torture, needs a power

base" (ARENDT, 2015, p. 128).

It is an endogenous struggle that the regime establishes, against the Communists, against the way of being of the population, no less bloody, no less alienating. Like Greece, there are enslaved in factories and crops, the same desire for reverence for the regime and intolerance to the different that was visualized with Nazism, the same forms of persuasion that are now used by the Americans.

It is the holders of power that divide society between cults and uneducated, who establish the place and roles of each group. In this logic, it is up to the bourgeois to organize society in order to preserve under control the instances of power. To conserve means to remain in a place of privilege, having the hand of the socially produced riches. This place of privilege is alongside the military, a space of legitimation of exploitation, where it provokes the rural exodus in order to supply the factories and make way for the landowners, where the transamazon threatens the entire environmental balance, tearing down forests and invading indigenous reserves in the name of progress, where working conditions are precarious resembling slavery.

The place of the bourgeoisie in the dictatorial period was legitimizing the macaw wood and everything else that occurred in the steps of the regime: The center of this system was the National Information Service (NIS), an intelligence and information collection agency that functioned as the main nucleus of an information network operating within society and at all levels of public administration<sup>1</sup>.

The place desired by the ruling class to the people was inside the factories, or in their surroundings. Those inside should produce the riches necessary for the consumption of European fashion, afford the purchases made in the art galleries, the going to the theater and watching over the horses of the Jockey Club. Those outside served as a warning to those who might rebel against the system. It was as a wage earner in the crop, in the condition of semi-slavery, for the country to export, so that it had a high Gross Domestic Product (GDP) that gave it the status of world economic power.

To maintain the "Order and Progress", civility was necessary, which for the working class was as good manners, acting civilly, understanding social differences as natural or else as a condition imposed by some deity. In the logic of the system it was up to the worker to take responsibility for absences with regard to food, education, leisure, etc. It was sought to establish, then, the culture of the good young man, and humility being an indispensable attribute to the population, which should not question, only legitimize the authority of the boss. Being humble was placed as a higher quality for the Brazilian working class. In this scenario of formatting of a popular ethos, in the cinema are shown the films of Amácio Mazzarope (1912-1981), where Jeca Tatu (1959), character of Monteiro Lobato, made fun of the misery of the population. In sport, Pelé, the poor black man, achieves the status of King of football, a sport that is systematically placed, by the bourgeois media, as the national passion.

### **Resistance considerations**

Giving in my body, that air told me in cries of freedom. But freedom - I bet - is still just joy of a poor little way, inside the iron of large prisons (Guimarães Rosa).

If the regime's repressive and alienating strategies reached a significant portion of the population, the young artists of the time, based and inspired, perhaps, by others who, like Graciliano Ramos (1892-

1953) had already resisted prison during the Vargas dictatorship, or classics relaunched in the period, such as the fifth edition of *Grande Sertão Veredas*, edited in 1967, where Guimarães Rosa speaks of "cries of freedom", they also began to manifest themselves with an active posture of criticism and resistance to the regime. It is also during this period that the translation in Portuguese of "*O Capital*" (NETTO, 2015, p. 107) begins. It is the transformative human praxis producing through the new subjectivities arts. "Seen in its most general and universal characteristics, human praxis consists in transforming chaos into order, or replacing one order with another" (BAUMAN, 2012 p. 230). The scenery evoked the image of volcanic boiling, people who wanted to talk, create from writing, from music. People wanting to work and enjoy the result of the work. People wanting acceptance of a way of being that differs from the bourgeois proposal perceived themselves contained, castrated under military authoritarianism with their codes and moral values. The desire for freedom, the ontological foundation of the human being, overcomes fear, this is how criticism of the system arises in various forms, in various places and circumstances.

[...] the cultural panorama of the years 1965–1968 – in the social sciences, in theater, poetry, in cinema, in fiction – is entirely dominated by critical, democratic and progressive currents, with sensitive weight even of cultural matrices extracted from the Marxist tradition (NETTO, 2015, p. 106).

In this scenario of authoritarianism, resistance and rebellion, when televisions, under the watchful eye of censorship, promoted the great music festivals, tropicalism arises. A contesting musical movement, which questioned music itself, moral values and the understanding of culture. The very name "tropicalism" would be a label placed by the press because of the unrestrained rebellion of two of its main exponents, Caetano Veloso and Gilberto Gil. This movement differed from others, who made direct criticisms of the regime, or who allied themselves with it. It was a mixture of rhythms, a way of creating, that did not obey a pattern, that not having a target defined shoots in several directions questioning the current corporate model, provoking reflection. In 1968 the album "*Tropicália*" was released, considered by experts as one of the best Brazilian records. That same year Gil and Caetano were arrested and expelled from the country.

In 1969, a composition by Gilberto Gil won the audience in the voice of Gal Costa. In the song "Culture and civilization", Gal sings "what the fun of culture and civilization, telling me to let me keep my life in hand". It's quite explicit: "Culture, civilization. They're the ones who don't. Or not." The lyrics show how intentional, being defined as a cry of protest, a manifesto against culture, which seeks to make clear the place from which it speaks, and may be the place of resistance, rebellion, the popular folklore, food, along with "an old Bahian 100%". On the cover of the vinyl record the look, the *orixás* cords, the aggressive posture and the hair "my hair beautiful as a lion's mane". In the sound, the mixture of rhythms, from *candomblé* to rock and roll.

Therefore, traces of a popular culture that emerged in São Salvador, a cosmopolitan city, where the most varied cultural manifestations gained space. There was the scenario where young Bahians perceived themselves as threatened and sang their world in the face of the possibility of a unique model. In cities like San Salvador: "Strangers find themselves in a way suitable for strangers" (BAUMAN, 2012, p. 111). There were no cordialities, since there was no past, which made the relationship that began as a threat to the

future. In the oral, in the sound, in the visual and in the gestural, the young bahians claimed its authenticity, which seemed compressed by an overwhelming pole. Which made them say "culture and civilization that's a dare. Or not."

Culture is the most varied forms of constitution and social interaction, a diverse scenario constituted because of the ontological foundation of the social being. In view of this concept, its endless expressions and characteristics are perceived as legitimate socially constituted and in a constant process of mutation: "The discussion of culture always refers to the process, to the historical experience. There is no sense in seeing culture as a closed system" (SANTOS, 2009, p. 22). A unique, unique process through which humanity is walking. However, it consists of particles such as local, regional, religious cells or particularities, etc. Varying in accordance with the modes of one or the other society, but composing the entire human species. Culture can have a conservative bias where social practices turn into communities, seeking through tradition to maintain empirically established order. Or revolutionary forms that constantly question imposing the transformation of lived reality. The concept of culture, in this sense, is centered on the formator nucleus of a society driven by its contradictory.

As for civilization, it is perceived as the foundation of life in society, since it meets the practical needs of coexistence in daily life, constituting a constant exercise of acceptance, denial and tolerance, a dialectical process that aims at urbanity. According to Bauman (2012), civilized beings would be protected from each other through the civic values that guide society. The author states: "Civility, like language, cannot be "private". Before becoming individually learned and privately practiced art, civility must be a characteristic of the social situation" (2012, p. 112). In this way, it must make up, through moral values and a democratic spirit, a model of society so that citizens have a harmonious way of living. Without civility would be barbarism, social chaos to the extent that one would be subject to the strangest and most inconsequential acts.

Sigmund Freud (2010), in "The malaise in civilization", refers to civilization being the sum of the achievements, values and norms that distinguish human beings from animals, which protects them against nature and adjusts social relationships. There is a positive view of this concept here, however, in the song performed by Gal Costa one observes the denial of the way of being civilized in the context of 1964, and music can be considered a cry of freedom that makes Freud turn once again (2010, p. 47)

What is felt in a human community as a desire for freedom can be its revolt against some existing injustice, and thus can be favorable to a greater development of civilization; can remain compatible with civilization. However it may also originate from the remnants of its original personality who is not yet be tamed by civilization. The impulse of freedom, therefore, is directed against specific forms and requirements of civilization in general.

In "Incident in Antares", published in 1971, Erico Veríssimo creates a scenario of disputes for political power between two families, the Campolargo and the Vacarianos. In the novel, he declares, in 1963, a general strike in the city of Antares, which, being adhered to by the cemetery staff, provokes the revolt of the dead, bringing, again, to the life of *Dona Quitéria Campolargo*, who is as the guardian of the

norms and customs of that community. Jorge Amado, with *"Tieta do Agreste"* (1989), in a different geographical scenario, explores the same issue, with regard to daily life in a small town. With a similar character, in Santana do Agreste is Dona Perpetua who takes care of preserving morals and good customs.

There is in the genius of these authors a satire on the way social relations take place within small communities, it can be observed that since the kind of the day to day norms and ways of circumventing them are established, that the being itself lives in constant conflict with the social being. In this conflict, sometimes, the layer that covers the desires is thin and these arise even if before the norms and moral precepts, in others they remain imprisoned for a lifetime. Individuals who free themselves from moral bonds seek ways to transform the whole society and those who imprison them from consoling it. Social beings live these ambivalences, the endogenous struggle to the individual extends through society polarizing it and, in this way, giving life to the values that constitute them. These values will bring about political parties, religions and other forms of ideological and spiritual representation that will legitimize or question dictatorial or democratic regimes.

For the Nazi party of Germany, civilization and culture were prerogatives of the Germans, "Aryan race". The Republican Party in the United States of America, when ruled by Donald Trump, argued that the country could be closed to some peoples, that transsexuals who today served in the Armed Forces lost this right and, as the Democratic Party also argues, Free Trade should be extended to all societies leaving to the invisible hand of the market (or for money) the function of regulating social relations. It is observed, therefore, from daily life, reaching the macrosocial, atrocities committed due to sociocultural factors and/or in the name of a alleged civility. In the military regime the civilized and cultured being is the one who has access to museums, art galleries, theater, cinema and universities, privileges historically reserved for those who have money. The non-cult or uncivilized would be the people who held only their capacity for the work.

Empirically, it can be observed that the term "people" appears in the official speeches in the third person, "we will do it for the people", "the people like carnival". The working class takes on this denomination and shouts "the united people will never be defeated." It remains clear, in these discourses, the differentiation between the people constituted by peasants, metalworkers, teachers and the non-people, the bourgeois elite where are the deputies, senators, landowners, owners of large companies. In this apartheid, typical of totalitarian regimes, the concepts of culture and civilization are linked to the owners of power, these do not belong to what is called a people, but who defines the necessary conditions for civility, who establishes the differences between worship and uncultured.

It is in this way that when one intends to establish what is culture and civilization by bourgeois autocracy, in the absence of the people, these concepts immediately appear as strangers to the majority of the population that does not identify and thus reject them. Culture and civilization in the bourgeois way, Gal Costa sings in 1969, "what the hell", because I do not constitute and I am not constituted by these values. "Or not," because it doesn't belong to me, I don't identify myself, I'm indifferent, "as long as they let me have my life in hand."

## **Final thoughts**

There is no democracy without a people, nor is there a dictatorship without a people. It is observed, therefore, that at some point, for various reasons, but that revolve around the search for the guarantee of subsistence, happiness or because of pure alienation, the people are called to give legitimacy to a government that deposes against their interests. But that, even though the authoritarian government has been instituted, voices rise up against and small portions that begin gradually claiming and gaining supporters, who gain spaces coming to constitute force with real capacity for confrontations.

A song in this scenario threatens a whole warlike power and the moral values that constitute the society in question, due to its easy and democratic assimilation by segments of the population, which, hindered by the barriers of the system, are far from university spaces and other forms of learning. Culture and civilization to the bourgeois way of being constitute a threat to a chain rich in diversities, because by hierarchizing these concepts seeks ways to reduce the different in order to control and maintain inequalities that historically condition the working class to the place of producer of wealth for the enjoyment of the holders of capital.

In the music of Gilberto Gil, sung by Gal Costa, the proposal to make the population think is implicit. Here's the threat, the terror for autocracy. Reflective thinking questioning the order that one wants to establish. This is where the macaw wood emerges, but it is where the contesting movement also gains strength and the revolution can happen:

Culture, civilization  
Let them be damned  
Or not  
Only interest me  
As long as they leave me my genipap liqueur  
The chat  
From the nights of Saint John  
Only interest me  
As long as they make my hair beautiful  
My beautiful hair  
Like a lion's mane  
As long as they leave me  
Stay in mine  
As long as they leave me  
Keep my life in hand  
My life at hand  
My life  
Culture, civilization  
Let them be damned  
Or not



I really like  
It's to eat with coriander  
I really like  
It is to stay inside  
As I've been awhile  
In Claudina's belly  
An old Bahian woman  
A hundred per cent

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# **Whole-Body Vibration in Bus Drivers: Association with Physical Fitness and Low Back Pain**

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## **Abstract**

*The aim of the study was to investigate the relationship between exposure to whole body vibration, prevalence of low back pain and level of physical fitness in bus drivers. The measurement of whole body vibration was in 100 city buses with different characteristics and the prevalence of low back pain was assessed in 200 drivers with a measurement of physical fitness level. Descriptive statistics with mean and standard deviation and inferential statistics were used with the Kurskal-Wallis test, Dunn's multiple comparisons test, Poisson regression and significance level of  $p < 0.05$ . The results demonstrate significant differences between the vehicle models, characterizing the conventional and articulated buses on the y and z axes with higher levels of vibration. Drivers working with conventional and articulated vehicles had a higher prevalence of low back pain with 57.5 and 60%, respectively. The level of physical fitness was low in most of the sample, however, the drivers of bi-articulated and micro bus had higher levels. Poisson regression with the outcome of low back pain, showed the factors that showed a significant prediction: age, working time, abdominal muscle resistance, lumbar strength, RMSy and RMSz.*

**Keywords:** Whole body vibration, bus drivers, low back pain and physical fitness

## **1. Introduction**

Bus drivers are essential professionals in today's society, as conduct thousands of passengers to their destination. Occupational exposure to whole-body vibration from the operation of buses has long been acknowledged as one risk factor for musculoskeletal disorders, more specifically, low back pain (SARSWAT et al., 2016). Various factors which can be the causes of such musculoskeletal disorders are vibrations produced in the vehicles, prolonged sitting, position of the driver's seat in the bus, differences in the anthropometric sizes of the drivers, environment in which they are working (like automatic or manual transmission, brake travel etc.), awkward postures and various physiological factors such as age, height, weight, sex, health issues, body mass index etc. (MAGNUSSON et al., 1996; KUMAR et al., 2005; YASOBANT et al., 2015).

The social consequences of low back pain, including its severity, may be assessed in terms of the extent to which people are prevented from carrying out their normal activities (reduced activities) and absenteeism (WIDANARKO et al., 2012). In a study conducted in Norway, it was found that the annual absenteeism, in the case of back pain lasting more than two weeks is 2.27% participants with a median of 43 days. After one month, the return to work is 35%, after three months 76%, and after six months 85%. 42% of those on sick leave after six months do not return to work even after a year and retire due to disability (HAGEN; THUNE, 1998). In France, for chronic back pain, sick leave is prescribed in 23% of cases, with an average duration of 11 days (DREISER et al., 1997).

An exponential dose–response relationship between hours of weekly driving and injury risk has been found (KRAUSE et al., 2004). Additionally, was identified back disorders as one of the largest sources for medical impairment and early permanent disability among mass transit operators (JOHANNING, 1998). Currently, there is limited data available on whole body vibration levels experienced by workers on transit systems, but much of the data that have been published suggests that these worker’s exposures exceed recommended standards (PADDAN; GRIFFIN, 2001). In addition, studies have identified road conditions as a major contributor to levels of whole body vibration exposure [TESCHKE et al., 1999; MALCHAIRE et al., 1996]. However, most of these studies have focused on short-term exposures for vehicle operators traveling along a fixed route or a test track, or equivalent average exposure for vehicle operators traveling a variable route.

Previous studies have demonstrated that individuals with low back pain show a decreased muscular strength and endurance in trunk muscles, lower levels of abdominal muscle strength than subjects without pain, reduced flexibility of back muscles and hamstrings when compared to those of normal subjects (ALPEROVITCH-NAJENSON et al, 2010; CASSIDY et al., 2005; JACKSON et al., 1998; MARSHALL et al., 2009; TAKEMASA et al., 1995; EBRAHIMI et al., 2014, DEL POZO-CRUZ et al., 2014, PORTELA et al., 2015). The literature has also reported that obesity or a high body mass index ( $BMI >30 \text{ kg.m}^{-2}$ ) is associated with low back pain and disability in general workers (RUBIN, 2007; PORTELA et al. 2015). The aim of this study was to determine the levels of vibration exposure for bus drivers, using the ISO 2631-1 and 2631-5 standards, measure the physical fitness and low back pain prevalence.

## 2. Material and methods

The study included subjects who specifically drove each of the types of buses that the company owned: conventional buses, direct line “ligeirinhos”, minibuses, articulated buses and bi-articulated buses. The sample of drivers consisted of a total of 40 subjects who worked specifically with one of the five types of buses, making a total of 200 individuals evaluated. At the time of the company's assessment, the total number of driver employees was 361 men.

The evaluation of the whole body vibration was performed by the researcher, using a triaxial accelerometer “*Triaxial DeltaTron Seat Pad Accelerometer Type 4515-B-002 - Bruel & Kjaer*” connected to the vibration analyzer “*Human Vibration Analyzer Type 4447 - Bruel & Kjaer*”. The accelerometer was installed on the seat and the analyzer was placed on a solid surface behind the driver's seat. Vibration measurements were carried out in accordance with the ISO 2631-1 (1997) standard. All vibration

measurements were carried out in the driver's usual working situation, reproducing the route on which the bus travels. The time period for each measurement was approximately 30 minutes, reproducing a complete route of the itinerary that the driver takes.

Subsequently, the measurements made were analyzed using the Vibration Explorer Software BZ-5623 by *Bruel & Kjaer*, which presented all the results obtained by measuring the equipment for subsequent statistical analysis. The ISO 2631-5 (2004) standard was also used, which covers the assessment of occupational exposure to vibrations with multiple shocks and effects on health. The parameters analyzed were: frequency-weighted RMS acceleration ( $A_w$ ), vibration dose value (VDV), crest factor, acceleration dose value ( $D_k$ ), Static Spinal Compression Dose ( $S_{ed}$ ) and Seat Effective Amplitude Transmissibility (SEAT). The parameters were normalized to reflect 8h of driving exposure (e.g.  $A_w$  (8), VDV (8),  $D_k$  (8) and  $S_{ed}$  (8)).

All the bus drivers were asked to complete the Pain Questionnaire of Corlett and Manenica (1980). This evaluation method for the prevalence of low back pain has been used in previous studies (PORTELA et al., 2015; ALPEROVITCH-NAJENSON et al., 2010). Participants were asked if they had work-related low back pain during the last 12 months (ache, pain or discomfort) for a day or more. Those who answered "yes" were included in the low back pain group and were asked to indicate in a body chart all of the pain sites and discomfort they had experienced. The participants who answered "no" were assigned to the group without low back pain. This study aimed to identify the prevalence of self-reported low back pain.

Height was recorded without shoes as stretch stature to 0.1 cm using a wall-mounted stadiometer. Body mass was measured to 0.01 kg on a calibrated electronic scale. Body mass index (BMI) was calculated from the ratio of body weight to body height in  $\text{kg.m}^{-2}$ .

The hamstring flexibility test was performed with a wooden box measuring 30.5 cm x 30.5 cm x 30.5 cm, and at the top, where the scale is located, there was an extension of 26.0 cm and the 23° cm of the scale coincided with the point where the subject touches the soles of his feet. The subject sat with his knees extended, touching his bare feet on the box under the scale, then placed his hands on each other on the scale, with his elbows extended, and performed a trunk flexion in front of him, registering the maximum point, in centimeters, reached by the hands.

To perform the abdominal test, the subject was positioned in the supine position on a foam mat. With hips and knees flexed, soles supported on the ground, arms were crossed in the anterior region of the chest holding the opposite shoulders. The appraiser immobilized the feet of the appraised, who received prior instruction to perform the greatest number of trunk flexions during the time of 1 minute. Only the flexions were recorded where the subject raised the trunk until contact between the anterior aspect of the forearms and the thighs occurred, and returned to the initial position, touching at least the anterior half of the scapula on the mat.

In the sample of drivers, strength assessment of the lumbar region was performed using a dynamometer. To assess lumbar strength, a dorsal dynamometer served as an assessment tool. The protocol consisted of the device being calibrated and zeroed, then asking the subject to position himself on the base of the device with the knees in extension, elbows in extension and the trunk erect. Soon after, the subject was asked to do the trunk extension, thus executing the movement force with the lumbar region. The result was the maximum force exerted by the tester, computing the best result of two attempts, measured in Kgf (kilogram-

force).

Descriptive statistics with mean and standard deviation were used to characterize the data. Next, the assumptions of normality and homogeneity were tested with the Shapiro Wilk and Levene test, respectively. After this stage, inferential statistics tests were chosen according to the parametric or non-parametric approach. Data comparison was performed using the Kruskal-Wallis analysis of variance test followed by Dunn's multiple comparison test. Categorical data were compared using Pearson's chi-square test. To verify the relationship between the level of whole body vibration, physical fitness variables in the outcome of low back pain, a Poisson Regression was performed. The data were tabulated in the Excel 2013 Software, while the inferential statistics occurred in the SPSS Software version 21.

### 3. Results and Discussion

The results for the evaluation of the whole body vibration in 100 urban buses in the city of Curitiba - PR are described in Table 1, in addition to the comparison between the five types of buses studied. The values presented for the vibrational evaluation are in accordance with the ISO 2631-1 (1997) standard, which establishes the instructions for measuring human exposure to whole body vibration. The result of the data normality test made from the Shapiro Wilk test and presented significance levels of less than 5% ( $p < 0.05$ ) for the whole body vibration data. Therefore, the analysis of the results was made using non-parametric inferential statistics.

Table 1. Descriptive statistics, analysis of variance and multiple comparison test of whole body vibration values in city buses, according to ISO 2631-1.

Parameter	Axis	CON	MIC	LIG	ART	BIA	p
RMS (m.s <sup>-2</sup> )	x	0,383 <sup>d</sup>	0,421 <sup>e, g</sup>	0,253 <sup>b</sup>	0,396 <sup>h, j</sup>	0,174	0,001
		±0,167	±0,036	±0,060	±0,107	±0,040	
	y	0,524 <sup>b, d</sup>	0,620 <sup>e</sup>	0,287	0,821 <sup>e, h, f, j</sup>	0,247	0,001
		±0,304	±0,055	±0,100	±0,5	±0,102	
	z	0,587 <sup>b, c, d</sup>	0,560 <sup>e, f, g</sup>	0,411	0,499 <sup>h, j</sup>	0,430	0,001
		±0,100	±0,083	±0,04	±0,08	±0,108	
Crest Factor (m.s <sup>-2</sup> )	x	10,390	9,939	12,387	22,782	13,381	0,001
		±2,3	±3,0	±4,756	±20,9	±3,7	
	y	15,411	12,738	19,277	26,540	17,354	0,001
		±3,6	±4,1	±11,2	±19,7	±5,8	
	z	14,903	11,167	12,716	12,240	13,874	0,029
		±11,8	±2,1	± 1,6	±1,3	±2,3	
VDV (m.s <sup>-1,75</sup> )	x	4,118	4,005	2,844	8,791 <sup>e, h, e, j</sup>	2,116	0,001
	y	7,243	7,739	5,001	20,595 <sup>e, h, e, j</sup>	3,973	0,001

	$\pm 4,5$	$\pm 2,0$	$\pm 3,1$	$\pm 20,7$	$\pm 2,4$	
$z$	6,390 <sup>a, b, c, d</sup>	5,377 <sup>c, h, g</sup>	4,582	5,290	5,050	0,001
	$\pm 1,4$	$\pm 1,2$	$\pm 0,5$	$\pm 0,4$	$\pm 0,6$	
RMS VTV	1,119 <sup>b, d</sup>	1,192 <sup>e, g</sup>	0,684	1,409 <sup>c, h, j</sup>	0,611	0,001
( $m.s^{-2}$ )	$\pm 0,4$	$\pm 0,09$	$\pm 0,1$	$\pm 0,6$	$\pm 0,1$	
VDV VTV	13,717	13,398	9,573	32,506 <sup>c, h, e, j</sup>	8,329	0,001
( $m.s^{-1,75}$ )	$\pm 6,0$	$\pm 3,1$	$\pm 3,8$	$\pm 30,5$	$\pm 2,9$	
A(8)	0,833 <sup>b, d</sup>	0,867 <sup>e</sup>	0,457	1,189 <sup>c, h, e, j</sup>	0,446	0,001
	$\pm 0,4$	$\pm 0,08$	$\pm 0,08$	$\pm 0,6$	$\pm 0,1$	

CON: Conventional bus; MIC: Minibus; LIG: Ligeirinho; ART: Articulated bus; BIA: Bi-articulated bus.

Kruskall-Wallis analysis of variance test;

Dunn's multiple comparison test: the statistical difference between CON and MIC; b difference between CON and LIG; c difference between CON and ART; d difference between CON and BIA; and difference between MIC and LIG; f difference between MIC and ART; g statistical difference between MIC and BIA; h statistical difference between LIG and ART; i statistical difference between LIG and BIA; j difference between ART and BIA.

Significance level:  $p < 0.05$ .

According to ISO 2631-1 (1997), the acceleration value that represents the magnitude of the whole body vibration is the RMS value between the three axes (x, y and z). When comparing the exposure between the types of vehicles, a significant difference is found between them ( $p < 0.05$ ), with the highest values found in articulated, minibus and conventional buses. The characteristics that can contribute to lower vibration magnitudes in light and bi-articulated vehicles are the location of the engine, in light vehicles the engines are distant from the drivers and use of streets with adequate pavement, bi-articulated vehicles travel on exclusive roads called “channels”, the which are exclusive to this type of bus.

The RMS values presented by the average of conventional vehicles, minibus, light, articulated and bi-articulated are above the values recommended by the European Union Directive, which establishes that at RMS acceleration levels above  $0.5 m.s^{-2}$ , actions must be taken in order to reduce the magnitude of whole body vibration transmitted to the worker.

To assess the relationship between exposure to whole body vibration, the measurement of the parameter  $S_{ed}$  (daily dose of static compression on the lumbar spine) and R factor (ratio between  $S_{ed}$  and maximum static compression force) was measured, in accordance with to ISO 2631-5 (2004). The values were found for each driver, adding up to a total of 200 measurements. Each bus gave rise to two measurements, as two drivers who worked on the same itinerary and with the same vehicle were evaluated. The results of this assessment are described in Table 2.

Table 2. Descriptive statistics, analysis of variance and multiple comparison test of whole body vibration values in city buses, according to ISO 2631-5

Parameter	CON	MIC	LIG	ART	BIA	p
$S_{ed}$ (MPa)	0,625 <sup>a, d</sup> ± 0,1	0,580 <sup>e</sup> ± 0,09	0,463 <sup>i</sup> ± 0,2	0,746 <sup>c, g, h, j</sup> ± 0,3	0,402 ± 0,06	0,001
Factor R	0,634 <sup>a, d</sup> ± 0,2	0,588 <sup>e</sup> ± 0,2	0,454 <sup>i</sup> ± 0,1	0,765 <sup>c, f, h, j</sup> ± 0,3	0,385 ± 0,1	0,001

CON: Conventional bus; MIC: Minibus; LIG: Ligeirinho; ART: Articulated bus; BIA: Bi-articulated bus.

Kruskall-Wallis analysis of variance test;

Dunn's multiple comparison test: the statistical difference between CON and MIC; b difference between CON and LIG; c difference between CON and ART; d difference between CON and BIA; and difference between MIC and LIG; f difference between MIC and ART; g statistical difference between MIC and BIA; h statistical difference between LIG and ART; i statistical difference between LIG and BIA; j difference between ART and BIA.

Significance level:  $p < 0.05$ .

The verification of the compressor stress on the spine ( $S_{ed}$ ) was performed on two types of buses in the city of Seattle, in the United States. It was identified that low-floor buses had 0.32  $S_{ed}$  (MPa), while high-floor buses had 0.33 (MPa) running on city streets (THAMSUWAN et al., 2013). It is noteworthy that the low floor bus is very similar to the conventional model analyzed in the present study. In another study with buses in the city of Seattle, it was found that the buses had  $S_{ed}$  values of  $0.71 \pm 0.21$  in MPa, (LEWIS; JOHNSON, 2012). With that, it is noticed that Curitiba vehicles have exposure values similar to the North American ones.

Other factors that can contribute to mitigate the exposure to whole body vibration are the characteristics of the seats used in the vehicle. In an American survey of forklift drivers, it was found that the transmission of vibration from the floor ( $S_{ed} = 1.05$  MPa) to the seat ( $S_{ed} = 0.43$  MPa) in vehicles with mechanical seats was greater than in pneumatic seats ( $S_{ed}$  floor = 0.88 MPa,  $S_{ed}$  seat = 0.48 MPa), (BLOOD et al., 2010). For Curitiba drivers, one of the major limiting factors for exercising the task of driving vehicles is the inadequacy of the seats on buses. The surveyed subjects reported that the bus seats have few ways of regulating the structure of each individual. As a result, the seats may have an inverse function in relation to their objective of attenuating the vibration transmitted to the driver, thereby increasing the vibration that reaches the driver.

Regarding Factor R, no study with bus drivers is found in the current literature. One of the few surveys that presents the R Factor calculation for workers exposed to full-body vibration, was developed with New Zealand farmers who drive boxes used in the agricultural environment. The study shows that the group of farmers is exposed to an average  $S_{ed}$  of  $0.26 \pm 0.1$  MPa and Factor R of  $0.31 \pm 0.12$  (MILOSAVLJEVIC et al., 2010). Thus, the individuals studied do not present a risk factor for the development of lesions in the lumbar spine, as they are below the recommended values of  $S_{ed} < 0.5$  and Factor R  $< 0.8$ .

The diagram by Corlett and Manenica (1980), was used for subjective evaluation of the symptoms of pain or discomfort in the subjects of the sample. For the present study, the data of those drivers who



reported pain only in the region of the lumbar spine are computed, thus, the sample of drivers was divided into subjects who had low back pain and subjects who did not. Furthermore, the results for age (years) and working time (years) are presented as a way to characterize the sample, according to Table 3.

Table 3. Descriptive statistics, analysis of variance and multiple comparison test of identification data and low back pain indexes in urban bus drivers.

Parameter	CON	MIC	LIG	ART	BIA	p
Age (Years)	46,9 ±9,7	46,5 ± 8,3	48,6 ± 9,3	47,3 ± 10,0	44,8 ± 9,5	0,489*
Working Time (Years)	9,7 ± 4,9	11,3 ± 4,9	11,5 ± 7,4	9,9 ± 5,8	10,1 7,6	0,561*
With Low Back Pain	23 (57,5%)	22 (55%)	19 (47,5%)	24 (60%)	18 (44%)	0,842**
Without Low Back Pain	17 (42,5%)	18 (45%)	21 (52,5%)	16 (40%)	22 (56%)	

conventional bus; MIC: minibus; LIG: Ligeirinho; ART: articulated bus; BIA: bi-articulated bus.

\* Kruskal-Wallis analysis of variance test.

\*\* Pearson's Chi-square test.

Significance level of  $p < 0.05$ .

In the study with Israeli bus drivers, out of a total of 361, 164 (45.4%) reported feeling pain in the lumbar spine (ALPEROVITSCH-NAJENSON et al., 2010). The authors emphasize that age was the factor that presented an inversely significant correlation with the prevalence of low back pain. As a result, it is evident that at a younger age and with consequent working time for the driver, the probability of developing pain on the coast increases substantially. Another factor that receives attention in the research was that the prevalence of drivers who are engaged in regular physical activity programs is higher in drivers without pain (67.3%) compared to those who have pain (48.5%). A survey of 164 bus drivers in the city of Kolkata in India revealed a 45.4% prevalence of pain in the lumbar spine (GANGOPADHYAY; DEV, 2012). The authors point out that ergonomic factors such as uncomfortable seats and without support for the coast contributed to the increase in the prevalence of low back pain, in addition to the long working hours and lack of breaks during occupational hours. Thus, the prevalence of low back pain in drivers has been related to several factors related to the exercise of the task of bus driver.

In order to investigate the level of physical fitness of the 200 urban bus drivers, a physical evaluation was conducted with the following measures and motor tests: body mass index in  $\text{kg.m}^{-2}$ , abdominal muscle endurance test (quantified in repetitions), dynamometric test of the lumbar spine in kgf, flexibility test and hamstring in centimeters. The results of the physical fitness assessment are shown in Table 4, segmented by the type of vehicle the driver was driving.



Table 4. Descriptive statistics, analysis of variance and multiple comparison test of values related to the physical fitness variables of urban bus drivers.

Variables	CON	MIC	LIG	ART	BIA	p
BMI (kg.m <sup>-2</sup> )	28,2 <sup>a</sup> ± 3,7	25,1 ± 3,6	26,3 ± 2,5	27,1 ± 4,3	26,4 ± 4,8	0,008*
Abdominal Endurance (rep)	18, 9 ± 8,2	20,3 ± 6,3	25,6 <sup>b</sup> ± 7,3	22,2 ± 9,2	22,6 <sup>d, g</sup> ± 8,0	0,001*
Lumbar Strength (Kgf)	82,3 ± 23,6	94,0 ± 24,3	136,1 <sup>b, e, h</sup> ± 35,6	100,9 <sup>c</sup> ± 15,8	132,2 <sup>d, g, j</sup> ± 29,3	0,001*
Isquiotibial Flexibility (cm)	18,6 ± 6,0	20,9 ± 7,3	21,7 ± 7,5	19,8 ± 6,8	19,9 ± 7,2	0,204

CON: conventional bus; MIC: minibus; LIG: Ligeirinho; ART: articulated bus; BIA: bi-articulated bus.

\* Kruskal-Wallis analysis of variance test.

Dunn's multiple comparison test: the statistical difference between CON and MIC; b difference between CON and LIG; c difference between CON and ART; d difference between CON and BIA; and difference between MIC and LIG; f difference between MIC and ART; g statistical difference between MIC and BIA; h statistical difference between LIG and ART; i statistical difference between LIG and BIA; j difference between ART and BIA.

\*\* Pearson's Chi-Square test.

Significance level:  $p < 0.05$ .

In the evaluation carried out with 481 bus drivers from the Hong Kong region, overweight was found in male subjects, but not in female subjects,  $25.2 \pm 3.4 \text{ kg.m}^{-2}$  and  $23.6 \pm 2.7 \text{ kg.m}^{-2}$ , respectively (SZETO; LAM, 2007). Changes in hip flexibility in the sit and reach test were not found in subjects who had pain in the lower back. However, the positive association was seen with the tests of manual dynamometry and pain in the region of the cervical spine and in the region of the shoulders, therefore, lower rates of manual strength are related to higher rates of pain in these parts of the body.

The results of the association between the level of exposure to whole body vibration, prevalence of low back pain and physical fitness variables were obtained from the use of Poisson Regression. In cross-sectional studies with binary categorical outcomes, the association between exposure and outcome is estimated by the prevalence ratio (PR), which is obtained by Poisson Regression (COUTINHO et al., 2008). When it is necessary to adjust for potential confounding variables, logistic regression models are usually used. This type of model produces odds ratio estimates, often interpreted as an estimate of the prevalence ratio. However, the odds ratio does not come very close to the prevalence ratio when the initial risk is high, and in these situations, interpreting the odds ratio as a prevalence ratio is inappropriate. It is noteworthy that the logistic regression can overestimate the odds ratio compared to the prevalence ratio, thus, being able to influence the observed interactions (BARROS; HIRAKATA, 2003).

In order to estimate the relationship between the identification variables (age in years and working time in years), physical fitness variables (body mass index in  $\text{kg.m}^{-2}$ , abdominal muscle resistance

measured in repetitions, lumbar strength in kgf, hamstring flexibility measured in centimeters, whole body vibration variables ( $RMS_x$  in  $m.s^{-2}$ ,  $RMS_y$  in  $m.s^{-2}$  and  $RMS_z$  in  $m.s^{-2}$ ) on the pain outcome low back. Table 5 shows the results of the Poisson Regression with the prediction coefficients (B), level of significance between the variables and the outcome of low back pain (p), prevalence ratio for the predictor variables (Exp (B)) and interval confidence level greater than and 95%.

Table 5. Results for binary Poisson regression between drivers with and without low back pain.

	B	p	Exp (B)	I.C. de 95%	
				For Exp (B)	
				Minimum	Maximum
Age (Years)	-0,156	0,000	0,856	0,799	0,917
Working Time (Years)	0,520	0,000	1,682	1,448	1,954
Body Mass Index ( $kg.m^{-2}$ )	0,092	0,111	1,096	0,979	1,227
Abdominal Resistance (rep)	-0,064	0,021	0,938	0,888	0,990
Lumbar Strength (kgf)	-0,024	0,022	0,976	0,956	0,997
Isquiotibial Flexibility (cm)	0,035	0,260	1,036	0,974	1,102
$RMS_x$ ( $m.s^{-2}$ )	-4,599	0,115	1,110	1,000	3,048
$RMS_y$ ( $m.s^{-2}$ )	2,514	0,030	1,060	1,000	1,757
$RMS_z$ ( $m.s^{-2}$ )	-5,143	0,038	2,360	2,077	9,664
Constant	5,648	0,054	283,837		

Level of Significance:  $p < 0,05$ .

The result of the binary Poisson Regression shows that the variables that presented significance considered to be excellent ( $p < 0.05$ ), were: age, working time, abdominal muscle resistance, lumbar strength,  $RMS_y$  and  $RMS_z$ . The scores resulting from the regression are not analyzed in the form of a formula presentation, as the Poisson method demonstrates only the relationship that exists for the prevalence of a certain characteristic in a sample.

Regarding the prevalence ratio, the variables working time and  $RMS_z$  stood out, indicating a relationship of increased probability in the outcome, increasing the chances of low back pain occurring by 1.4 times and 2.4 times, respectively. The fact that the constant showed a positive value means that, based on the group of drivers under study, the work environment and individual variables provide a high probability of low back pain.

The variables of age, abdominal muscle resistance and lumbar strength showed a characteristic of decreasing the probability of low back pain, according to the established prevalence ratios. Thus, it is shown that subjects with increasing age decrease the prevalence of pain by 14.4%, while abdominal muscle resistance decreases by 6.2% and lumbar strength by 2.4%.

Other studies have used logistic regression to identify the probabilities of pain occurring in subjects exposed to vibrations. The influence of body mass index on the increase in the prevalence of low back pain

in subjects exposed to whole body vibration was tested in a sample of 467 drivers of different vehicles in the Netherlands (NOORLOOS et al., 2008). The authors found that there was no significant association between high values of body mass index and low back pain in environments with full body vibration (odds ratio 0.97; 95% I.C.: 0.92–1.01). Thus, the data are similar to the present study, in which there was also no significant relationship between the prevalence of low back pain and BMI ( $p = 0.111$ , odds ratio 1.09; I.C. 0.979-1.227).

#### **4. Conclusion**

It has been demonstrated that most urban bus drivers are exposed to vibrational levels that require the initiation of control actions, and some of them can exceed the daily exposure limit established by the European Directive 44/2002 / EC, of 25 June 2002. Thus, such exposure can trigger disorders related to the health of workers who act as bus drivers. It was determined that there was a high percentage of low back pain in the sample of drivers studied. The subjects who worked with models of articulated vehicles, conventional vehicles and minibuses were the ones who presented more low back pain, compared to drivers of bi-articulate and light vehicles.

Regarding the level of physical fitness of the drivers, it was shown that most subjects were within limits below the recommended for health, having as an example the high body mass indexes, low abdominal muscle resistance, low hamstring flexibility, low strength low back and high level of physical inactivity. It is noteworthy that the drivers of light and bi-articulated buses showed better levels of physical fitness compared to drivers of conventional vehicles, minibuses and articulated vehicles. The association between the level of whole body vibration, prevalence of low back pain and physical fitness revealed that the factors that most influenced the pain dependent variable were abdominal muscle resistance, lumbar strength and the level of RMS vibration transmitted vertically on the z axis. It is noteworthy that the physical fitness variables were considered to be mitigating factors and the level of vibration of the whole body was considered aggravating the prevalence of low back pain in urban bus drivers.

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# **High Brachial Artery Bifurcation Clinical finding in Cadaveric Specimen by Medical Students During Internship**

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## **Abstract**

*The high brachial artery bifurcation is an anatomical variation found in the arm segment. Although it does not present any alteration in the arterial blood functionality, it is considered a common spot for vascular lesions during surgical interventions that consist of the absence of anatomical knowledge. The research objective was to describe the high brachial artery bifurcation found in a cadaveric specimen from the anatomy laboratory as well as its main anatomoclinical aspects. Twenty-six upper limbs were investigated and dissected from the Universidade Brasil's Human Anatomy Laboratory, SP. These were formalized cadaveric specimens from both sexes. During upper limb dissection, arterial anatomical variations were observed in a single-arm segment. The variation was unilateral in the left hemisphere. The clinical findings were high brachial artery bifurcation and a rare case of the radial artery in the medial path, as well as an ulnar artery with a lateral path in the arm median third. It is clear that the understanding of anatomy and anatomical variations patterns is of utmost importance and a requirement for surgery, so surgeons need to be aware of clinical, anatomical, and arterial variations data, avoiding vascular lesions during the surgical interventions. Dissection is an important learning tool for students and resident doctors. It is suggested the use of dissection as a pedagogical resource to acquire skills in surgeries during internship and also to improve the anatomical variation cognition of upper limbs.*

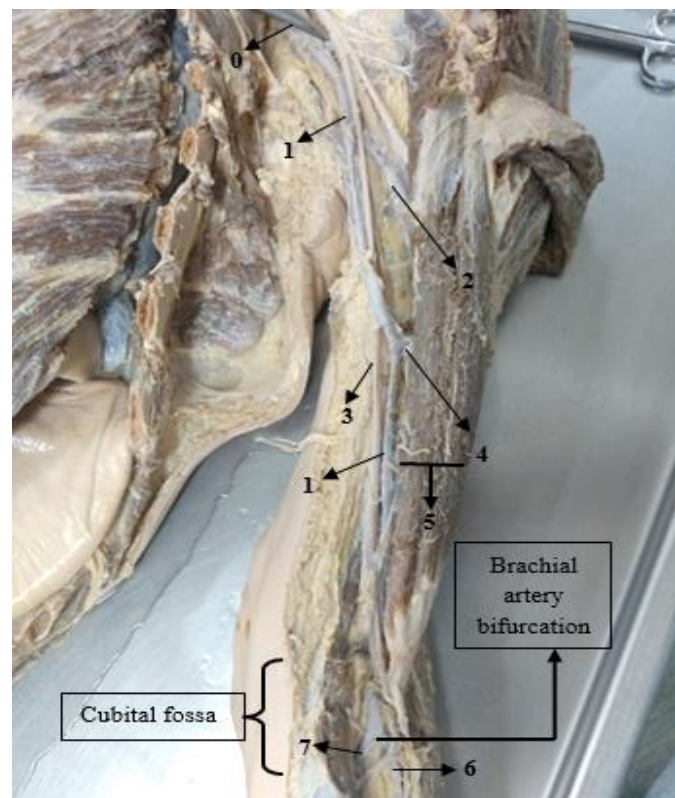
**Keywords:** Anatomoclinic Understanding; Surgery Skills; Dissection; Brachial Artery Anatomical Variation; Radial Artery; Ulnar Artery.

## 1. Introduction

The brachial artery, the main vessel by upper limb irrigation, originates in the axillary artery at the lower edge of the round major muscle, exhibits a path in the arm medial portion, at the distal end it extends to the anterior side, in the cubital fossa it is divided into two terminal branches (Figure 1), in radial and ulnar arteries<sup>[1,2]</sup>. However, anatomical variations are assessed in the arm segment, occurring mostly in radial and ulnar arteries<sup>[3]</sup>, while variation in the brachial artery is less common<sup>[4]</sup>. Still, the morphological variation of the brachial artery is uncommon, the bifurcation is evidenced at a higher point than the usually found, called this anatomical variation of high brachial artery bifurcation<sup>[5]</sup> (Figure 2). It stands out during the teaching to medical students and resident physicians who glimpse the surgical specialty, the arterial variation is often found during cadaveric dissections in human anatomy laboratory and surgical interventions.

This shaping has major clinical implications, as the arm is a frequent injury area and is involved in many surgical and invasive procedures<sup>[6]</sup>. It is important to emphasize that the absence of surgical skills, the patient's hemodynamic stability, and especially the anatomical knowledge, can hinder the surgery outcome, knowing that the anatomoclinic understanding and surgical skills are prerequisites for surgery.

Given this complexity, the study brings evidence to update and improve anatomical and clinical knowledge to resident doctors, especially to medical students who are taking disciplines like Human Anatomy, Morphophysiology, Surgical Technique, and the Medical Internship, since it is notorious the scholars difficulties regarding the cognitive aspects of learning and understanding the anatomical arterial variation. Thus, the research objective was to describe the high bifurcation of the brachial artery found in cadaveric specimens of the anatomy laboratory and its main anatomoclinical considerations.



**Figure 1.** Brachial artery and its arterial branches with cubital fossa bifurcation. Legend: (0) the instrument pointing to the humerus circumflex artery, branch of the axillary artery; (1) brachial artery; (2) deep brachial artery; (3) median nerve; (4) superior ulnar collateral artery; (5) biceps brachial muscle; (6) radial artery and (7) ulnar artery.



**Figure 2.** Brachial artery high bifurcation. Legend: (0) arm mid-third cross-section; (1) brachial artery bifurcation in arm mid-third; (2) radial artery; (3) ulnar artery; (4) basilica vein; (5) middle elbow vein; (6) cubital fossa; (7) biceps brachial muscle; (8) brachioradialis muscle.

## 2. Materials & Methods

The samples consisted of 26 upper limbs from the Universidade Brasil's Human Anatomy Laboratory, Fernandópolis Campus, SP. These are formolized cadaveric specimens of both sexes. The samples were used under Law 8501, November 30th of 1992, which stipulates the use of unclaimed cadavers for study or scientific research purposes. Inclusion criteria covered cadaveric specimens with an anatomical variation of the brachial artery and its terminal branches. Anterior, posterior, lateral, and medial sides of the arm and forearm dissections were performed to visualize the blood vessels.

## 3. Results

During the dissection of the human specimen, stored in the Universidade Brasil's Anatomy Department, it was possible to visualize and identify the arterial vessels anatomical variation in the arm

segment. Of the 26 limbs analyzed, only 1 left hemisphere upper limb was found to have a brachial artery high bifurcation (Figure 2) in the arm mid-third part. In addition to the high bifurcation, it was found a rare anatomical variation of the radial and ulnar arteries, the radial artery with a medial path in the arm mid-third part, as well as the ulnar artery with a lateral path (Figure 2), unusual case of the paths reported in the literature and in the clinic. For arterial pathway comparison, two male specimens were utilized, Figure 1 showing the arteries without anatomical variation, and Figure 2 illustrates the brachial artery high bifurcation.

#### **4. Discussion**

The arterial web clinical anatomy of the upper limb begins with the brachial artery (BA). Figure 1 shows that the BA has its origin from the axillary artery, with a descending path, in the upper third of the arm medially follows the median nerve, in the middle one crosses the median nerve in a lateral direction, then medially follows the biceps brachial muscle and ends in the cubital fossa, bifurcated into radial and ulnar arteries, considered brachial artery terminal branches<sup>[7,8]</sup>. In the same Figure, two arterial branches are observed, the deep brachial artery and the superior ulnar collateral artery. It is important to note that the deep brachial artery and the ulnar collateral arteries are important vessels because they exhibit connections with branches of the radial artery, ulnar artery, and common interosseous, forming periarticular anastomoses of the elbow. The clinical aspects of the arterial network of Figure 1, present similar data from the authors Epperson et al.<sup>[1]</sup>, Mostafa et al.<sup>[2]</sup>, Drake et al.<sup>[7]</sup>, and Moore et al.<sup>[8]</sup>, indicating that the data are reliable and up-to-date.

In Figure 2, the limb cross-section was observed in the arm mid-third part. The cross-section location shows the terminal portion of the Brachial Artery with two artery releases, the radial and the ulnar. With the origin of the radial and ulnar arteries in the arm mid-third, this arterial web exhibits BA anatomic variations, a known clinical characteristic of high brachial artery bifurcation. Another point found in the Figure was the radial artery with medial path and the ulnar artery with lateral path, as in this case it is a rare event, these clinical aspects being divergent from the studies of Madhyastha et al.<sup>[6]</sup>, Moore et al.<sup>[8]</sup>, and Sieger et al.<sup>[9]</sup>. However, these blood vessels alter their paths in the lower third of the arm, the radial artery crosses the ulnar artery anteriorly in a lateral direction, following the biceps medial edge brachial and brachioradialis muscle, following to the radiocarpal articulation<sup>[10]</sup>. For Standring<sup>[11]</sup>, the ulnar artery appears at the level of the radial incisura of the ulna in the cubital fossa. This blood vessel leaves the cubital fossa, going deep in the pronator round muscle, and runs through the forearm between the flexor carpi ulnaris and the flexor digitorum profundus, following the wrist, ending at the superficial palmar arch. The radial artery leaves the cubital fossa, crossing laterally the forearm, following the brachioradialis muscle to the deep palmar arch.

An anomaly of the deep brachial artery (DBA) was found in the Madhyastha et al.<sup>[6]</sup> research, presenting the origin of the posterior circumflex humeral artery (PCHA). It should be evidenced that the PCHA usually originates in the axillary artery third part and the DBA is an important collateral branch of the brachial artery that is anastomosis with recurrent radial and interosseous artery in the elbow region. The authors reported that the brachial artery high bifurcation was found in the upper third of the arm about 4

cm distal from the lower edge of the round major muscle. The brachial artery terminal branches descended parallel, deeply to the biceps brachial muscle. In the region of the elbow, the radial artery went through the cubital fossa, while the ulnar artery went deeply through the round pronator muscle. It is important to emphasize that arm arterial variations can cause erroneous blood pressure readings due to the presence of two arteries.

Sieger et al.<sup>[9]</sup> found three less frequent cases. The first case was the bilateral brachial artery high bifurcation in each arm proximal third part. It is worth pointing out that there are few commentaries in the literature about the high brachial artery bifurcation, when it is found in the literature, it is usually cited in a hemisphere body. Chakravarthi et al.<sup>[3]</sup> explain that this arterial anomaly is probably due to induction and branching of primitive vascular plexus during embryogenesis. The second case is the ulnar artery, in the cubital fossa (right and left), the ulnar arteries medially crossed the median nerve, continuing the path superficially to the forearm flexor muscles. This condition is rare and can be easily confused with a vein, which is considered a clinically significant factor and accident risk in intra-arterial injections<sup>[12,13]</sup>. The third case refers to the common interosseous artery. This blood vessel was found exiting the radial artery, deep into the forearm flexor muscles, and usually originates from the ulnar artery. This artery is considered important due to supplying the interosseous membrane and having anastomosis with DBA.

It is evident that the anatomoclinic knowledge and anatomical variations patterns are of extreme importance in the repair surgeries performance in the arm area, thus, the surgeons need to comprehend all the web and arterial anomalies, avoiding possible vascular lesions during the surgery. Another point that should be highlighted is the low publication rate of the high brachial artery bifurcation, this draws attention to the scarce local and international literature, therefore makes it impossible to train and improve professionals and, in addition, it is harder to make more accurate diagnoses and safer surgical interventions in the upper limb region.

## **5. Conclusion**

Learning Anatomy and anatomical variations of the arteries is a mandatory requirement for planning invasive and surgical treatments since the lack of such knowledge can cause serious vascular lesions, especially errors during orthopedic and plastic procedures in the upper limbs. Therefore, the cadaveric dissection is an important tool for Anatomy learning and arterial anomalies, using it as a pedagogical resource to acquire surgical skills during the internship and also improve the surgical techniques of resident doctors. In case of doubt about arterial path alteration, pre-operative angiography is indicated, because it helps in the variant artery tracking and the discovery of its place of origin. With the low publication of studies on high brachial artery bifurcation and its clinical aspects, it is suggested more medical research and case reports in national and international journals.

## **CONFLICTS OF INTEREST**

The authors declare no conflict of interest.



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# **Implementation of a Costing System in the Fleet Management of a Brazilian Public University**

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## **Abstract**

*This work presents the implementation of a costing system in Fleet Management at a Brazilian Public University, applying concepts of cost accounting, engineering, indexes, and maintenance management, as well as using the cost absorption method. As a methodology, an action research is applied to meet the objectives of being exploratory and descriptive; about the nature of the research, and applied research is adopted through a case study procedure in a Transport Coordination. To prepare for this work, the operational data of the fleet were collected during 12 months in the different units and internal control systems. The results of the study showed the operating costs of the fleet such as total fuel spent annually, totally spent on maintenance, as well as their respective indices, cost per kilometer, fixed and variable costs sufficient for accountability with the Official Bodies of Control. It was noted that the study applied in this work provided a basis for implementing a Costing System for fleet management of a Brazilian public university, respecting the guidelines of Normative Instruction No. 3, of May 15, 2008, which deals with the use and accountability, even fully complied with the requirements of the regulations regarding the Performance Control and Maintenance Maps of the Official Vehicle in an individualized manner, providing information on operational costing of the fleet sufficient for the decisions of the managers of the Public Institution.*

**Keywords:** Costing Systems, Fleet Management; Maintenance Management;

## **1. Introduction**

In recent years, the country has been going through a series of changes in the economic, financial, and patrimonial scope, adopting more and more resource rationing policies, such as Portaria nº 179, of April 22, 2019, and Portaria e nº 424, of August 21 of the same year, which provide for measures to rationalize expenses and reduce expenses for the financial year in the sphere of the Ministry of Economy, autarchies and related foundations. In view of this scenario, the adoption of effective management tools in Public Administration is of paramount importance to reach the organ's final activities.

It is known that the public administration has perfected its procedures with the intention of minimizing the stagnation arising from the bureaucratic model. The first attempt at administrative reform of the State was proposed by Bresser-Pereira (1995) through the Master Plan for the Reform of the State Apparatus - PDRAE, which for many was considered a landmark for managerial public administration, causing a change in policies of the government. From the introduction of the Plan, a more efficient positioning was adopted, with a focus on results and the accountability of the public manager.

In this context, the scenario of this research will be the Transport Coordination, linked to the City Hall of the University Campus-PCU of a Brazilian Public University, responsible for the management, conservation, document regularization, and maintenance control, in addition to logistical support and other administrative actions. Its performance is important to enable the displacement of people and goods, in support of the final activities of teaching, research, extension, including support for institutional events, as well as providing administrative assistance to the various decentralized units in the interior of the State of Amazonas.

The Management Report (2018-2019) indicates that with the development of logistical activities, the University has its own fleet, consisting of 76 vehicles, distributed in its 6 (six) campuses in light and heavy types. The research will be applied on the Manaus campus of a Federal Institution of Brazilian Education, which annually receives approximately 6 thousand requests for transfers, in addition to transporting, in 2019 alone, some 34 thousand passengers in the most different academic activities of the institution. The research target Campus holds 73.68% of the fleet, considering active and inactive vehicles. The Transport sector team is composed of 5 administrative-technical servers and 21 drivers.

As the main problem, there is a lack of information on the operational costs of the fleet capable of assisting in rendering accounts with the Control and Inspection Bodies, in addition to the non-compliance with Normative Instruction No. 3, of May 15, 2008, which provides for the classification, use, specification, identification, acquisition and disposal of official vehicles. For this reason, it is necessary to adhere to quality control mechanisms and efficient costs in order to avoid waste, negative impacts, and property losses to the Institution.

The general objective will be the implementation of a Costing System for Fleet Management at the University, in order to make efficient decision making by managers within the Institution. The system to be implemented will allow for compliance with Normative Instruction No. 3, of May 15, 2008, regarding the Performance Control and Maintenance Map for the Official Vehicle; Evidence the operating costs of the fleet in 2019; Identify the main vehicles that most consumed the annual budget, in addition to checking those that spent the most on maintenance in addition to checking their respective indexes; show the current situation of the Institution's fleet.

## **2. Theoretical framework**

The theoretical framework will deal with themes on Higher Education Institutions in the context of Brazilian Public Administration; Public Budget, Costing Systems, and Vehicle Maintenance;

### **2.1 Public Administration and IFES**

According to the Federal Constitution of 1988, the Federative Republic of Brazil is formed by the indissoluble union of States and Municipalities and the Federal District, it constitutes the Democratic State of Law, in which all the power emanates from the people, who exercises it through elected representatives or directly. CF itself (1988) brought in its legal framework that the powers of the Union are independent and harmonious with each other, which are called the Legislative, the Executive, and the Judiciary.

In the pursuit of political and administrative activities, the federal authorities need tools to reach the satisfaction of the needs of the population and, in a broad sense, the public administration, in addition to the administrative functions, following the understanding of Alexandrino and Paulo (2018) the public administration prepares public policies through government agencies, establishing government action guidelines and programs, government action plans and public policy setting.

From the point of view of the strict sense, regardless of the power it exercises, Public Administration means the set of state bodies and agents in the exercise of administrative function (MAZZA, 2020).

In this context, Federal Higher Education Institutions appear, as Public Foundations of Indirect Public Administration, which operate in competition with the private sector, linked to the Ministry of Education - MEC. The main characteristics of Public Foundations, for Mazza (2020), are the creation and extinction by a specific law, to hold public services, to have administrative autonomy, own assets, operation funded by Union resources and other sources.

For ANDIFES (2004), the links between the defense of its academic nature and the constant concern with the role of knowledge in the construction of a more just and inclusive society are indissoluble to public institutions, including for the quality of the system and the development of the parents. IFES are opinion makers and knowledge generators, which require their managers to have a reflective, proactive, knowledge, vision, ability to plan, coordinate, control, and evaluate management processes (MIZAEL; VILAS BOAS; PEREIRA; SANTOS, 2013).

### **2.2 - The Public Budget and Cost Management**

The management of costs in the public service is not related to making a profit, as in a private company, however, it is linked to the effectiveness of service to the population, since the public budget is annually marked out and controlled by budget laws: federal law n°. 4,320 / 64, complementary law 101, of May 4, 2000 (tax liability law), bidding law 8,666, of June 21, 1993, in addition to the Federal Constitution itself (1987).

For public expenditure to take effect, according to Law No. 4,320 (1964), it must follow three stages, which are: commitment, settlement, and payment: the first corresponds to an act issued by the competent authority that creates an outstanding payment obligation for the State whether or not to implement the condition; the second is the verification of the right acquired by the creditor and aims to ascertain the regular condition of the good or service provided to the Administration; and the third, consists of the outflow of funds from the entity in favor of the creditor in order to extinguish the obligation, usually by payment orders or credit in the account.

For Nogueira (2017), the cost management must be known by the manager in order to analyze the most accurate scenario to identify the deficit points with the objective of reducing operating expenses.

Directing the search to the operational costs of a fleet, the classification is used in which the administrative costs are incorporated in the fixed costs, without detailing all the components of the costs, however, those adopted in fleet management may be the following:

- Variable Costs: fuels, oils, and lubricants, washing, running, parts and accessories (BULGARI FILHO, 2019; VALENTE, NOVAES, PASSAGLIA, VIEIRA, 2015);
- Fixed Costs: Capital cost, depreciation, driver remuneration, personal expenses, administrative expenses, licensing, and compulsory insurance (BULGARI FILHO, 2019; VALENTE, NOVAES, PASSAGLIA, VIEIRA, 2015).

For Valente, Novaes, Passaglia, and Vieira (2015), several factors can substantially determine costs and their composition, such as the mileage developed by the vehicle, since the cost decreases as the vehicle is used.

Also in accordance with the authors, the type of traffic, the type of road, the region, and the size of the vehicle, as well as the imbalance inflows do system, can be factors of increase or decrease in operating expenses.

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### **2.3 Costing Systems**

The Federal Accounting Council-CFC (2012) understands that a costing system understands how the entity measures different costs, which are appropriated to products or services through costing methods, and can use different units of measurement. The main costing methods are: direct or variable; absorption; by activity; and full.

The method adopted for the elaboration of the system was the absorption costing, which was shown to be the most adequate in the decision-making by the fleet manager, providing reliable information for analysis and optimization of the company's resources.

According to Pereira Filho and Amaral (1998), Absorption Costing can be used for legal and tax requirements, while variable costing can be used to assist the company's management decision process.

### **2.4 Fleet Management**

Considering a key point in the elaboration of this research, there is the concept of Fleet Management, which is not limited to specific software or activity, but also to a set of procedures aligned in order to bring about better vehicle management organization. For Valente et al. (2016), fleet management consists of managing in a more balanced way a set of vehicles belonging to the same division or agency.

For Nogueira (2017), fleet management encompasses several strategic areas of administration with regard to vehicle management, such as an organization's economic, accounting, contractual, and administrative areas. In agreement with Rodrigues et al. (2015), vehicle management through grouped tasks can serve to assess and support decision making by senior management.

According to Valente et al. (2016), the challenges presented in vehicle management are complex and empirical knowledge is often adopted in decision making. According to the authors, there is some resistance and insecurity in changes, since the process has been going on for some time, without significant interruptions. However, there is a lack of tools and computer systems capable of improving management, at affordable costs, in addition to the execution of operations with planning.

### **2.5 Maintenance**

According to the Brazilian Association of Technical Standards - ABNT (1994), maintenance is the combination of all technical and administrative actions aimed at maintaining or replacing the equipment in order to perform a required function, which may even be with the modification equipment.

Corroborating the concept of ABNT (1994), Mirshawka and Olmedo (1993) define maintenance as a set of activities and resources used in systems or equipment to ensure the productivity and safety of operations in order to avoid failures within availability parameters.

It is peaceful, however, the understanding that the maintenance activity improves the performance of the equipment, reduces costs, and increases the useful life of the equipment. Slack, Chambers, and Johnston (2002) list six benefits resulting from it, which are: improved safety, increased reliability, higher quality,

lower operating costs, longer life, higher final value (for resale).

As explained, vehicle maintenance encompasses all types of intervention that can prolong the life of the vehicle/equipment. According to Slack et al. (2002), the main types of maintenance are preventive, corrective, and predictive.

According to Valente et al. (2016), preventive vehicle maintenance is intended to conserve the vehicle by previously preventing it from returning due to breakages. This type of maintenance includes the services of Revision of the electrical system; Mechanical system; Checking of paint, chassis and body shop; Changing and checking the oil level; Review of other essential equipment for the vehicle (NOGUEIRA, 2017).

It is known that the correct preventive maintenance can minimize costs with fleet management, in order to increase the efficiency of the equipment and avoid unnecessary downtime, as well as complex and expensive problems for the organization.

Valente et al. (2016) state that corrective maintenance has the ability to reestablish the functions of the vehicle or the system for which it was designed through the correction, recovery, and restoration of the equipment's productive capacity. Bearing in mind that, according to the author, stopping the machinery can compromise the entire production system.

Reinforcing this idea, Alvarez (2016) states that corrective maintenance occurs, in most cases, at more inopportune moments, such as distant trips or without a cell phone signal for distress calls. This is because the vehicle is used until its failure, resulting in high repair costs, long periods of maintenance time in the workshop, in addition, to directly impacting the organization's logistical efficiency.

Another type of maintenance is predictive, which according to Takahashi and Osada (2015), once implemented, anticipates failures to avoid over-maintenance. It takes place through the control and evaluation analysis of the facilities, making it possible to determine effective remedial measures.

Within the scope of maintenance management, there are numerous indicators for monitoring equipment. However, they need to be well used to obtain effective results. According to Kardec and Nascif (2001), it is unnecessary to use so many non-specific indicators. The authors argue that it is necessary to choose the essential indicators for each specific case, in order to obtain the high performance of the machines.

According to Medeiros, Mendes, and Ferraz (2005) and Souza (2007), performance indicators assist in determining goals and monitoring the results achieved in certain areas. The authors list some important indicators to support the monitoring and maintenance management such as Average Time to Failure - TMPF, Average Time to Repair - TMPR, Average Time between Failures - TMEF, and Operational Availability, which will be addressed in Table 1:

Table 1. Maintenance Indexes.

INDICATOR	INITIALS	DESCRIPTION
Mean Time To Failure	MTTF	According to Medeiros et al. (2005), this metric shows the average time of operation of the system without failures or interruption if the measurement time is taken for each operation until the first defect or failure.
Mean Time To Repair	MTTR	Determines the maintainability of equipment and systems, in addition



		to allowing viewing the time spent for repair actions, it can assist in the control of operational and safety goals: the smaller the number of repairs carried out on equipment, the higher the TMRP, that is, the sustainability of the service (MIRANDA, 2007).
Mean Time Between Failures	MTBF	According to Braniva (2018), it is a metric that reports the reliability of the system. TMEF is the average time that a system/equipment can perform its function without interruption. It is measured from the moment the item starts to work, until its next failure. For Villanueva (2015), the TMEF is the inverse of the failure rate, which determines the reliability of the system/equipment.
Operational Availability	-	Operational Availability can be understood as the fraction of the time that the equipment or system is performing the function, or that is in operating conditions during the determined time interval (ABNT, 1994; MONCHY, 1989; NAGAO, 1998; SOUZA, 2007, VILLANUEVA, 2015).

Source: Prepared by the authors (2020).

Given what is shown in Table 1, it is noted that maintenance indicators are important for equipment control and ensure that the machines are available for use, in safe and operational conditions. However, it is known that in fleet management it is possible to adopt other criteria so that the manager may be able to bring responses to changes and have a clear view of the system's sustainability and effectiveness.

### 3. Methodology

The methodology adopted in this work is action research. For Silva (2017), action research works on issues of shared interests and involves specific problems of a certain group, in addition to encouraging a process of changes to solve problems of the company or organization.

Regarding the nature of the research, applied research is adopted through a Case Study procedure. To solve the problems found through descriptive and exploratory research, techniques, tools, data, and action plans collected from the Institution's Transport Coordination are used.

To meet the objectives, initially all the supply and maintenance data per vehicle contained in the spreadsheets, requisitions, maintenance system, documents, records and interpretations of the Agency's 2018-2019 Management Report, letters, contracts, notes of commitment available. Then, articles, dissertations, publications at congresses on topics such as fleet management, costing systems, vehicle maintenance costs applied to fleet management were selected.

Consequently, the impacts of the lack of information on the previous rendering of accounts were verified, as well as the inefficiency in decision making by the fleet managers.

### 4. Elaboration of the Fleet Costing System (Step by step) and Data Capture

After the data collection and analysis stage, it was noted that they were disorganized, therefore, unable to

assist the manager, which would directly impact the detailed cost analysis. Therefore, it was implemented practically and technically, with the aid of the Excel software of the Office package, in addition to the Astah software used for modeling and diagrams, a costing system for fleet management using the absorption method divided into the modules described in Figure 1.

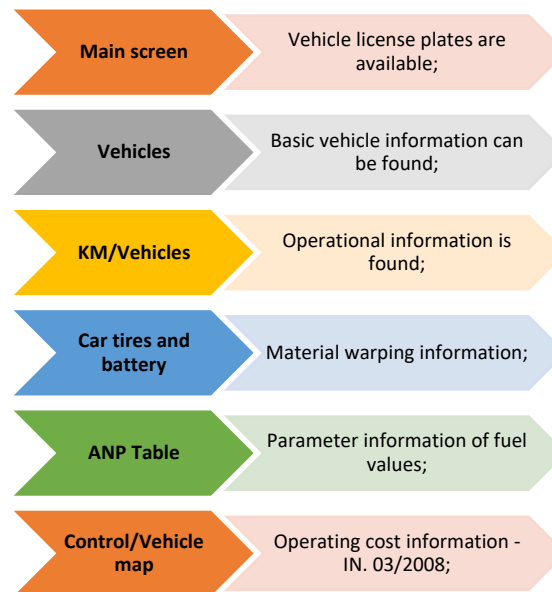


Figure 1 - Modules - Fleet Costing System.

Source: Prepared by the authors (2020).

**Main Screen:** The main worksheet of the system was called “Menu”, comprising the ranges of A1: K33. In cell "A1", the system header was inserted: "TRANSPORT COORDINATION - UF / MAP OF PERFORMANCE CONTROL AND MAINTENANCE OF OFFICIAL VEHICLES - YEAR". In the remaining cells (A2: K33), all license plates of the fleet vehicles were inserted using the SmartArt tool, as well as the following items at the bottom of the spreadsheet: Vehicles, KM / Vehicles, Unavailable, Tires and Batteries, and ANP Table also using the SmartArt feature of the Office. Thus, we have the initial screen of the system as shown in Figure 2.

TRANSPORT COORDINATION - UFAM

MAPS=> INTERIOR

MAP OF PERFORMANCE CONTROL AND MAINTENANCE OF OFFICIAL VEHICLES - 2019-MANAU

01 - L200 TRITON	• JXW-6801	16 - MICROÔNIBUS	• NOR-4063	31 - FORD RANGER	• NOY-3288	50 - VW/NOMBI	• NOY-0559
02 - L200 TRITON	• JXW-6851	17 - CITROEN/ JUMPER	• JXV-2716	32 - VW/NOMBI	• NOJ-4235	51 - FIORINO	• NOJ-6355
03 - L200 TRITON	• JXW-6841	18 - L200TRITON	• JXW-6871	33 - FORD KA	• NOK-9094	52 - STRADA FIRE	• JXS-6478
04 - L200 OUTDOOR	• OAD-3099	19 - L200TRITON	• JXW-6821	34 - FORD KA	• NOK-3055	53 - TOYOTA BANDERANTE	• JWF-9830
05 - L200 OUTDOOR	• OAB-2350	20 - FORD/RANGER	• NOY-5319	35 - FORD KA	• NOK-3105	54 - VW/NOMBI	• JWF-1816
06 - VW/NOMBI	• NOY-0579	21 - POLO SEDAN	• JXS-5152	36 - FIORINO	• NOJ-6345	55 - MARCOPOLO/ VOLARE	• JXE-9199
07 - VW/NOMBI	• NOY-0669	22-TOYOTA	• JWR-1246	37 - CHEV/SPIN	• NOR-9751	56 - MMC/L200 4X4	• JWV-9544
08 - FORD KA	• NOY-4075	23 - VW/NOMBI	• NOY-0599	38 - CHEV/SPIN	• NOR-5731	57 - VW/NOMBI	• JXP-7557
09 - FORD KA	• NOK-9144	24 - VW/NOMBI	• NOY-0639	39 - AGRAL/PURGO VAN	• JXG-0521	58 - YAMAHA/YBR 125K	• JXZ-9081
10 - FIORINO	• JXH-6231	25-VW/NOMBI	• JXU-9094	40 - RENAULT KGOO	• OAM-6792	59 - VW/GOL 1.6	• JXV-7925
11 - STRADA	• OAK-3665	26 - FORD KA	• NOK-3065	41 - MARCOPOLO/ VOLARE	• NOX-1778	62 - L200	• NOS-6837
12 - TRANSIT	• NOV-5419	27 - FORD/RANGER	• NOY-5329	42 - FIAT/DOBLO	• JXQ-6557	68 - BUS 3	• NON-3335
13 - CAMINHÃO	• NOW-8379	28 - FORD RANGER	• JXI-2701	43 - FORD KA	• NOK-9124		
14 - BUS 1	• NOI-1675	29 - L200TRITON	• OAA-6371	44 - RENAULT/MST	• JXJ-8851		
15 - BUS 2 Scania - 44	• NOO-4904	30 - L200 4X4 GL	• JWV-9228	45 - L200 TRITON	• JXW-6791		

VEHICLES

KM/VEHICLE

AVAILABLE

TIRES AND  
BATTERIES

ANP TABLE-2019

Figure 2 - Home Screen - Fleet Costing System.

Source: Prepared by the authors (2020).

In this initial screen, shown in Figure 2, red sunk vehicles are identified. These vehicles, according to Federal Decree 9.373 / 2018, can no longer be used for the purposes for which they are intended or their recovery is not justified by the market value. Therefore, it is considered that they are within the category unserviceable to the Administration, according to the Arts. 3rd, 6th, and 7th of the said regulation.

**“Vehicles” module:** In this module, fleet information is distributed in the respective columns (A: S) with the following denominations: Item (Identification Code, Vehicle / Brand, License Plate, Year of Manufacture / Acquisition, Municipality, Fuel (type), Chassis, Renavam, Tipping, Status (Activated or Inactive, Power, Market Value, Tachograph, Issue Date, Tachograph, Date / Expiration; Number of maintenance interventions, Available days and Unavailable days. After setting the information for the module was inserted with the data available in the institution's internal control system.

**“KM / Vehicles” module:** In this module, all information about the institution's fleet is located. They are the main instrument for decision-making which is most evidently used by absorption costing methods through formulas and applications. By linking the different modules, the power will be provided automatically. As well as the “Vehicle” module, the distribution of information comprises columns (A: X), with the following denominations: Item (Identification Code), Vehicle / Brand, License Plate, Year of Manufacture, KM KM, Fuel Consumption ( in liters), KM Rotated (per liter), Total Annual Fuel (R \$), Total Annual Maintenance (R \$), Total Annual (R \$), Average Per KM Annual Rotated, Fuel Tank (liters), Municipality, Age, Group (Category), Lubricating Oil, Lubricating Oil Type, Lubricant Qty / Annual, Tire Dimensions, Annual Tire Qty, Battery Amperage, Annual Battery Qty, Status (Active or Inactive) and, finally, the Observations column. After inserting the aforementioned denominations, they were fed with the data available in the reports of the institution's internal control system, except for the consumption columns that depended on the direct cost values, because, at this stage, there is still no link with the

modules of the plates of vehicles (Control / Vehicle Map).

**“Unavailable” Module:** This module contains information on vehicles and energy generators not managed by the Transportation Coordination, which is only for control and monitoring purposes since there are expenditures to the institution not linked to the object of the research. They were distributed by the following denominations, each with its module: External Vehicles (agreements), Indoor Units, Energy Generators, UF, PAAV (Annual Vehicle Acquisition Plan), Control Sheets, Generator Sheets. All using Excel's SmartArt feature.

**“Car tires and battery” module:** In this module, there is a history of the lubricating oil consumption of official UF vehicles, based on legally authorized commitments. To obtain greater control, it was distributed as follows between columns (A: H): Order, Requisition No., License Plate, Vehicle, KM (current), Date (effective exchange), Specification (the same described in the module “ KM / Vehicles ”), Lubricant, Qty (requested), Responsible Driver.

**“ANP Table” module:** In this module, the average spent values are available in the table of the National Agency of Petroleum, Natural Gas and Biofuels (ANP). Such amounts were used as a reference by the institution to pay fuel suppliers in 2019 for the campus in Manaus. The following information was collected: Month (NF reference), Gasoline, Diesel, Diesel S10. The values shown in Figure 3 were obtained.

TRANSPORT COORDINATION ANP TABLE - 2019			
ANP TABLE (AVERAGE PRICE) - 2019			
MONTH	Gasoline	Common Diesel	Diesel S10
January	R\$3,79	R\$3,61	R\$3,71
February	R\$3,88	R\$3,53	R\$3,65
March	R\$4,07	R\$3,64	R\$3,74
April	R\$4,27	R\$3,65	R\$3,75
May	R\$4,12	R\$3,71	R\$3,83
June	R\$4,59	R\$3,65	R\$3,70
July	R\$4,57	R\$3,69	R\$3,80
August	R\$4,08	R\$3,68	R\$3,78
September	R\$4,27	R\$3,69	R\$3,79
October	R\$4,36	R\$3,79	R\$3,89
November	R\$4,55	R\$3,78	R\$3,88
December	R\$4,12	R\$3,78	R\$3,78

Figure 3 - ANP Table Values in 2019.

Source: Research data (2020).

**Module "Control / Vehicle Map":** In this module, the individualized structure for each vehicle/license plate was developed based on the data needs requested by Normative Instruction No. 3, of May 15, 2008, and annexes. All bases collected in the Annex to the standard were stratified in this module.

Continuing the elaboration of this module, after renaming the spreadsheet with the individual code plus the license plate, such as, for example, 01\_UFS-0001, the part of the graphical analysis of supplies was created in cells A52: N62 (see Figure 4), using Excel's own graphical tool with KM as the parameter per liter consumed (column N). Then, the spreadsheet was fed with the supply data authorized in the requisitions and registered in the columns (A63: N63). In this step, the following nomenclatures

presented in this order were used: Supply Qty (Numeral Order of Supply); Date, Time, Driver, Coupon Code (unique request-id), Liters Qty, KM-Current, KM-Previous, KM Difference, Fuel Type; Value per Liter, KM / Liters, Total Fuel in \$, Annual depreciation. After elaborating and inserting the data, we have Figure 4.

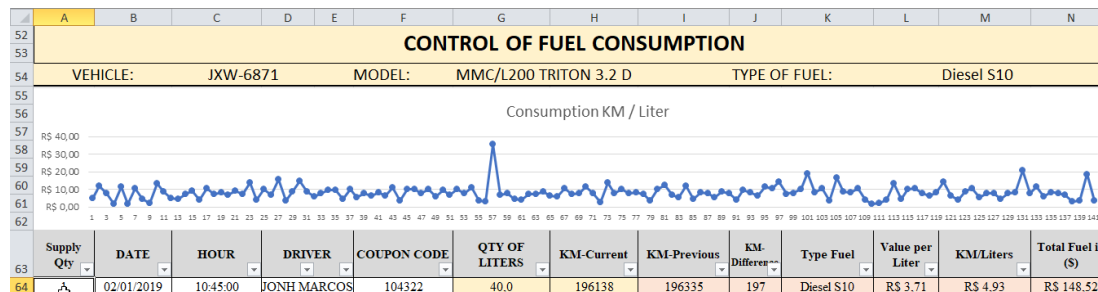


Figure 4 - Graph - Control of Fuel Consumption.

Source: Prepared by the authors (2020).

Given the above until the elaboration of this stage, it is necessary to prepare the formulas, obeying the financial techniques of apportioning the method by absorbing costs, which automatically link the various information between the modules. Table 2 shows the schedule, line "64", as an example for registering the first supply record.

Table 2 - Formulas - Control / Vehicle Map Module.

DESCRIPTION	LOCATION LINE 64 (COLUMN)	FORMULA / EXPLANATION	USER ACCESS LEVEL
"Supply Qty (order of supply)	A	Number format	Free
Date	B	Short date format	Free
Hour	C	Text format	Free
Driver	D-E	Formato em texto	Free
Coupon code (Unique supply identification)	F	Number format	Free
Qty of Liters	G	Number format	Free
KM-Current	H	Number format	Free
KM-Previous	I	= supply_posterior_line  Example: = H65 (1st supply)	Restrict with password, as

			the update is automatic.
KM difference	J	<p>= IF (AND(H64 &lt;&gt; 0; I64 = 0); 0; I64-H64)</p> <p>Description: If the values of cell H are different from zero and the value of I is equal to zero, the value shown will be null. Otherwise, the value displayed in J will be the mileage traveled by the vehicle with the last refueling.</p>	Restrict with password, as the update is automatic.
Type Fuel	K	<p>= IF(F64 &lt;&gt; 0; \$ M \$ 54,0)</p> <p>Description: If the values of cell F are different from zero, it means that a fuel request was released; therefore, the system will recognize the type of fuel located in cell M54 (the same located in cell G8).</p>	Restrict with password, as the update is automatic.
Value per Liter	L	<p>= IF (K64 &lt;&gt; 0; INDEX (TABLE_ANP; MONTH (B64) +1; IF (K64 = "Gasoline"; 2; IF (K64 = "Diesel"; 3; 4))); "")</p> <p>Description: If the values of cell K are different from zero, it means that fuel has been released; therefore, the system filters by the month entered in "B" and searches for the respective fuel value registered in the "ANP Table Module",.</p>	Restrict with password, as the update is automatic.
KM / Liters	M	<p>= IF(J64 &lt;&gt; 0; J64 / G64; "")</p> <p>Description: If the values of cell "J" are different from zero, it means that there was mileage covered; therefore, the system calculates the amount traveled in KM (J) per liter supplied (G).</p>	Restrict with password, as the update is automatic.
Total Fuel in (\$)	N	<p>= IF(J64 &lt;&gt; 0; L64 * G64; "")</p> <p>Description: If the values of cell "J" are different from zero, it means that there was mileage covered; therefore, the fuel value (L) is multiplied by the quantity of liters supplied (G).</p>	Restrict with password, as the update is automatic.

Source: Prepared by the authors (2020).



From this stage, after replicating the formulas elaborated in Table 2 for the subsequent lines (of Line 65), as well as filling in the information contained in the supply requisitions (columns A: H), it is already possible to view the information graphic shown in Figure 4. In this way, it was possible to connect this information from Table 2 to the “Control / Vehicle Map” module and also as it allowed to elaborate table 3.

Table 3 - Formulas - Control / Vehicle Map Module.

CELL ADDRESS	FORMULA	EXPLANATION
Line 5 – F5	-	Vehicle code described in the “Vehicle module”.
Line 6 – (A6-E6)	=VLOOKUP(\$F\$5;VEHICLES!A2:Q78;2;1)	The system searches, using the unique vehicle code in F5, for the information "BRAND / TYPE MODEL" in the "Vehicles" module.
Line 6 – (G6)	=VLOOKUP(\$F\$5;VEHICLES!\$A\$2:\$Q\$78;7;0)	The system searches, using the unique vehicle code in F5, for the “COLOR” information in the “Vehicles” module.
Line 6 – (J6)	=VLOOKUP(\$F\$5;VEHICLES!\$A\$2:\$Q\$78;4;0)	The system searches, through the unique vehicle code in F5, for the information “YEAR OF MANUFACTURING” in the module “Vehicles”.
Line 12 – (A12-C12)	=VLOOKUP(\$F\$5;VEHICLES!\$A\$2:\$Q\$78;3;0)	The system searches, using the unique vehicle code in F5, for the information “CURRENT PLATE” in the “Vehicles” module.
Line 12 – (D12-E12) Line 12 – (J12)	=VLOOKUP(\$F\$5;VEHICLES!\$A\$2:\$Q\$78;9;0)	The system searches, using the unique vehicle code in F5, for the “UF” information on the “Vehicles” module plate.
Line 12 – (F12-I12)	=VLOOKUP(\$F\$5;VEHICLES!\$A\$2:\$Q\$78;8;0)	The system searches, through the unique vehicle code in F5, for the information “LOCATION-MUNICIPALITY” in the module “Vehicles”.

Line (14-15) (A14:D15)	=VLOOKUP(\$F\$5;VEHICLES!\$A\$2:\$Q\$78;1 2;0)	The system searches, through the unique vehicle code in F5, for the information "CHASSIS" in the "Vehicles" module.
Line (14-15) (E14:F15)	=VLOOKUP(\$F\$5;VEHICLES!\$A\$2:\$Q\$78;1 6;0)	The system searches, using the unique vehicle code in F5, for the information "CV" in the "Vehicles" module.
Line (14-15) (G14:I15)	=VLOOKUP(\$F\$5;VEHICLES!\$A\$2:\$Q\$78;1 7;0)	The system searches, using the unique vehicle code in F5, for the information "MARKET VALUE" in the "Vehicles" module.
Line (14-15) (J14:K15)	=VLOOKUP(\$F\$5;VEHICLES!\$A\$2:\$Q\$78;1 3;0)	The system searches, using the unique vehicle code in F5, for the information "CODE. RENAVAN" in the "Vehicles" module.

Source: Prepared by the authors (2020).

From the formulas elaborated in Table 3, it is possible to establish the header pattern of the Control Map and the linking of the "Vehicles" modules with the "Control Map" module. And considering that the formulas in Tables 2 and 3 have the correct applicability, a connection is created with the consumption information per vehicle, which occurred in the manner obtained in Table 4.

Table 4 - Formulas - Control / Vehicle Map Module.

CELL ADDRESS	FORMULA	EXPLANATION
Month (A21)	-	Standard date format.
Km traveled per month (B21)	=SUMIFS(\$J\$63:\$J\$214;\$B\$63:\$B\$214;">="&A21;\$B\$63:\$B\$214;"<="&EOMONTH(A21;0))	This formula - applied to the absorption costing concepts - causes the sum of the effective mileage to be automatically rotated, taking as a parameter the month in which the supply was made.
Fuel consumption (C21)	=SUMIFS(\$G\$63:\$G\$214;\$B\$63:\$B\$214;">="&A21;\$B\$63:\$B\$214;"<="&EOMONTH(A21;0))	This formula - applied to the absorption costing concepts - makes the sum of the quantity in a liter of the fuel supplied automatically, taking as a parameter the month in which the supply was made.

KM rotated per liter (D21: E21)	=IF(B21<>0;B21/C21;0)	This formula - applied to the absorption cost concepts - calculates the mileage per liter of fuel per month. If there is no information registered, the cell phone is reset.
Fuel (\$) (F21)	=SUMIFS(\$N\$63:\$N\$214;\$B\$63:\$B\$214;">="&A21;\$B\$63:\$B\$214;"<="&EOMONTH(A21;0))	This formula - applied to the absorption costing concepts - makes the sum of the amounts spent on fuel automatically, taking as a parameter the month in which the supply was made.
Maintenance/ Conservation (G21)	-	Feed via the Link Card Maintenance system manually.
Mechanical repair (H21)	-	Feed via the Link Card Maintenance system manually.
Total Sum (R \$) (I21)	=SUM(F21:H21)	This formula sums total monthly operating expenses per vehicle.
Average per km traveled (R \$) (J21: K21)	=IF(B21>0;I21/B21;I21)	This formula calculates the average per kilometer traveled per month if there is mileage traveled during the month; otherwise, the amount will be the total monthly operating cost.

Source: Prepared by the authors (2020).

Table 4 is taken as an applied example for recording the first month of the year (January). However, the respective formulas must be replicated in the following cells (other months) until completing the information on the official vehicle performance and maintenance Control Map shown in Figure 3.

After the elaboration of the costing system modules is completed, the connection between the modules is made through the References and Hyperlinks resources of the Office package.

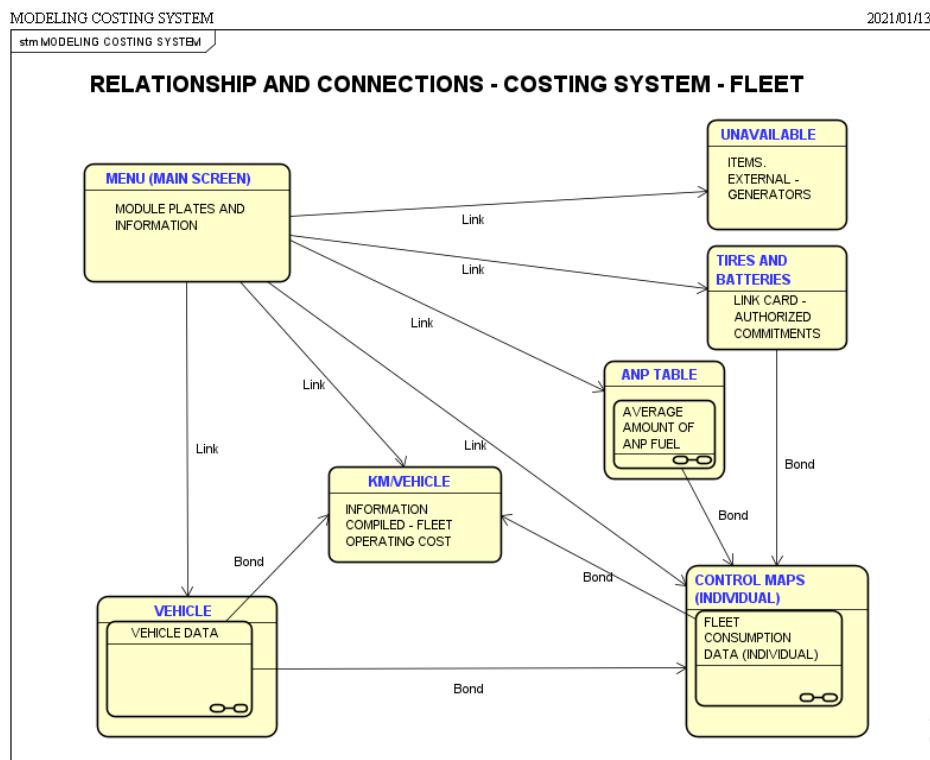


Figure 5 - Basic Modeling of the Costing System.

Source: Elaborated by the authors (2020).

In Figure 5, with the aid of the Astah modeling tool, the relationship diagram of the costing system modules was created, showing the links and links between the screens. Note that the MENU module (Main Screen) has connections to all screens in the system and that the other screens communicate by sharing information.

Continuing with the implementation of the system, the linking and sharing of information from each of the “CONTROL MAP” modules with “KM / VEHICLE” is done using the formulas presented in Table 5 in “KM / VEHICLE”.

Table 5 - Formulas and Links between the Control Map Modules with “KM / Vehicle”.

DESCRIPTION - LOCATION	FORMULA	EXPLANATION
A3: Item	-	-
B3: Vehicle / Brand	-	-
C3: Plate	-	-
D3: Year of Manufacture	-	-
E3: KM rotated	=1_JXW-6801!B34	Links the information in cell B34 of the “CONTROL MAP” of the vehicle code “1” in this cell.

F3: Fuel consumption per liter	=1_JXW-6801!C34	Links the information in cell C34 of the “CONTROL MAP” of the vehicle code “1” in this cell.
G3: KM rotated per liter	=IF(E3<>0;1_JXW-6801!D34;0)	Links the information in cell D34 of the “CONTROL MAP” of the vehicle code “1” in this cell, if the value of cell E3 is not null.
H3: Total - annual fuel (R \$)	=IF(F3<>0;1_JXW-6801!F34;0)	Links the information in cell F34 of the “CONTROL MAP” of the vehicle code “1” in this cell, if the value of cell F3 is not null.
I3: Total - annual with maintenance (R \$)	=IF(D3<>0;1_JXW-6801!G34;0)	Links the information in cell G34 of the “CONTROL MAP” of the vehicle code “1” in this cell, if the value of cell D3 is not null.
J3: Total - annual (R \$)	=1_JXW-6801!I34	Links the information in cell I34 of the “CONTROL MAP” of the vehicle code “1” in this cell.
K3: Average per km driven	=IF(E3<>0;1_JXW-6801!J34;0)	Links the information in cell J34 of the “CONTROL MAP” of the vehicle code “1” in this cell, if the value of cell E3 is not null.

Source: Prepared by the authors (2020).

Table 5 and Figure 6 show the registration of formulas for the first vehicle registered in the “KM / VEHICLE” module. However, the procedure carried out as other posterior cells was replicated following the same parameters in Table 5, changing only the license plate corresponding to the vehicle in the “CONTROL MAP” module.

RETURN TO MAIN MENU				DATA EXTRACTED FROM:		13/02/2020				
ITEM	VEHICLE / BRAND	VEHICLE PLATE	YEAR OF MANUFACTURE	KM ROUND	FUEL CONSUMPTION IN LITERS	KM PERFORMED BY LITERS	TOTAL - ANNUAL FUEL (R \$)	TOTAL - ANNUAL MAINTENANCE (R \$)	TOTAL - ANNUAL (R \$)	AVERAGE PER KM ROUND (ANNUAL) (R \$)
A3	B3	C3	D3	E3	F3	G3	H3	I3	J3	K3

Figure 6 - “KM / VEHICLE” module.

Source: Elaborated by the authors (2020).

Finally, all the vehicle data of the institution's fleet in its last modules were elaborated and registered, as well as all the fueled and maintenance purchased were recorded, the cost accounting concepts were

evaluated in the formulas and there is a Costing System using the method by absorption, prorating the direct costs individually by vehicle and fully operational to the Transport Coordination of this Public University.

## 5. Analysis and Results.

This research proposed the implementation of a Costing System to comply with Normative Instruction No. 3, of May 15, 2008, annex II, relating to the Performance Control and Maintenance of the Official Vehicle License of the Brazilian Public University efficiently, as well as how to make up for the lack of information on fleet operating costs. Applied to the universe of 73.68% of vehicles located at the campus headquarters in the city of Manaus / AM, it generated the following results described in Table 6:

With the implementation of the application developed in Excel, it was possible to generate strategic information about the fleet (see Table 7), in addition to the operational information seen in Tables 2 and 4;

Table 6 - Strategic results of the application of the costing system.

GENERATED INFORMATION	DESCRIPTION	LOCATION – MODULE
<b>TOTAL - ANNUAL FUEL</b>	The annual sum of amounts spent on debts; stratified by vehicle;	Column “H” - Module “KM per vehicle”.
<b>TOTAL - ANNUAL MAINTENANCE</b>	The annual sum of amounts spent on maintenance; stratified by vehicle;	Column “I” - Module “KM per vehicle”.
<b>DEPRECIATION - FIXED COST</b>	Based on the depreciation rate applied to the value of the vehicle, excluding the Residual Value; the criterion adopted was 10 years for heavy vehicles (buses, micro, truck, and tractors) and 5 years for light vehicles.	Column “L” - Module “Vehicle”.
<b>LICENSING - FEES AND INSURANCE - FIXED COST</b>	Value registered according to the network by the Traffic Agency;	Column “M” - Module “Vehicle”.
<b>TOTAL - ANNUAL (R \$) - VARIABLE COST</b>	The annual sum of amounts with expenses and maintenance;	Column “H” - Module “KM per vehicle”.

Source: Elaborated by the authors (2020).

To analyze the biggest consumers of the maintenance budget (more than 50%), and after inserting the data available in the IFE Transport sector in the "Vehicles" module, maintenance indexes were obtained for each of the vehicles that were in this cost category, using the concepts applied in Table 1 to calculate the indices.



Table 7- Application of Maintenance Indexes.

VEHICLES	QTY OF INTERVENTIONS	AVAILABLE DAYS	DAYS - IN MAINTENANCE	MTTR	MTBF	OPERATIONAL AVAILABILITY
BUS 1	16	246	119	7	15	67,4%
BUS 2	12	260	106	9	22	71,1%
MICRO-BUS 1	13	324	42	3	25	88,6%
MICRO-BUS 2	15	335	30	2	22	91,8%
BUS 3	3	350	15	5	117	95,9%
VAN-JUMPER	11	330	36	3	30	90,3%
PICAPE 1	10	301	64	6	30	82,5%
PICAPE 2	16	336	29	2	21	92,1%
PICAPE 3	21	295	70	3	14	80,8%
VAN	6	284	81	14	47	77,8%

Source: Elaborated by the authors (2020).

According to Table 7, it is noted that the heavy vehicles of the bus models 1 and 2 were the least available, with high rates of MTTR and low MTBF, indicating that the vehicle ran for a few days and was returning to the workshop with mechanical problems. Besides, it has an availability index below 70%, resulting in system idleness and excessive maintenance expenses. The maxim that every fleet manager needs to know has been ratified: the more the vehicle is in use, the lower its cost per kilometer, which directly impacts logistical activities and the effectiveness of service to the University's academic community.

## 6. Final Considerations

The concern with effectiveness in Public Administration should be the focus of every manager in conducting the budget. Therefore, one of the necessary tools to guide them in the best decisions, according to legality, is to know the control data of the managed business; after all, what is not controlled cannot be improved. In this work, it was concluded, efficiently, and free of cost, how to implement a costing system for fleet management of a Public University using tools and software that are easy to handle.

This research, which had as the main objective the implementation of a Costing System for fleet management of a public university, followed the guidelines of Normative Instruction No. 3, of May 15, 2008. It was found, at the end of the system, the full compliance with the requirements of the regulations regarding the Performance Control and Maintenance Maps for the Official Vehicle in an individualized manner, among other information on costing the fleet.

In addition, this costing system showed the actual situation in which the fleet was in the period under analysis, as it provided reliable information to managers, to be used in the institution's strategic planning, as well as in the formulation of fleet management policies. It was also possible to plan and establish studies for the implementation of fuel management and maintenance software more suitable for

management.

As noted, the System provided support to accountability to the Control Bodies, to decision making by fleet managers and to Senior Management, identified the individualized costs per vehicle, in addition to showing the situation of the fleet, including evidencing the advantages of the indexes of the system's operability. It is important to highlight that this research was applied to fleet management of a public University, however, the system proposed here can be adapted according to the reality of a specific fleet (up to 100 vehicles), just making the necessary adjustments, once that the information requested by IN 03/2008 applies to any fleet management, whether public or private.

This work was limited to the elaboration of a technical and comprehensive way of a costing system for the fleet that any manager, or user with basic knowledge in the tools proposed here, can reproduce and use in daily operations without major investments in robust software or database, since the elaboration of this research practically did not demand financial costs. It can even be developed using free software, such as LibreOffice Calc. Furthermore, as a point of improvement, a real-time web application could be created to collect this information, using the parameters adopted in this system.

As a suggestion for future studies, this application based on this fleet system may be shared with the other campuses of the Educational Institution, in order to identify vehicles that are not usable to the University or those that need to be relocated among the campuses due to idleness based on maintenance indexes. Another point to study would be the stratification of the main fleet maintenance problems on all campuses.

Given the above, it is believed that the research objectives have been achieved and, in addition to the benefits already listed, one can note the concern with the Accountability of the public service through transparency in the use of public resources and more accountability clear and efficient way to society.

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## **Analysis of realistic simulation as an educational tool in the academic and professional contexts of nursing**

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**Abstract**

*Nursing education and training based on content and technicality has undergone a process over the years mainly with the proposal of national curriculum guidelines to implement changes in the curriculum and the insertion of new teaching methodologies by educational institutions. Thus, realistic simulation is born with the proposal to actively teach students and promote the development of numerous skills and competences. **Objective:** to analyze evidence of the use and effectiveness of realistic simulation as an active method of teaching and learning in nursing in the academic and professional context. **Methodology:** Integrative review, carried out on the databases: Cochrane, ERIC, Medline, Science Direct and PubMed. The descriptors were selected based on the list of Health Sciences Descriptors - DeCS / MeSH were: Nursing, Active learning, simulation training, matching the search terms, using the Boolean operator AND. **Results:** The final sample resulted in 37 articles. It was possible to observe that the simulation helps in critical thinking, reasoning, clinical judgment, leadership, autonomy and decision-making favoring patient care and that it can be performed in different formats, such as virtual simulation, clinical case simulators, simulation with games and room simulation with simulated scenario. The introduction of this methodology in educational institutions ended up being a limitation found, in addition to the need for technologies and training for teachers. **Conclusion:** From the results of this study, it is concluded that realistic simulation is a method capable of preparing students and professionals to meet health needs.*

**Keywords:** Nursing; Active Learning; Simulation training.

## **1. Introduction**

Historically the training of health professionals has been based on traditional teaching methods with a foundation based on technicality and content. Under this perspective, the teaching-learning process for years was limited to the vertical transmission of knowledge and the fragmentation of knowledge, since the teacher assumes the role of transmitting knowledge and the student plays the role of retainer of knowledge. Thus, the student becomes limited to knowledge without developing self-confidence, curiosity and autonomy (Colares; Oliveira, 2018; Costa et al., 2020).

In this sense, higher education institutions (HEI) have been motivated to reflect and implement changes in their curriculum, so that innovative alternatives are adopted for the education and training of health professionals. Thus, the national and international scenario has also been modified over the years, implementing new methodologies such as simulation in undergraduate curricula (Fini, 2018; Costa et al., 2018).

In Brazil, the approval of Law 9.394 / 1996 of the National Education Guidelines and Bases by the process of preparing and implementing the National Curriculum Guidelines, for nursing courses in the country, urged the need to recommend the implementation of methodologies that encourage students to reflect on social reality with a focus on training a humanist, critical and reflective professional, qualified to act in health situations (Brasil, 2001).

In this context, the learning scenarios seek to associate the didactic pedagogical methods with the areas of practices and experiences. Thus, simulation appears as a teaching tool that presents itself as a methodology that reproduces fictitious situations that allows the student to play an active role in understanding and solving the problem. In the context of teaching and learning in nursing, simulation has the ability to insert the student in an environment close to what they will face in reality, in addition to integrating the complexities of practical and theoretical learning with the opportunity for repetition, feedback, evaluation and reflection of the that was carried out (Lacerda et al., 2020).

Realistic simulation (RS) has a significant relevance in the performance of students in practice scenarios, since it allows the execution of care practices in a safe environment, in which the error is acceptable without generating risks to themselves and others, in addition to defining new strategies with a view to success before being subjected to practice. Another benefit of simulation is the interconnection between fragmented content from different disciplines in a single context, enabling the articulation of content in an interdisciplinary perspective (Fonseca et al., 2020).

The fictitious situations proposed in the simulation encourage the active participation of students, favoring their technical-scientific development in an environment in which mistakes are allowed and safe. The repetition of activities also provides professional and emotional security to the student, who will feel prepared to face the challenges of professional life (Rissi et al., 2020).

Simulation-based education in nursing is about countless activities using simulators, in which they use realistic virtual environments, high-fidelity mannequins and sophisticated devices. Education with this type of active methodology gives nurses or students the development of skills and a variety of authentic situations found in the real life scenario. The advantages of simulation include providing immediate feedback, repetitive hands-on learning, the ability to adjust the level of difficulty, and adapting the student

or professional to different types of learning scenarios (Kim; Hwa; Shin, 2016).

In the current scenario of education, it is possible to note that simulation as an active teaching methodology has been spreading worldwide, so nursing teaching from the use of simulation contributes to the development of evidence, expansion of the applicability of its use and improvement of quality of professional training. In this perspective, the present study is justified in obtaining evidence regarding the effectiveness of this methodology in the training of nursing professionals.

After contextualizing the problem, some questions about the study proposal lead us to reflect the following guiding question: What evidence is found in the literature regarding the application of realistic simulation as an active methodology in the process of training and developing professional practice in nursing? Given the context evidenced above, the objective of this study is to analyze evidence of the use and effectiveness of realistic simulation as an active method of teaching and learning in nursing in the academic and professional context.

## **2. Methodological Procedures**

### **2.1 Eligibility criteria and search strategy**

In a preliminary research in the Cochrane Database of Systematic Reviews, the Joanna Briggs Institute Library of Systematic Reviews and PubMed, with research related to Realistic Simulation as an active methodology in the training process, however, the outline of objectives is different from the one proposed in this research.

The research was guided according to the recommendations of Cochrane Collaborations for the following steps: 1st. Problem formulation; 2nd. Location and selection of publications; 3rd. Evaluation of the inclusion and exclusion criteria; 4th. Data collect; 5th. Analysis and presentation of results; 6th. Interpretation of results; 7th. Writing of the scientific article (Higgins; Green, 2011).

A preliminary search was carried out on the PubMed portal to identify controlled and uncontrolled terms contained in study titles and abstracts. The searches were carried out by two reviewers independently, the search terms and strategies developed by the main reviewer were validated by peers.

After determining the objective, formulating hypotheses to be analyzed, a search for scientific material was carried out in computerized databases to identify and collect the maximum relevant research on the topic to be discussed. The search was carried out from July to September 2020 using the databases related to the health area: Cochrane, ERIC, Medline, Science Direct and PubMed.

From the search in DeCs (Health Sciences Descriptors), the descriptors included for research in all databases were: Nursing, Active learning, simulation training. The crossing of the included search terms was performed using the Boolean operator AND.

The inclusion criteria applied in this research were: studies published in the period 2015-2020, in full, in Portuguese, Spanish or English, which presented as RS the contributions of RS as an active methodology in the process of training and development of professional practice in nursing.

Publications in the format of an editorial letter, theses and dissertations, poster or did not fit the review were excluded from this study.

From these, articles were selected, with inclusion criteria and exclusion criteria established, with the objective of verifying which are adequate to the guiding question of the study. The selection of studies by title and abstracts and by complete reading was performed by the primary (E.S.C) and secondary (G.A.S.O.) reviewer independently. The studies that generated some disagreement among the reviewers regarding the inclusion were discussed with a third reviewer (F.C.M.G). In data collection, criteria were used addressing authors, year of publication, methodological design, participants and sample, objectives and main results.

## 2.2 Data analysis

The results were presented through a descriptive and exploratory analysis of the data, showing the relationship / contributions of the simulation among nursing students, teachers and nurses.

## 3. Results

In view of the initial screening, a total of 1,921 studies were identified, 312 of which were indexed simultaneously in two or more databases. In sequence, the titles and abstracts were read, which after careful analysis resulted in 96 articles to be read in full. The final sample of this study was composed of 37 articles indexed in the proposed databases (Figure 1).

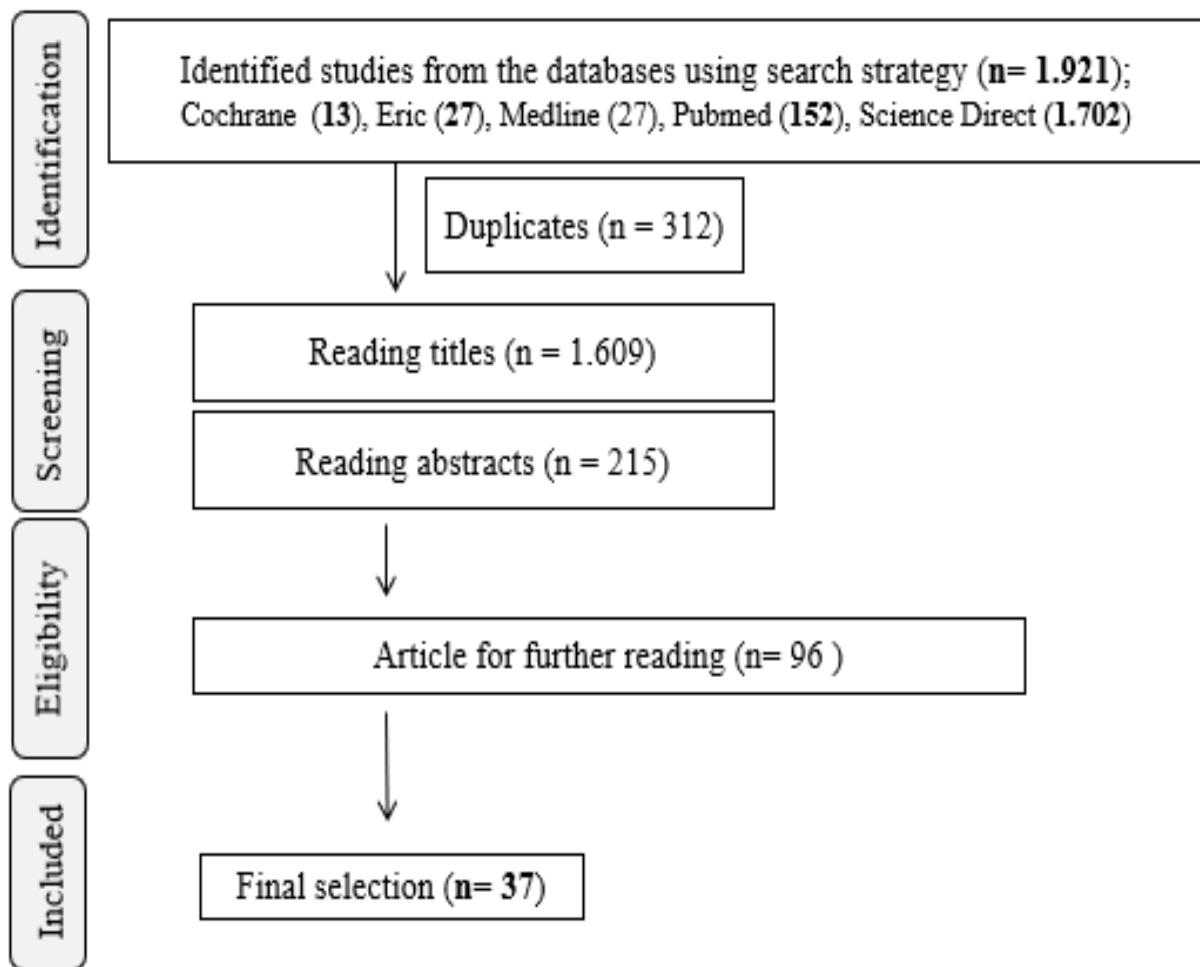


Figure 1. Flowchart of included studies.

Source: Own authorship, 2020

In analysis of the selected articles, characteristics were evaluated regarding year of publication, object of study, sample size used for the development of the research and main results. Regarding the year of publication, there is a predominance of publications in the period from 2016 to 2019, with eight articles published each year, followed by the years 2020 and 2015, with three and two articles published respectively.

The studies were carried out in nineteen different countries, including the USA ( $n = 11$ ), Australia ( $n = 4$ ), Norway ( $n = 3$ ), Spain ( $n = 2$ ), Canada ( $n = 2$ ), Portugal ( $n = 2$ ), United Kingdom ( $n = 1$ ), Italy ( $n = 1$ ), Sweden ( $n = 1$ ), Hong Kong ( $n = 1$ ), South Korea ( $n = 1$ ), Thailand ( $n = 1$ ), Iran ( $n = 1$ ), Denmark ( $n = 1$ ), Pennsylvania ( $n = 1$ ), Ethiopia ( $n = 1$ ), Turkey ( $n = 1$ ), Israel ( $n = 1$ ) and Lebanon ( $n = 1$ ). The sample used for the research of the articles included ranged from 14 to 509 participants, resulting in 4054 participants, being students, nurses and educators. In view of the analyzed articles, it was observed that twenty-six studies addressed the use of simulation in the academic context (Table 1).

Table 1. Characterization of the studies included in the academic context.

Authors / Year	Location	Study design	Participants	Main results
Agea et al., 2018	Spain	Qualitative study	30 fourth year nursing students	<ul style="list-style-type: none"> <li>Students recognized the importance of learning about ethical issues through simulations reported having a positive feeling of well-being when participating in scenarios with bioethical content.</li> </ul>
Berndt et al., 2015	Canada	Sudy does not experiment	198 nursing students	<ul style="list-style-type: none"> <li>Simulation promoted their ability to make sound clinical judgments.</li> <li>Debriefing provided opportunities for students to articulate the process of reasoning and preparing for the next scene in the simulation scenario.</li> </ul>
Bland; Tobbell, 2015	United Kingdom	Qualitative study	31 nursing students	<p>Video data allows for more dynamic data, particularly because they capture social interaction and evidence of activity in the context inherent in simulation-based learning</p> <p>The simulation facilitates the preparation for clinical rotations to maximize the experiences. The faculty's feedback indicates that the simulation is a method to guarantee the standardization of experiences. students are better prepared for clinical practice and function more independently than students who have not experienced this standardized clinical simulation structure</p>
Calohan et al., 2016	USA	Experimental study	15 nursing students	<p>Most students reported that learning through simulation cases was useful and beneficial. Teachers must be well trained to implement clinical simulation. The importance of integrating theory into practice, as well as learning from your mistakes, improves classroom learning. Peer teaching strategies can help overcome barriers to facilitate large cohorts and increase involvement.</p>
Alconero-Camarero et al., 2016	Spain	Mixed, quantitative and qualitative study	150 nursing students	<p>Students reported high satisfaction and self-confidence after exposure to the simulation experience conducted by a student with a medium level of fidelity.</p> <p>Medium level fidelity equipment is economical and can result in high levels of student satisfaction and self-confidence</p>
Curtis et al., 2016	Australia	Descriptive exploratory study	637 second and third year students of the Bachelor of Nursing	<p>Active learning with standardized patient scenarios increases self-confidence in the nursing skills learned; The use of the standardized patient simulation program adds to the real-world human</p>
Donovan; Mullen, 2019	USA	Quantitative research	160 nursing	



students

interaction experience

Simulation laboratories with an active learning model boost the retention of new knowledge by the student nurse.

Table 1. Characterization of the studies included in the academic context (continued).

Authors / Year	Location	Study design	Participants	Main results
Dubovi; Levy; Dagan, 2017	Israel	Study Quasi- experimental	104 nursing students	A positive correlation was found between the sense of presence and learning. Improving students' sense of control in virtual reality can improve the learning process. Virtual reality can bridge the gap between theory and practice in higher education.
Fawaz; Mansour, 2016	Lebanon	Study Quasi- experimental	56 nursing students	The high-fidelity simulation experience was useful in the development of clinical judgment, helping students to perceive, interpret, respond, reflect and make decisions. High-fidelity simulation enabled a safety training culture.
Griffiths, 2018	USA	Experimental study	205 nursing students	The students agreed that the scenario resembled real life and that the necessary supplies were available Instructor feedback was helpful for enhanced learning reflection and post-simulation summary.
Kaplan; Murihead; Zhang, 2017	USA	Post-test study	23 nursing students	The simulation increased the understanding of pathophysiology, communication with the health professional, the ability to think critically and challenge their decision-making skills. Student simulation experiences carried out in situ can leverage clinical partnerships.
Karlsen et al., 2017	Norway	Qualitative, exploratory and descriptive study	14 nursing students	Communication skills and their interaction with patients were evident. The use of standardized patients was seen as positive, giving a more realistic scenario, than acting against another student.
Lillekroken, 2019	Norway	Qualitative exploratory	150 nursing students	<ul style="list-style-type: none"> <li>The theoretical basis gained from their preparations helped them to reflect on how theory could be linked to practice.</li> </ul>
Opsahl et al., 2019	USA	Descriptive study	173 nursing students	Students stressed that the event's realism enhanced the learning experience. Most students pointed out positive aspects of having resident nurses present.

Omer, 2016	Hong Kong	Qualitative, exploratory and descriptive study	117 nursing students	The results indicated general satisfaction with the clinical simulation experience. The data indicated high levels of self-confidence being built after the clinical simulation experience.
Padilha et al., 2018	Portugal	Qualitative, exploratory and descriptive study	426 nursing students	They pointed out greater ease, usefulness and willingness to use the virtual clinical simulator on an interactive table, in class and in a web application outside of class. Younger participants are more prepared and willing to use virtual technology.

Table 1. Characterization of the studies included in the academic context (continued).

Authors / Year	Location	Study design	Participants	Main results
Park et al., 2017	South Korea	Prospective study	69 nursing students	Increase disposition of critical thinking, and motivation to learn. The simulation was useful for integrating knowledge and skill.
Riley-Baker et al., 2020	USA	Descriptive study	253 nursing students	The simulation provides a safe and controlled environment for training nursing students. Among the four skill sets, students were more likely to achieve communication skills. Students' skills improved as the case evolved through the three care environments sequenced over time.
Rubbi et al., 2016	Italy	Prospective observational study	51 nursing students	It provided active learning by increasing levels of self-confidence, psychomotor and affective skills.
Samosorn et al., 2019	USA	Quasi-experimental study before and after test	21 nursing students	Students and teachers felt well immersed in virtual environments. Lessons learned can be reinforced on a traditional simulation dummy basis and real-world clinical settings. The intervention was widely accepted by students and teachers, showed a high level of virtual presence, absence of cybersickness and statistically and practically significant knowledge gains.
Unver et al., 2018	Turkey	Quasi-experimental study	69 nursing students	<ul style="list-style-type: none"> <li>Improvement in critical thinking, decision-making skills and self-confidence before clinical activity.</li> </ul>

Valen et al., 2019	Norway	Qualitative exploratory study	55 nursing students	The participants reported that the simulation contributed to the participants' experience that influenced their knowledge, skills and attitudes. Debriefing made participants feel safer and more confident in practice.
Verkuyl et al., 2017	Canada	Experimental study	500 nursing students	<ul style="list-style-type: none"> <li>Virtual simulation provided students with opportunities for theoretical and practical integration.</li> </ul>
Wang; Etrini, 2018	Thailand	Quasi- experimental study	104 nursing students	Collaborative practice in patient care settings has increased mutual understanding and improved attitudes towards teamwork. The performance gaps in the student team were notable. Team performance gaps imply that more preparation is needed to support student learning.

Table 1. Characterization of the studies included in the academic context (conclusion).

Authors / Year	Location	Study design	Participants	Main results
Webster; Carlson, 2019	Sweden	Descriptive observational study	100 nursing students	He results in relation to teaching to establish therapeutic relationships as a patient positive. Relation to the fusion of theory and practice for the development of therapeutic relationships, the responses indicated that simulation is a highly potent pedagogical method.
Zarifsanaiey; Amini; Saadat, 2016	Iran	Quasi- experimental study	40 nursing students	Scores on thinking and communication have been improved. Integrated training (simulation and critical thinking strategies), compared to simulation training, improves student performance

**Source:** Own authorship, 2020.

The research covered academics of different years. The studies that evaluated the use of simulation as a learning tool in the training of students mainly measured reasoning skills and clinical judgment (Berndt et al., 2015; Fawaz; Mansour, 2016), self-confidence (Curtis et al., 2016; Omer, 2016; Rubbi et al., 2016; UNVER et al., 2018; VALEN et al., 2019), critical thinking (Kaplan; Murihead; Zhang, 2017; PARK et al., 2017; Unver et al., 2018; Zarifsanaiey; Amini; Saadat, 2016), decision making (Fawaz; Mansour, 2016; Kaplan; Murihead; Zhang, 2017; Unver et al., 2018), communication skills (Riley-Baker et al., 2020; Zarifsanaiey; Amini ; Saadat, 2016) and Teamwork (Wang; Etrini, 2018).

Through the analysis of the research, it is also observed that the application of the simulation was carried out in various ways, such as the use of virtual reality (Dubovi; Levy; Dagan, 2017; Samosorn et al., 2019; Verkuyl et al., 2017), virtual simulators with clinical cases (Padilha et al., 2018), high-fidelity simulation (Valen et al., 2019) and simulation mannequins (Samosorn et al., 2019).

In the professional context, eleven articles were included in the research (Table 2), the articles approached the use of simulation encompassing nursing assistants and nurses working in teaching, focusing on the development and improvement of professional skills (Table 2).

Most surveys were carried out in countries in America (45.5%), followed by Oceania (27.2%), Europe (18.2%) and Africa (9.1%). The main results direct contributions to professional practice, especially with regard to care security (Bailey; Mixer, 2018; Boje et al., 2017; Turkelson; Keizer, 2020), increased knowledge (BLISS; AITKEN, 2018; Starodub et al., 2020) and Trust (Boyde et al., 2018; O'leary; Nash; Lewis, 2015).

Table 2. Characterization of studies included in the professional context.

Authors / Year	Location	Study design	Participants	Main results
Bailey; Mixer, 2018	USA	Descriptive exploratory study	10 nurses	The participants showed more security when performing the simulation and described that the more realistic the simulation, the better the performance in practice. In addition, the program contributed to clinical competence and therefore patient safety.
Bliss; Aitken, 2018	Australia	Qualitative exploratory study	8 nurses	<ul style="list-style-type: none"> <li>All participants reported that the simulation improved their knowledge and realized that they could transfer knowledge and skills to the practice environment. Simulation realism was an important factor in retaining information.</li> </ul>
Boling et al., 2017	USA	Descriptive exploratory study	100 nurses	<p>Participants reported that simulation is important for their learning, and participation was more beneficial than a lecture on the topic.</p> <ul style="list-style-type: none"> <li>Custom scenarios are delay to create, but can be more valuable than inventory scenarios.</li> </ul>
Boje et al., 2017	Denmark	Observatory and descriptive study	33 nurses educators	<ul style="list-style-type: none"> <li>Significant increase in confidence through simulation. A definite barrier to the effective simulation identified was time.</li> </ul>
Boyde et al., 2018	Australia	Quasi-experimental study	50 nurses	<ul style="list-style-type: none"> <li>The results support the positive simulation learning experience about anxiety, self-efficacy in clinical performance, satisfaction and self-confidence in learning and clinical improvement.</li> </ul>
O'leary; Nash; Lewis, 2015	Australia	Quasi-experimental study	30 pediatric intensive care nurses	<p>Participants demonstrated significant increases in knowledge scores after learning by having greatest gains in items related to trust.</p> <ul style="list-style-type: none"> <li>The simulation increases the self-efficacy of pediatric intensive care nurses, improves knowledge retention compared to standard instruction.</li> </ul>
Padilha et al., 2020	Portugal	Cross-sectional study	131 emergency nurses	<p>Emergency nurses perceive virtual clinical simulation as an important complementary strategy in their lifelong learning.</p> <p>Average perceived ease of using CVS of 9.03, perceived utility of 9.14 and an intention to use CVS in lifelong learning of 8.85.</p>

Recznik et al.,  
2019

Pennsylvania

Randomized study

25 nurses

All participants had a satisfactory improvement in screening.

The groups were not significantly different from each other, there seems to be an educational advantage for either method.

▪

Table 2. Characterization of the studies included in the professional context (conclusion).

Authors / Year	Location	Study design	Participants	Main results
Starodub et al., 2020	USA	Randomized study	52 nurses	Simulation-trained professionals benefit from retaining their knowledge of target temperature management for longer. The simulation resulted in an immediate improvement in the target temperature management skills and the participants in the simulation group were more satisfied with the training.
Teni; Gebretensaye, 2019	Ethiopia	Quantitative and qualitative descriptive	99 nurses	Professionals trained in simulation benefit by maintaining 83.8% agreed that clinical simulation improves students' knowledge, skill, critical thinking and confidence. Nursing educators with bachelor's degrees showed better knowledge than those who have a master's degree.
Turkelson; Keiser, 2017	USA	Quasi-experimental study	26 nurses	<ul style="list-style-type: none"> <li>▪ Better adherence to critical care processes and reduced errors in patient management in simulations as well as real patient events.</li> </ul>

**Source:** Own authorship, 2020.

▪



## **4. Discussion**

In view of the use of realistic simulation as an educational tool, studies that met the inclusion criteria were more frequent in the academic context than in the professional context, with a predominance of publications in the period from 2016 to 2019.

The National Curricular Guidelines for the Nursing course highlight the need and importance of training health professionals with the acquisition of competence for decision-making, critical thinking, based on practical knowledge capable of evaluating appropriate behaviors in face of their reality. In this context, from the analysis of the articles, it is observed that the RS as an educational tool provides the acquisition and development of innumerable competences and skills necessary for students and nurses in addition to psychomotor and affective contributions among the participants, improving the assistance and effectiveness of the care provided.

Regarding the benefit of the simulation, it is possible to observe in three studies that the realism of the simulation was a highly relevant factor for better information retention and that the more real the simulation scenario, the similarity with the practice becomes even closer (Nopsahl et al., 2019; Griffiths, 2018; Bailey; Mixer, 2018; Bliss; Aitken, 2018).

The use of virtual clinical simulation has relevant potential to improve practice in teaching and learning by both students and nurses. It is noteworthy that the use of virtual simulation with technological innovation, obtained a favorable acceptance by most professionals, being a pedagogical method that allows the obtaining of different dynamic scenarios that favors clinical reasoning. In addition, the articles list that virtual simulation provides greater utility and ease, since it allows the presence and realization on virtual platforms on the internet, bringing more comfort and convenience to participants in any location (Padilha et al., 2020; Padilha et al., 2018).

The RS environment is controlled, so it is possible to avoid exposing patients to risk situations resulting from inexperience by Nursing students. In this way, students are able to think critically about what has been accomplished by learning from their mistakes, making it possible to adopt safer behaviors and strategies aimed at patient safety (Bailey; Mixer, 2018; Alconero-Camarero et al., 2016).

Videos are also part of the learning process along with methodologies such as simulation, thus bringing several cases of patients to class. Thus, students can apply whatever content was learned in class by increasing clinical reasoning. Results of a study in which the participants received video training and high-fidelity simulation, it was possible to observe that they obtained better scores of psychomotor skills after the intervention when compared to the participants who received training by video lecture (Starodub et al., 2020; Powers, 2020).

In some studies, it was possible to observe that participants of a younger age group are more prepared and willing to use virtual technology. Another study that addressed virtual simulation among educators showed that nursing educators with a bachelor's degree obtained adherence and greater ease compared to those who have a master's degree. This may be due to those who have a bachelor's degree being recently graduated with greater ease and better acceptance to understand and use the teaching methodology (Padilha et al., 2018; Teni, Gebretensaye, 2019).

As most of the articles analyzed, it is possible to show that there is an increase in confidence and greater engagement of students and nurses in relation to their conduct, since the various scenarios promoted by the simulated environment are capable of reproducing some situations experienced in real life assistance that often become impossible in clinical practice during graduation (Valen et al., 2019; Donovan, Mullen, 2019; Unver et al., 2018; Curtis et al., 2016; Omer, 2016; Rubbi et al., 2016; Teni, Gebretensaye, 2019; Boyde et al., 2018; Boje et al., 2017; O'leary; Nash; Lewis, 2015).

The acquisition of skills and values through RS is evidenced by the development of attributes related to the cognitive field, psychomotor, affective and communication activities that provided the development of more human aspects and therapeutic relationships in care, allowing greater proximity and interaction with patients (Rubbi et al., 2016; Karlsen et al., 2017; Agea et al., 2018; Webster; Carlson, 2019).

From this perspective, Doolen and contributors (2014) states that the simulation reinforces the idea of acquiring appropriate strategies to face psychological issues such as communicating bad news to patients at the end of their lives, as well as communicating with patients with depression, schizophrenia and anxiety. It is noteworthy that problem-based learning (PBL) helps in personal interpretation based on a problem, thus strengthening the learning processes and ability to solve the problem, in addition to understanding the performance scenario with group discussion, improving the relationship with the integration of ideas in different aspects of the case (Zarifsanaiey; Amini; Saadat, 2016).

It was observed in some articles that simulation is seen as a vehicle for the development of critical thinking and clinical reasoning, promoting greater effectiveness in care. This justification is also supported by a study in which it states that a simulated situation allows students to think more actively than passively, facilitating the development of critical thinking and decision making (Teni; Gebretensaye, 2019; Padilha et al., 2020, Park et al., 2017; Bento, 2014).

After the moment of the simulation, the debriefing takes place, which becomes a moment of great relevance, since through it is possible to list the positive points and actions that were not carried out, in addition to solving doubts about the behaviors taken by the student. After evaluating some articles, it is possible to notice that debriefing provided opportunities to articulate the reasoning process and preparation for the next simulation scenario, anticipating the potential complications of the patient and the desired results. It is worth mentioning that this moment also leads the student to develop new models of thinking and feedback on theoretical and practical knowledge (Berndt et al., 2015; Alconero-Camarero et al., 2016; Vallen et al., 2019).

In contrast to the advantages offered by the use of simulation, limitations are reported mainly regarding the implementation of the method in undergraduate nursing courses and inadequate planning for the implementation of the method. In research by Padilha et al. (2018) and Boje et al. (2017), there was a need to have more time to carry out the proposed interventions. This information is justified in another study that lists the need for highly sophisticated technologies, training for teachers involved in simulation, continued preservation of materials since they have a high degree for institutions (Pereira, 2017).

With this study, some educational tools essential for maintaining the simulation inserted in the teaching-learning process can be added, given the andragogy. Andragogy is defined as a teaching strategy for adults in which it starts from the premise of emancipating the student so that he develops autonomy and builds self-directed learning. Thus, the teacher moves away from the vertical model of teaching by approaching

and integrating teaching strategies such as simulation since these two methodologies are based on real life experiences (Moura, 2013).

Andragogy can be combined with different teaching-learning theories. It is worth mentioning that this method needs to be reassessed for each situation, as it is not an ideology, but a system of elements. In addition, it is up to the educator to evaluate the best way to apply the model in each scenario (Andrade, 2015; Waxman, 2010).

The relevance of this method for the learning of students and nurses is noticeable, however, little research has been found on the use of this learning method in nursing.

## **5. Conclusion**

The present study analyzed the evidence of the use and effectiveness of realistic simulation as an active teaching method of teaching and learning in nursing, in addition to contributions to the process of training and development of professional practice in nursing. Given the studied scenario, it can be seen that several articles address simulation as a methodology that allows students to acquire competence, skills, autonomy, leadership, confidence, security and association with various disciplines, integrating theory with practice and inserting students and nurses in environments that simulate the reality of care, improving clinical reasoning and critical judgment for decision making.

Taking into account the aspects related to the debriefing that is carried out after the simulation scenario with the teacher / instructor, it is well known that this moment provides an opportunity to articulate the reasoning process, evaluating the mistakes made and correcting them in order to avoid them during the assistance in reality with the patient.

It is worth considering that the RS makes it possible to build new ways of carrying out health training, surpassing traditional teaching models. On the other hand, there are several limitations to its applicability, since despite presenting high fidelity in the scenario with the programming for the reproduction of clinical signs, the simulator does not foresee complications seen in practice resulting from the action performed by the student.

In view of the aspects mentioned above, other limitations of the RS can be highlighted, given the need for highly sophisticated investment requiring allocation of large financial resources by the institution. In addition, the application of a simulation center requires professionals, in this case teachers / instructors trained to command software, robots and others. Therefore, it is necessary to invest in the training of this instructor in courses, considering that it is a relatively new strategy and that needs to be updated in order for it to happen effectively, ensuring the robustness of the teaching-learning process.

From the reflections presented, it was found that RS is a potentially transforming teaching method in the training context in nursing, preparing students and nurses so that they meet the different health needs and transform the realities to which they are inserted.

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# **Entrepreneurship, intellectual property and innovation ecosystems**

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## **Abstract**

*This research aims to determine the relationship between entrepreneurship, intellectual property and innovation ecosystems at a global level. To assess the structural relationships between ecosystems, the unconditional quantile regressions using annual country data are estimated from two perspectives, namely: pooled data and data with fixed effects and time control. The Global Entrepreneurship Index (GEI), the US Chamber International IP Index (IPI) and the Global Innovation Index (GII) are used as a proxy for the entrepreneurship, intellectual property and innovation ecosystem, respectively. The results indicate that the entrepreneurship and intellectual property ecosystems has a causal relationship with the global innovation ecosystem. However, when control of individual and fixed time effects is included, the relationship between ecosystems is confirmed in just a few quantiles. The sterile results require efforts from public, private and other agents to improve the performance of ecosystems, especially to increase the generation of innovative assets. This study looks at ecosystems from a different perspective, and the results are relevant to policymakers looking to improve the ecosystems of entrepreneurship, intellectual property and innovation. The originality of this article lies in bringing together issues that are generally dealt with in theoretical and empirical literature in separate domains. The study of the relationship between ecosystems from global indexes remains a little explored field, despite the various alternative approaches already investigated.*

**Keywords** Entrepreneurship, Intellectual property, Innovation, Innovation Input, Innovation Output, Entrepreneurship Ecosystem, Intellectual property Ecosystem, Innovation Ecosystem, Global Entrepreneurship Index (GEI), the US Chamber International IP Index (IPI), Global Innovation Index (GII), Quantile regression.

## **1. Introduction**

Schumpeter (1934) was the theoretical precursor who pointed out the relationship between entrepreneurship and innovation, especially as these categories determine growth and economic

development. He advocated that innovative processes are generated by the entrepreneur, who has a high perceptive and creative capacity. Schumpeter (1934) also explains that the entrepreneur is responsible for creative destruction, which dynamizes capitalism by introducing technological innovations, spontaneously and discontinuously changing the channels of the conventional circular flow of the economy. The performance of the entrepreneur with his innovations is seen as a force that promotes and stimulates economic development.

However, although he did not explicitly discuss intellectual property rights, Schumpeter (1934) dealt with the extraordinary profit resulting from innovations introduced into the economy, which he saw as a reward paid by consumers to innovative entrepreneurs. He characterized extraordinary profits as fleeting gains, which tend to disappear as new competitors start to copy and spread innovation in the economy.

Intellectual property rights, structured from the mid-20th century and the beginning of the 21st century by the United States and advanced industrialized countries (Baker *et al.*, 2017), have the principle of ensuring that those responsible for intellectual production (inventors and authors) have the right to obtain a reward for their innovative creations. Intellectual property reinforces, formally and legally, the possibility of generating extraordinary profit according to Schumpeter (1934) through the right to exclusive production for a certain period.

Entrepreneurship, intellectual property and innovation are categories that include the participation of various economic actors that can articulate, within an institutional environment, to undertake, produce, protect and commercialize innovative assets. The protection of intellectual property plays a fundamental role in this process, constituting the strategy adopted by companies and countries, as a mechanism for economic appropriation by the innovative entrepreneurial effort.

In the scientific field, the phenomenon of entrepreneurship, intellectual property and innovation are investigated in the light of the theory of intellectual capital. Entrepreneurship is directly linked to human capital and reflects the creative capacity and skills of individuals (Yang and Lin, 2009; Luo *et al.*, 2009; Doong *et al.*, 2011; Ramezan, 2011; Secundo *et al.*, 2018; Martin-Sardesi and Guthrie, 2018). Intellectual property and innovation are examples of relevant components of structural capital, which are associated with intangible elements of organizational culture and the ability to generate technological assets (Bukh *et al.*, 2001; Burr and Girardi, 2002; Ramezan, 2011; Orlando *et al.*, 2020).

Entrepreneurship, intellectual property and innovation are also discussed based on a holistically conception, whose main characteristic is systemic research. Moore (1996) contributes theoretically to the existence of the innovation ecosystem by identifying and encompassing all economic agents in a mutually interacting relationship network.

The concept of innovation ecosystem is adapted to support the discussion on entrepreneurship ecosystems (Ács and Szerb, 2009; Ács *et al.*, 2009; Ács and Szerb, 2012; Acs *et al.*, 2013), and ecosystem intellectual property (Pugatch *et al.*, 2012; 2014; 2015; 2016; 2017; 2018; Kaplan and Beall, 2017; Pugatch *et al.*, 2017; 2018; Pugatch and Torstensson, 2019; 2020). The applied scientific literature presents a variety of methodologies that seek to measure ecosystems through composite indicators which make it possible to combine multiple dimensions of a given quantifiable reality.

Cornell University, the European Institute of Business Administration (INSEAD) and the World Intellectual Property Organization (WIPO) devised the The Global Innovation Index (GII) in 2007, whose objective was to apply metrics to measure the different dimensions of innovation annually in many countries. In 2019 the GII was calculated for 129 nations. The methodology measures five large areas designed to monitor inputs (Institutions; Human Resources and Research; Infrastructure; Market Sophistication; Business Sophistication) that define aspects of the environment

favorable to innovation within an economy, and two large areas designed to monitor outputs (Knowledge and Technology Products; Creative Products).

In 2011, the Global Entrepreneurship Network (GEN) developed The Global Entrepreneurship Index (GEI), which annually measures the entrepreneurship ecosystems of several countries. In 2019, the GEI was calculated for 137 countries. The methodology uses 14 sub-areas that support the three major areas (Entrepreneurial Attitudes, Entrepreneurial Abilities and Entrepreneurial Aspirations).

In 2012, the U.S. Chamber of Commerce's Global Innovation Policy Center (GIPC) created the U.S. Chamber International IP Index (IPI), which measures the performance of countries' intellectual property ecosystems. In 2019, the index monitored 50 countries across eight specific categories in the intellectual property environment (Patents; Copyrights; Trademarks; Trade Secrets; IP Asset Marketing; Application; Systemic Efficiency; Affiliation and Ratification of International Treaties).

Through specific statistical techniques, these surveys seek to synthesize a varied and complex set of data and information about a given reality to provide a multidisciplinary and, therefore, more comprehensive view.

The problem, however, is that the methodologies used to measure ecosystems (GEI, IPI and GII) are not evaluated from a perspective of cause and effect among their component parts, especially between ecosystems. They only synthesize a final result of the status quo of entrepreneurship, intellectual property and innovation in several countries, based on the categories of variables mapped annually.

The objective of this research is to determine the relationship between entrepreneurship, intellectual property and innovation ecosystems at a global level. To assess the structural relationships between ecosystems, this work estimates unconditional quantile regressions using a panel with annual country data. GEI, IPI and GII are used as a proxy for the entrepreneurship, intellectual property and innovation ecosystems, respectively. This study analyzes ecosystems based on global indexes, and the results are relevant for policy makers looking to improve entrepreneurship, intellectual property and innovation in countries.

## **2. Entrepreneurship, Intellectual Property and Innovation Ecosystems**

Ács and Szerb (2009), Ács *et al.* (2009), Ács and Szerb (2012), Ács *et al.* (2013), Ács *et al.* (2014) and Szerb *et al.* (2018) define the entrepreneurship ecosystem as a complex collaborative network of systems and subsystems that interact dynamically where individuals incorporate attitudes, skills and aspirations in search of innovative ventures. However, this entrepreneurship ecosystem is restricted to observing the behavioral phenomena of entrepreneurial activity, such as attitudes, skills and aspirations, which are the driving forces of capacity and the search for the generation of innovations.

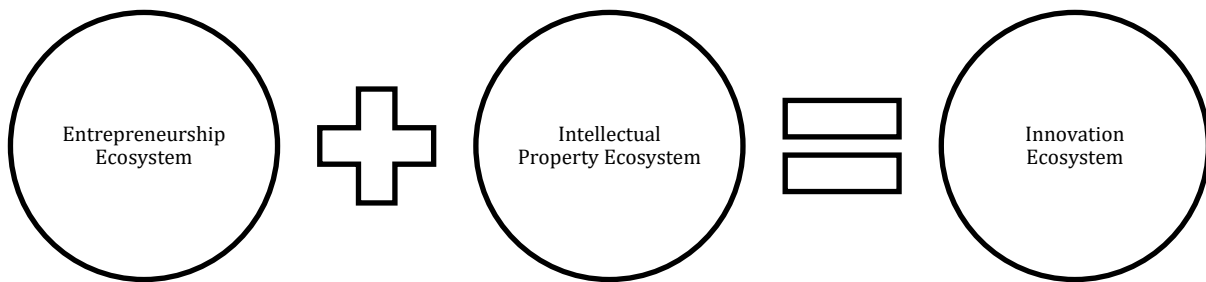
The intellectual property ecosystem functions as a network of relationships between government, business and institutional actors that interact dynamically to provide protection for the intellectual assets generated by entrepreneurs who wish to innovate.

The innovation ecosystem also consists of a relationship network in which all economic agents interact with each other (Moore, 1996). In principle, the innovation ecosystem operates with the objective of gathering the necessary inputs for innovation, combining them in order to generate and materialize new goods, processes, services, among other innovative assets.

It is essential to note that the entrepreneurship ecosystem brings together important elements for momentum, capacity and the creative inspiration of the innovation ecosystem. It is assumed that

the intellectual property ecosystem also influences the entrepreneurship and innovation ecosystems, objectively interfering in the strategies and stimulating individuals and organizations have to undertake and innovate.

These three ecosystems function through strong channels of connection (Figure 1), the entrepreneurship and intellectual property ecosystem being relevant inputs for the concrete generation of technological innovations. When identifying market opportunities, they seek to develop their ideas and protect them to start their businesses, in search of economic gains from innovative activity.



**Figure 1.** Concept of the relationship between entrepreneurship, intellectual property and innovation ecosystems

Source: Authors' own (2020)

The functioning of the entrepreneurship, intellectual property and innovation ecosystem is complex and regulated by a series of structural conditions (market, physical and human capital, institutions, the State, among others). The theoretical purpose of ecosystems is to operate and allocate available resources (tangible and intangible) efficiently, providing conditions for the agents involved to innovate. However, it is a process that does not generate automatic results, especially when one wants to observe the materialization of innovation in technological assets.

## 2.1 Global Indices

The concept developed in Figure 1, about the ecosystems of entrepreneurship, intellectual property and innovation, constitutes an important guideline that can be measured from several perspectives. As it is a relevant topic for global economic and social growth and development, several agencies have endeavored to produce a portrait of these ecosystems separately.

The GEI comprises a combination of multiple dimensions of the entrepreneurial ecosystem and classifies the data in three main areas: attitudes, skills and aspirations, as shown in Table 1. Ács *et al.* (2013) reveal that positive attitudes are understood as necessary for individuals. Competent

people choose entrepreneurship over alternative occupations, skills reflect the capacity and quality of new ventures, and aspirations reflect the potential of startups to achieve internationalization, rapid growth and high productivity.

**Table 1.** Composition of the GEI

Global Entrepreneurship Index	Sub-index	Pillars	Variables
	Attitudes Sub-index	Opportunity Perception	<i>Opportunity Recognition</i>
			<i>Freedom (Economic Freedom*Property Rights)</i>
		Start-up Skills	<i>Skill Perception</i>
			<i>Education (Tertiary Education*Quality of Education)</i>
		Risk Acceptance	<i>Risk Perception</i>
			<i>Country Risk</i>
		Networking	<i>Know Entrepreneurs</i>
			<i>Agglomeration (Urbanisation*Infrastructure)</i>



		Cultural Support	Career Status
			Corruption
	Abilities Sub-index	Opportunity Start-up	Opportunity Motivation
			Governance (taxation*Good Governance)
		Technology Absorption	Technology Level
			Technology Absorption
		Human Capital	Educational Level
			Labour Market (Staff Training*Labour Freedom)
		Competition	Competitors
			Competitiveness (Market Dominance*Regulation)
	Aspiration Sub-index	Product Innovation	New Product
			Tech Transfer
			New Technology
		Process Innovation	Science (Gerd*(Average Quality of Scientific Institutions + Availability of Scientists and Engineers))
			Gazelle
		High Growth	Finance and Strategy (Venture Capital*Business Sophistication)
			Export
		Internationalisation	Economic Complexity
			Informal Investment
		Risk Capital	Depth of Capital Market

Source: GEI (2017).

The GEI index and sub-indices are quantitative measures ranging from 0 to 100. The higher the score, the more developed the entrepreneurship ecosystem. It is reasonable to assume that, in the business environment, higher levels of attitudes and more skills qualify individuals to have more aspirations (Reis *et al.*, 2019). Therefore, it is assumed that entrepreneurial attitudes and entrepreneurial skills provide the strength for entrepreneurs to realize their aspirations for innovation.

Lagrost *et al.* (2010) set out to identify an appropriate method for evaluating intellectual property, providing useful guidance. However, the intellectual property ecosystem model proposed by Pugatch *et al.* (2018) allows countries to be evaluated from different perspectives. Table 2 provides a detailed view of the intellectual property ecosystem. The concept of an intellectual property ecosystem is evident when considering that its legal architecture may change due to the influence of economic, governmental, institutional and social actors, who interact with each other. As it evolves, the intellectual property ecosystem becomes more or less restrictive, objectively interfering in the strategies and stimulus that individuals and organizations have to undertake and innovate. The cumulative score of the IPI index ranges from a minimum of 0 to a maximum of 40. The indicators are scored using three different methods: binary, numeric and mixed.

**Table 2.** Composition of the IPI

	Pillar	Variables	
IPI	Patents, Related Rights, and Limitations	Patent term of protection	
		Patentability requirements	
		Patentability of computer-implemented inventions	
		Pharmaceutical-related patent enforcement and resolution mechanism	
		Legislative criteria and active use of compulsory licensing of patented products and technologies	
		Patent term restoration for pharmaceutical products	
		Membership in Patent Prosecution Highways (PPHs)	
		Patent opposition	
		Copyright (and related rights) term of protection	
	Copyrights, Related Rights, and Limitations	Legal measures that provide necessary exclusive rights that prevent infringement of copyrights and related rights (including Web hosting, streaming, and linking)	
		Expedition injunctive-style relief and disabling of infringing content online	
		Availability of frameworks that promote cooperative action against online piracy	
		Scope of limitations and exceptions to copyrights and related rights	
		Digital rights management legislation	



		Clear implementation of policies and guidelines requiring that any proprietary software used on government ICT systems should be licensed software
	Trademarks, Related Rights, and Limitations	Trademarks' term of protection (renewal periods)
		Ability of trademark owners to protect their trademarks: requisites for protection
		Legal measures that provide necessary exclusive rights to redress unauthorized uses of trademarks
		Availability of frameworks that promote action against the online sale of counterfeit goods
		Industrial design term of protection
		Legal measures that provide necessary exclusive rights to redress unauthorized use of industrial design rights
	Trade Secrets and Related Rights	Protection of trade secrets
		Regulatory data protection (RDP) term
	Commercialization of IP Assets	Barriers to market access
		Regulatory and administrative barriers to the commercialization of IP assets
		IP as an economic asset
	Enforcement	Physical counterfeiting rates
		Software piracy rates
		Civil and procedural remedies
		Pre-established damages and/or mechanisms for determining the number of damages generated by the infringement
		Criminal standards including minimum imprisonment and minimum fines
		Effective border measures
		Transparency and public reporting by customs authorities of trade-related IP infringement
	Systemic Efficiency	Coordination of IP rights enforcement efforts
		Consultation with stakeholders during IP policy formation
		Educational campaigns and awareness-raising
	Membership in and Ratification of International Treaties	WIPO Internet Treaties
		Singapore Treaty on the Law of Trademarks
		Patent Law Treaty
		At least one free trade agreement with substantive and/or specific IP provisions such as chapters on IP and separate provisions on IP rights provided it was signed after WTO/TRIPS membership

Source: Authors' own, based on GIPC (2018).

Regarding the innovation ecosystem, Saisana *et al.* (2017) state that the GII tracks innovation inputs, related to a favorable innovation environment (Institutions; Human Resources and Research; Infrastructure; Market Sophistication and Sophistication of Business) and outputs, defined as results of innovation (Technological and Knowledge Base Products; Creative Products), according to Table 3.

It is essential to highlight that innovation outputs mean the materialization of innovation and intellectual property in the economy, as they include, for example: patent deposits by residents in the national office; patent deposits filed internationally through the PCT; utility models deposited by residents in the national office; scientific and technical articles published in journals; trademarks registered by residents in the national office; industrial projects included in applications in a regional or national office; calculates the export of cultural and creative services, as a percentage of total trade; measurement of the number of national films per capita produced in a given country, among other aspects.

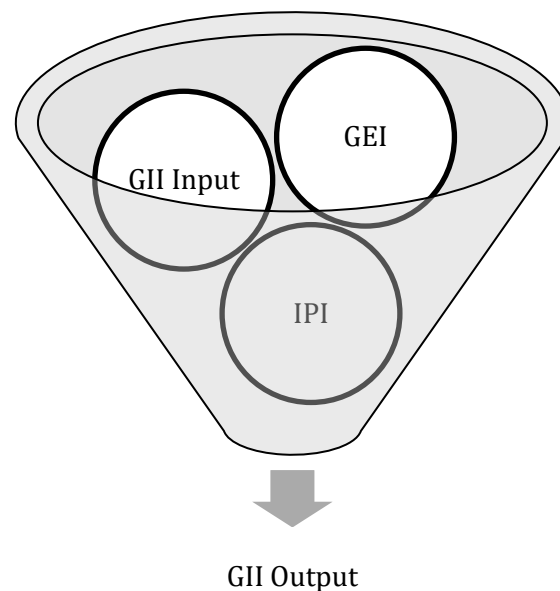
**Table 3.** Composition of the GII

GII	Sub-index	Pillars	Area
Global Innovation Index	Innovation Input	Institutions	Political environment
			Regulatory environment
			Business environment
		Human capital and research	Education
			Tertiary education
			Research & Development
		Infrastructure	ICTs
			General infrastructure
			Ecological sustainability
		Market sophistication	Credit
			Investment
			Trade, competition, & market scale
		Business sophistication	Knowledge workers
			Innovation linkages
			Knowledge absorption
	Innovation Output	Knowledge and technology outputs	Knowledge creation
			Knowledge impact
			Knowledge diffusion
		Creative outputs	Intangible assets
			Creative goods and services
			Online creativity

Source: Authors' own (2020), based in Saisana *et al.* (2017).

The GII index and sub-indices are quantitative measures ranging from 0 to 100. The higher the score, the more developed the innovation ecosystem. It is logical to assume that the higher the levels of innovation inputs, the greater the innovation products may be. These sub-indices are based on the input-output model.

Figure 2 illustrates the macro process of combining innovation efforts between the indexes and the global sub-index. We are interested in whether higher levels of robustness in the intellectual property ecosystem (IPI) combined with the performance of the entrepreneurship ecosystem (GEI) and innovation inputs (GII Inputs) result in greater innovation results. This macro process constitutes a proposal for a theoretical relational model between human capital and structural capital. Structural capital is understood as the capacity of a country to generate innovation through its human capital and the intellectual property rules that guide entrepreneurial behavior.



**Figure 2.** Macro theoretical process of combining innovation efforts and innovation output Source: Authors' own (2020)

The ecosystems of entrepreneurship, intellectual property and innovation are constituted by several economic actors that articulate, within an institutional environment, to undertake, protect, produce and commercialize innovative assets. It is expected that the creative expression of the innovative entrepreneur combined with an environment of protection of intellectual property rights will stimulate the profusion of intellectual assets.

### 3. Review of the Empirical Literature

The perspective of entrepreneurship, intellectual property and innovation ecosystems based on global indexes has not been developed by the empirical literature. However, a variety of studies address these ecosystems individually, or with some interrelationships.

The entrepreneurship ecosystem and the GEI were investigated by Ács and Szerb (2009), Bulut *et al.* (2013), Ghazinoory *et al.* (2014), Natarajan and Angur (2014), Inácio Júnior *et al.* (2016), Szerb *et al.* (2016), Jovanovic *et al.* (2017), Cătălin *et al.* (2017), Szerb (2017), Atiase *et al.* (2018), Szerb *et al.* (2018), Reis *et al.* (2019) and Inacio Junior *et al.* (2020).

Other studies have assessed the role of intellectual property in the entrepreneurship ecosystem, namely: Dan and Chunyan (2006), Acs *et al.* (2009), Gu (2009), Fini *et al.* (2010), Yong and Sheng (2014) and Nogueira *et al.* (2019).

The empirical literature investigating the innovation ecosystem and GII is discussed by SaiSana (2011), Dutta *et al.* (2012), Hollanders (2013), Xiangjiang *et al.* (2013), Al-Sudairi and Bakry (2014), Dutta *et al.* (2015), Crespo and Crespo (2016), Carpita and Ciavolino (2017), Lybbert *et al.* (2017), Aubert (2018) and Salinas-Ávila *et al.* (2020).

The studies dealing with the relationship between intellectual property and innovation are represented by Dan and Chunyan (2006), Kumar and Ellingson (2007), Zhou and Hu (2007), Gu (2009) Li *et al.* (2010), Ståhle *et al.* (2011), Sweet and Eterovic (2015), Elahi *et al.* (2016), Rojas (2016), Dixit *et al.* (2018), Brandl *et al.* (2019).

There is also a set of studies that set out to investigate entrepreneurship, intellectual property and innovation in a creative way, opening up new domains at the frontier of knowledge, such as Borin

and Donato (2015), Kashyap and Agrawal (2019), Alvino *et al.* (2020), Crupi *et al.* (2020), Usai *et al.* (2020) and Huang *et al.* (2020).

Empirical literature reveals some interesting perspectives. However, there was a scarcity of studies that address the possible connections between entrepreneurship, intellectual property and innovation ecosystems through global indexes. Therefore, we test three hypotheses:

*H1.* Entrepreneurship and intellectual property ecosystems positively affect the innovation ecosystem.

*H2.* Entrepreneurship, intellectual property and innovation input ecosystems positively affect the production of innovation in the innovation ecosystem.

*H3.* Entrepreneurship and intellectual property ecosystems positively affect the production of innovation in the innovation ecosystem.

#### 4. Methodological Procedures

This is a quantitative study based on documentary research. Information about the sample design and the empirical estimation strategy is provided in the following subsections.

##### 4.1 Sample design

The sample data for GEI, IPI and GII were obtained from the annual reports of GEDI, GIPC and GII between 2014 and 2019, according to the availability of data for each country, as shown in Table 4. It is relevant to highlight that the reports published annually by the GEI and the GII are always based on country data for the past two years. The published IPI report is always based on data from the country for the previous year. Thus, for the purposes of organization and estimation, data from the GEI, IPI and GII index and sub-index reports were allocated in the correct years.

**Table 4.** Number of countries mapped by the indexes (GEI, GII, IPI)

Index <sup>1</sup>	2014	2015	2016	2017	2018	2019
GEI	120	130	132	137	137	137
GI	143	141	128	127	126	129
IPI	25	30	38	45	50	50

Source: Authors' own (2020). **Notes:** 1- For more information on the methodology, consult the annual reports. To ensure better comparability and stability between the indices, we opted for the data available from 2014.

Given the changes and discontinuities in the coverage of the indices, the investigation was conducted using all the data available between 2014 and 2019 (time series and cross-country data). It is an unbalanced panel.

The non-homogeneous number of countries mapped annually by the indexes requires specific methodological treatment. In addition to the sub-indices and indices used, a control variable related to economic activity from the World Bank was introduced, as shown in Table 5.

**Table 5.** Variables used

Fonte	Variáveis	Sigla
<b>GED/GEI</b>	Attitudes; Abilities; Aspirations	GEI
<b>GII</b>	Innovation Inputs	INPUT
<b>GII</b>	Innovation Products	OUTPUT
<b>GII</b>	Innovation Inputs and Products	GII
<b>GIPC/IPI</b>	U.S. Chamber International IP Index	IPI
<b>World Bank</b>	Gross Domestic Product per capita based on Purchasing Power Parity (international dollars of GDP - base 2011)	GDP

**Source:** Authors' own (2020).

#### 4.2 Empirical Model

The indices cover several countries with varied dynamics and economic performance, as well as specific social, political and cultural characteristics. Therefore, it is essential to consider the high heterogeneity in the structural relationship. We propose the estimation of quantile regression models in a panel with pooled data and fixed effects.

Quantile regression has been used to analyze the behavior of a response variable throughout its distribution. The effect on the expected or average value can hide important characteristics of the behavior of the response variable. In addition to controlling unobserved and time-invariant heterogeneity, quantile panel regression with fixed effects can assess the effect of a specific covariate on different quantiles of the response variable, which makes the inference more informative and robust.

Koenker and Bassett (1978) were pioneers in quantile regression. Koenker (2004), Firpo *et al.* (2009; 2018), Bache *et al.* (2013), Powell (2017) and Rios-Avila (2019) also proposed estimators for longitudinal data.

In our investigation, we used an unconditional quantile panel regression based on the Recent Influence Function (RIF) proposed by Firpo *et al.* (2009) and Rios-Avila (2019). This method has the advantage of separating the composition and structure effects of the variable of interest for any statistic. The structure effect indicates how the  $F(Y | X)$  distribution changes over time. The calculation of the probabilities for each group obtained in the propensity score is re-weighted and used to estimate the RIF regression. This regression replaces the dependent variable with the estimated RIF value.

Firpo *et al.* (2009) and Rios-Avila (2019) propose the model with the following general structure:

$$RIF(y_i; v(F_y)) = X_i' \beta + \varepsilon_i. \quad (1)$$

Firpo *et al.* (2009) and Rios-Avila (2019) use this strategy to estimate unconditional partial effects on distribution statistics  $v$  (for example, the quantiles of the response variable) from marginal changes in the distribution of covariates. The linear regression RIF (i.e. RIF-OLS) uses the estimated value  $RIF(y_i; v(F_y))$  for each observation  $y_i$  as a second step response variable. The unconditional partial effects can be estimated by first calculating the unconditional expectation of equation (1) (Rios-Avila, 2019):

$$E[RIF(y_i; v(F_y))] = v(F_y) = E(X_i' \beta) + E(\varepsilon_i) = \bar{X}' \beta, \quad (2)$$

assuming  $E(\varepsilon_i) = 0$ . The unconditional partial effect for the independent variable  $x_k$  is given by:

$$\frac{\partial v(F_y)}{\partial \bar{x}_k} = \beta_k \quad (3)$$

The coefficient  $\beta_k$  is the expected change in distributive statistics  $v$  (for example, a specified quantile) given by a unit change in the unconditional average of  $x_k$ . In line with the hypotheses of this study (H1; H2; H3), we estimate three models:

$$GII_{it} = \beta_0 + \beta_1(\tau) IPI_{it-1} + \beta_2(\tau) GEI_{it-1} + \beta_3(\tau) GDP_{it-1} + C_i + \delta_t + \varepsilon_{it}, \quad (4)$$

$$OUTPUT_{it} = \beta_0 + \beta_1(\tau) IPI_{it-1} + \beta_2(\tau) GEI_{it-1} + \beta_3(\tau) INPUT_{it-1} + \beta_4(\tau) GDP_{it-1} + C_i + \delta_t + \varepsilon_{it}, \quad (5)$$

$$OUTPUT_{it} = \beta_0 + \beta_1(\tau) IPI_{it-1} + \beta_2(\tau) GEI_{it-1} + \beta_3(\tau) GDP_{it-1} + C_i + \delta_t + \varepsilon_{it}, \quad (6)$$

where  $i$  is the index of countries and  $t$  is the index of years.  $C_i$  is a term that captures specific unobserved and time-varying effects in each country.  $\delta_t$  is a term that captures fixed time effects common to all countries. The estimator proposed by Rios-Avila (2019) allows for unbalanced panels and is implemented through the "RIFHDREG" package in STATA.

Equation (4) is an attempt to investigate the relationship between ecosystems through the aggregated indices, shown in Figure 1. In equation (5) the GII is decomposed into its sub-indices, with the variable innovation products becoming the variable strategic response that synthesizes the results of the generation of technological assets. The innovation input is incorporated as another important explanatory variable of the model, according to the macro process described in Figure 2. The rationality in the functional formula of equation (5) allows to objectively evaluate if there is a relationship between ecosystems. In equation (6) we remove the variable of innovation inputs as a way to investigate whether the ecosystems of intellectual property and entrepreneurship are sufficiently capable of affecting the profusion of innovation results in the countries, inhibiting possible disturbances in the human capital captured by the GEI and the INPUT.

The three models (4, 5 and 6) were estimated in pooling and with control of fixed effects of countries and time. We estimate the models using log variables (coefficients are elasticities). We believe that changes in intellectual property legislation in a given year do not instantly affect the innovation ecosystem or innovation results in the same year. Therefore, we expect variations in the intellectual property ecosystem to affect the production of innovation with a delay. We also assume that the contemporary model may be endogenous. The entry of the innovation can be determined simultaneously by the exit of the innovation in the same time window, as the process innovation. To overcome this problem, we delay all explanatory variables by one year.

To estimate the quantile regression with stacked data, we removed  $C_i$  and  $\delta_t$  from equation (4, 5 and 6). The modeling that groups the stacked data is useful because it presents the relationship between the explanatory variables and the dependent variable in general. The limitation of this type of estimate is that the fixed and constant, time-invarying effects are possibly incorporated into the indiosyncratic error, which may be correlated with the explanatory variables, which can generate

biased results. In this sense, the fixed-effect and time model is the most appropriate because it controls the individual characteristics of countries.

## 5. Results

### 5.1 Descriptive Statistics

The theme of entrepreneurship, innovation and intellectual property ecosystems is strategic for the development of countries, and therefore it is relevant to investigate their connections. Figure 3 shows the geographical spatial location of the 47 countries in the sample. Highlighted in green, the 47 countries are distributed on all continents, which amplifies the scope of the research and the global reach of its results.



**Figure 3.** Spatial distribution of the sample countries

Source: Authors' own (2020)

Table 6 lists the countries in the sample according to the United Nations classification. It is important to highlight the predominance of European and Asian countries in the sample.

**Table 6.** Spatial distribution of sample countries

Regions	Countries	Number of Countries
<b>Europe - EUR</b>	France; Germany; Hungary; Ireland; Italy; Netherlands; Poland; Russian Federation; Spain; Sweden; Switzerland; Ukraine; United Kingdom.	13
<b>North America - NAC</b>	Canada; United States of America.	2
<b>Latin America and the Caribbean - LCN</b>	Argentina; Brazil; Chile; Colombia; Costa Rica; Ecuador; Mexico; Peru.	8
<b>Central and Southern Asia - CSA</b>	India; Pakistan.	2
<b>Southeast Asia, East Asia, and Oceania - SEA</b>	Australia; Brunei Darussalam; China; Indonesia; Japan; Korea, Republic of; Malaysia; Philippines; Singapore; Thailand; Vietnam.	11
<b>Northern Africa and Western Asia - NAWA</b>	Algeria; Egypt; Israel; Jordan; Morocco; Saudi Arabia; Turkey; United Arab Emirates.	8
<b>Sub-Saharan Africa - SSF</b>	Kenya; Nigeria; South Africa.	3
<b>Total</b>		<b>47</b>



Source: Authors' own (2020)

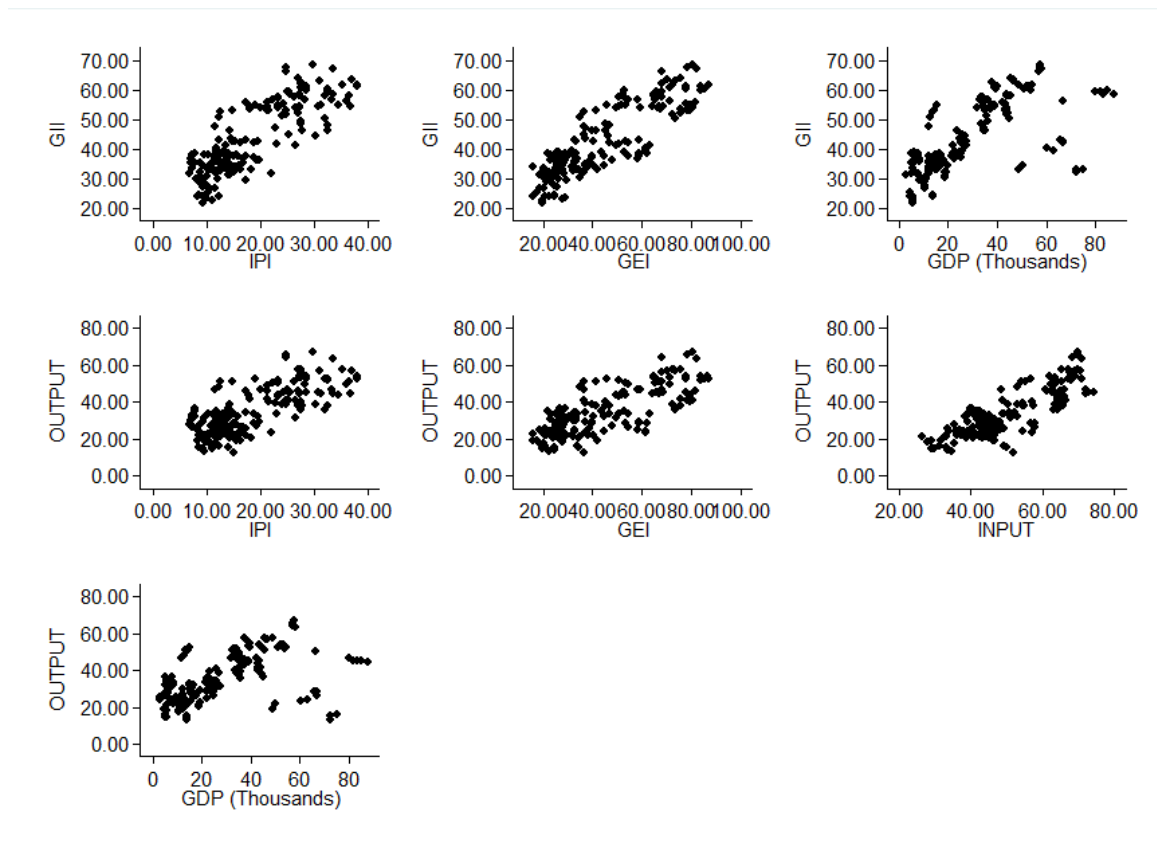
In Table 7, the means of the variables used (IPI; GEI; GII; INPUT; OUTPUT; GDP) were higher than the medians, which suggests that more than half of the countries are below the average value. The high standard deviation indicates that the sample is quite heterogeneous, as expected. This evidence is confirmed by the minimum and maximum values obtained for all variables, especially the economic performance per capita (GDP) variable. The countries in the sample therefore vary greatly in the characteristics of their entrepreneurship, intellectual property and innovation ecosystems.

**Table 7.** Descriptive statistics (2013 to 2017)

	IPI	GEI	GII	INPUT	OUTPUT	GDP
<b>Mean</b>	18.16	44.32	43.10	51.28	34.92	28,164.17
<b>Median</b>	15.08	38.50	38.80	48.30	33.30	23,664.43
<b>Standard Deviation</b>	8.34	20.20	11.82	12.11	12.53	19,632.45
<b>Minimum</b>	6.42	13.00	21.90	26.30	12.95	2,891.49
<b>Maximum</b>	37.98	86.80	68.40	74.23	67.13	87,760.37
<b>Observations</b>	188	183	181	181	181	181

Source: Authors (2020)

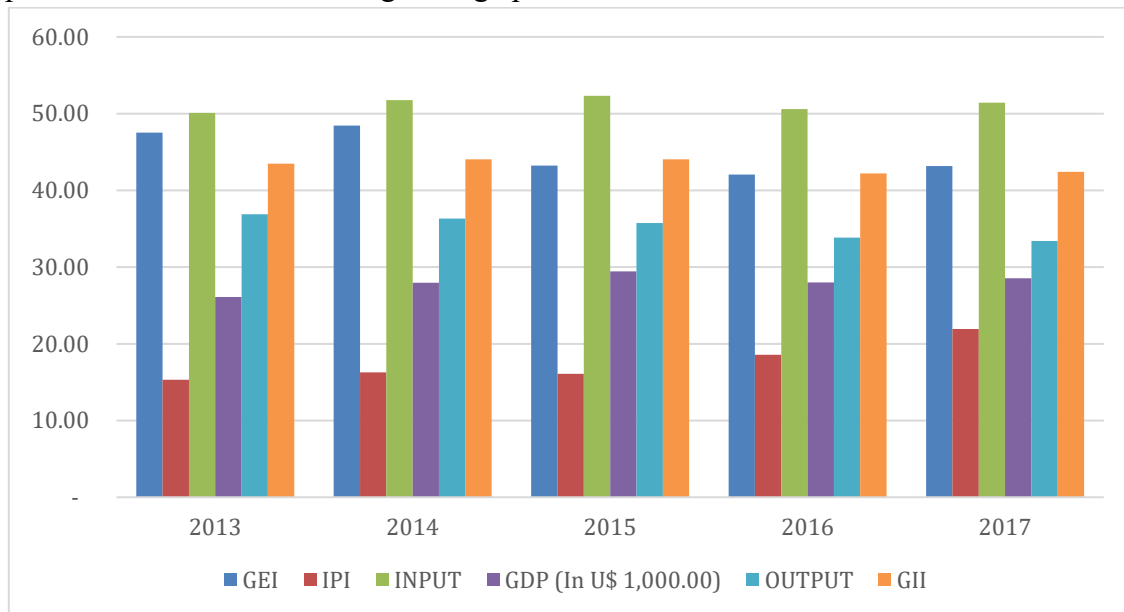
Figure 4 shows the dispersion between the variable GII and each of the covariates, and OUTPUT and each of the covariates. With the exception of the GDP variable, it can be seen that the covariates are associated in an apparently linear way both for the global innovation index and for the innovation product, over time.



**Figure 4.** Dispersion of variables in the period (2013 to 2017)

Source: Authors' own (2019).

Figure 5 shows the countries' average annual performance between 2013 and 2017. The IPI index, which ranges from 0 to 40, jumped from an average of 15.32 in 2013 to 21.92 in 2017, revealing the strengthening of the global intellectual property ecosystem. Innovation inputs and GDP per capita also showed an increasing average performance between 2013 and 2017.



**Figure 5.** Annual average results (2013 to 2017)

Source: Authors' own (2020)

However, the variables GEI, OUTPUT and GII showed an average decline when comparing the year 2017 with 2013. This demonstrates that the average results of the entrepreneurship and global innovation ecosystems were low in the period. In Appendix A, we provide the geometric growth rate of the variables in this study (IPI, GEI, GII, INPUT, GDP and OUTPUT) for all the countries in the sample. We can see that half of the countries recorded a decline in the entrepreneurship ecosystem, while the majority experienced a strengthening of IP rules and a growth in innovation efforts. In addition, most countries have seen a drop in innovation production (Appendix A).

Even countries located in higher quantiles, considered highly innovative, showed a reduction in the production of innovation. Few countries achieved a positive growth rate in innovation production in the period. We argue that the highly innovative countries that lead with high scores have failed to substantially increase their production of innovation, with a few exceptions.

Table 8 contains the sample quantiles (10% to 90%). It shows that the sample composition is substantially heterogeneous. The important thing, however, is that the quantiles generated monotonically stratify the countries present in the sample. As a result, countries with the best performance in their entrepreneurship, intellectual property and innovation ecosystems occupy the highest quantile positions.

**Table 8.** Sample quantiles (2013 to 2017)

QUANTILE	IPI	GEI	GII	INPUT	OUTPUT	GDP
10%	8.86	21.36	29.80	36.10	20.80	6,516.17
20%	10.90	25.52	32.93	41.00	23.30	10,748.29
30%	12.30	28.16	35.34	43.12	26.35	13,534.85
40%	13.70	33.40	37.42	45.26	29.10	17,149.78
50%	15.07	38.50	38.80	48.30	33.30	23,664.43
60%	18.36	48.22	44.51	54.20	36.59	33,220.45

70%	23.31	58.18	53.06	62.60	43.00	37,575.81
80%	27.14	66.24	55.20	64.80	46.60	43,672.13
90%	30.90	74.98	59.81	67.81	52.75	54,470.80

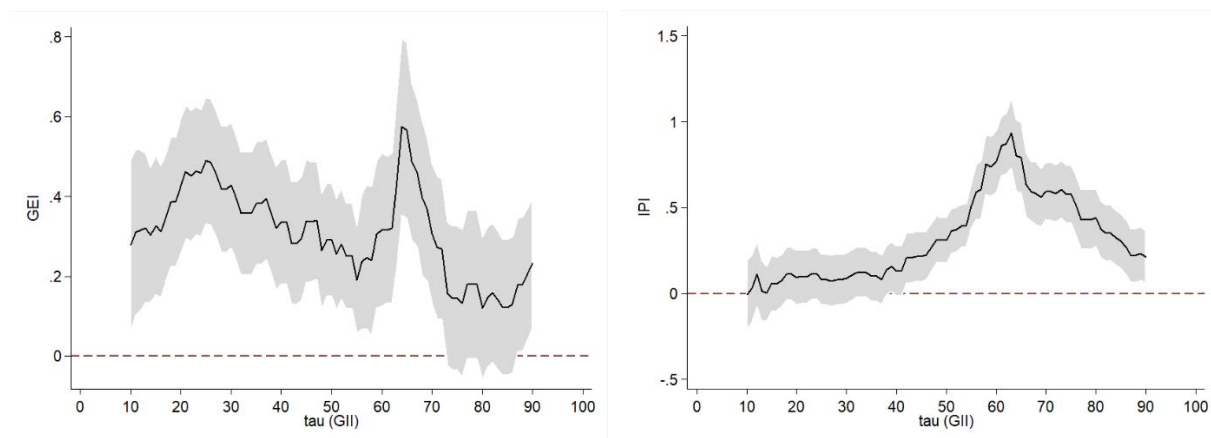
Source: Authors' own (2019).

### 5.2 Regression results

The results of the estimates for all the models are available in Appendix B. We chose to present and discuss the results of the estimates through Figures. This has the advantage of showing the effect of covariables on the broader quantile distribution of the response variable with greater power information, with significance levels of 10%. Figure 6 shows the results of the quantile regression for model (4) with a focus on the ceteris paribus effect of GEI and IPI.

The results stacked in cross-section indicate that the effect of the entrepreneurship ecosystem is positive and significant on the innovation ecosystem throughout the distribution of the response, with the exception of quantiles above 70% and below 90%. The intellectual property ecosystem, on the other hand, has a significant and positive effect on the innovation ecosystem on the right tail of the distribution, more specifically above the 40% quantile.

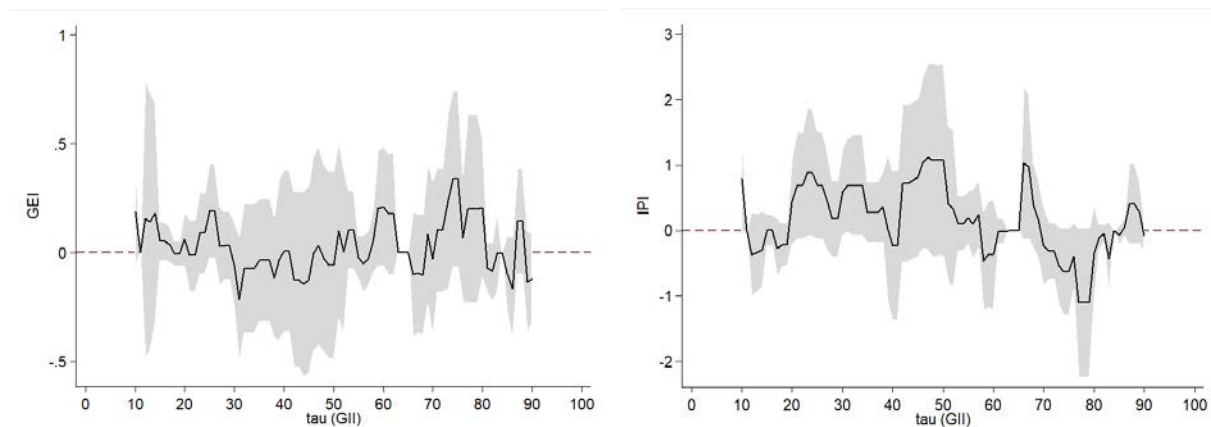
It is also possible to observe that between the 60% and 70% quantiles, the magnitude of the IPI coefficient reaches its maximum value, starting to decline significantly to assume the inverted "U" shape. The results confirm the hypothesis (H1) that the entrepreneurship and intellectual property ecosystems positively affects the global innovation ecosystem, but in a heterogeneous way throughout the GII distribution.



**Figure 6.** Effect of GEI and IPI on GII (pooled data)

Source: Authors' own (2020)

Figure 7 illustrates the results of quantile regression by controlling for individual fixed and time effects. We now observe that the elasticity of the entrepreneurship and intellectual property ecosystem is not significant. Therefore, the hypothesis (H1) is not confirmed.



**Figure 7.** Effect of GEI and IPI on GII (controlling for time and country fixed effects)

Source: Authors' own (2019).

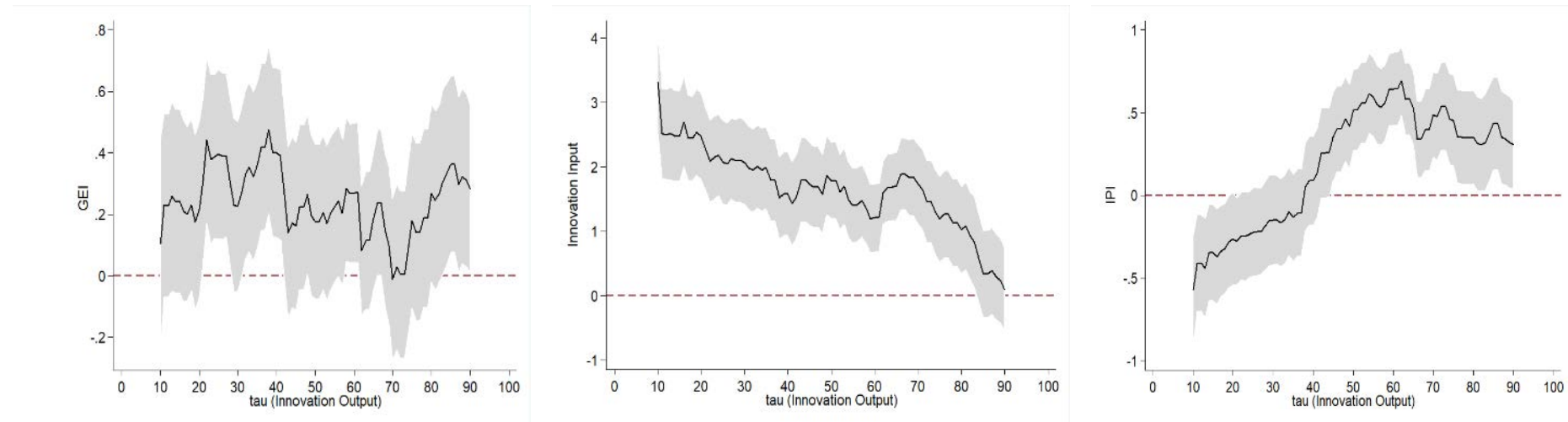
Figure 8 presents the results of the quantile regression with stacked data for the model (5), focusing on the three covariates of interest (GEI, INPUT and IPI). The results indicate that the effect of the entrepreneurship ecosystem is positive and significant on the production of innovation between the quantiles above 20% and below 30%, above 30% up to 40%, above 60%, and above 80 % up to the 90% quantile. The pattern of elasticity of the GEI is evidence that the effect of the entrepreneurship ecosystem is quite similar between the OUTPUT quantiles, that is, the relationship between OUTPUT and GEI is apparently linear.

Innovation inputs significantly and positively affect the generation of innovations in most quantiles. The intellectual property ecosystem has a significant and positive effect on the global production of innovations in the upper tail of the quantile distribution, with the exception of the 80% quantile. In summary, both innovation inputs and the intellectual property ecosystem exhibit a non-linear effect on innovation production. As we move through the quantiles, the marginal effect of covariates changes significantly. In the case of OUTPUT x INPUT the effect of INPUT decreases as it approaches the right tail, until it becomes insignificant. In the case of OUTPUT x IPI the effect of the IPI increases until it stabilizes at around 0.4 in elasticity.

The higher the level of innovation production, the greater the likelihood that the intellectual property and entrepreneurship ecosystem will impact the generation of new innovative goods, processes and services. This confirms the hypothesis (H2) and is relatively in line with the findings of Sweet and Eterovic (2015), Elahi *et al.* (2016), Brandl *et al.* (2019) and Orlando *et al.* (2020).

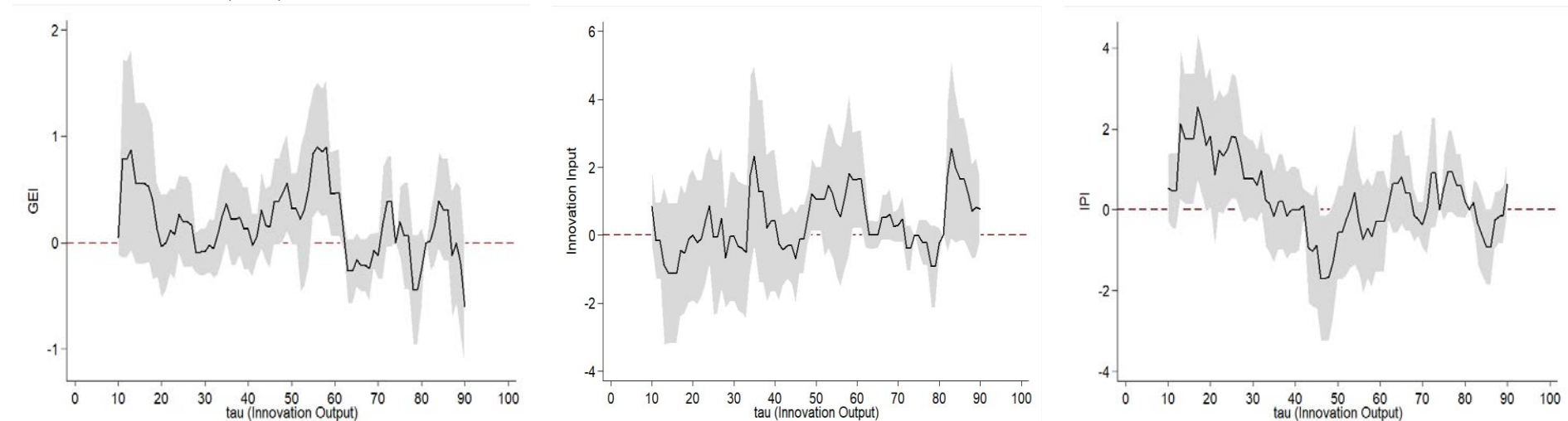
Figure 9 illustrates the effect of the marginal variations of GEI, INPUT and IPI on the unconditional distribution of the response, controlling the time and the individual fixed effects. We see that the effect of the entrepreneurship ecosystem is significant and positive above the 50% quantile, below and in the 60% quantile. The unconditional partial effect of innovation inputs is significant and positive in the quantiles 50% and 60%.

The intellectual property ecosystem, on the other hand, generates a significant and positive effect above the 10% quantile up to 20%. This result confirms with constraint the hypothesis (H2) that the entrepreneurship and intellectual property ecosystem positively affects the production of innovation in the countries' innovation ecosystem. The significant effect identified indicates the importance of the intellectual property ecosystem for the expansion of innovation output.



**Figure 8.** Effect of GEI, INPUT and IPI on OUTPUT (pooled data)

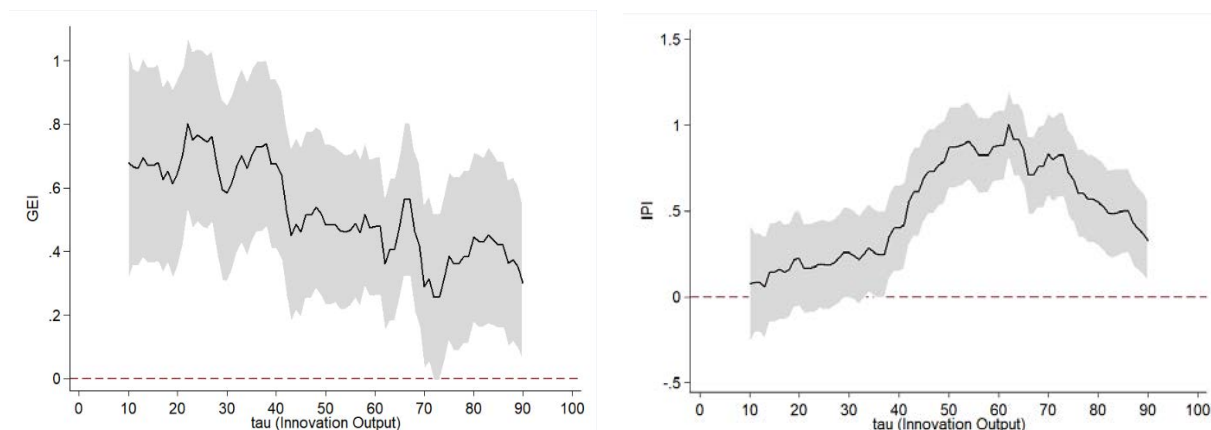
Source: Authors' own (2019).



**Figure 9.** Effect of GEI, INPUT and IPI on OUTPUT (controlling for time and country fixed effects)

Source: Authors' own (2019).

Figure 10 shows the results of the quantile regression for the model (6). The results indicate that the effect of the entrepreneurship ecosystem is positive and significant, but decreasing, over the distribution of innovation production. This evidence is supported by Inacio Junior *et al.* (2020), who argue that innovation-oriented economies with lower positions in the GEI classification tend to have higher productivity rates when compared to economies with higher positions in the GEI classification. The intellectual property ecosystem, on the other hand, has a significant and positive effect on the global production of innovations in the upper tail of the inverted U-shaped quantile distribution. In summary, the hypothesis (H3) is confirmed in the pooling specification.

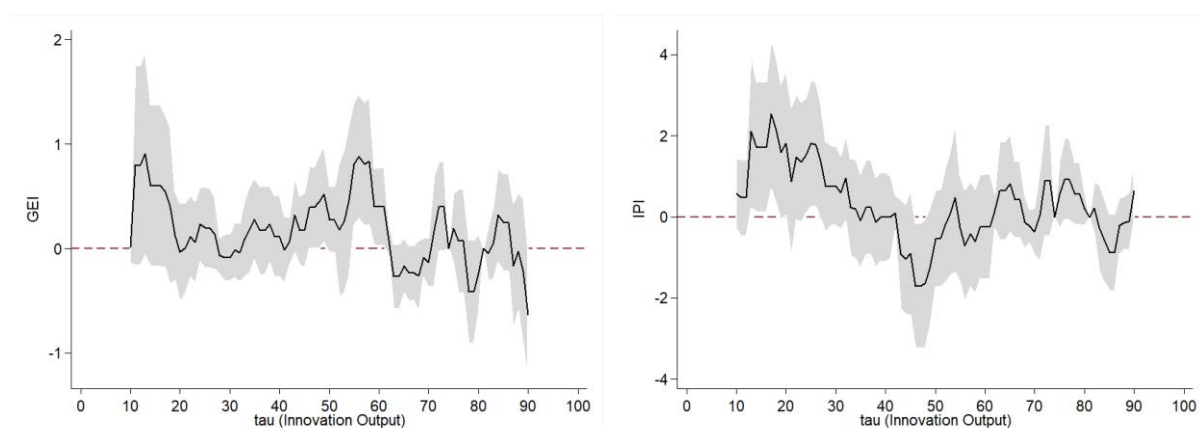


**Figure 10.** Effect of GEI, and IPI on OUTPUT (pooled data)

Source: Authors' own (2019).

Figure 11 details the results of the quantile regression by controlling the time and fixed effects of countries in the model (6). There is an unconditional partial effect of the significant and positive entrepreneurship ecosystem above the 50% quantile, below and in the 60% quantile. The intellectual property ecosystem generate a significant and positive effect above the 10% quantile to 20%, and below the 30% quantile. Visually, Figure 11 is similar to Figure 9, constituting an important test of robustness by discarding the variable of innovation inputs in the model (6).

In summary, changes in the entrepreneurship and intellectual property ecosystem impact the production of innovation with important restrictions, partially confirming the hypothesis (H3) in a panel configuration. The restrictions, that is, the non-significant results are in line with the discussions of Zhou and Hu (2007), Dosi and Stiglitz (2014), Baker *et al.* (2017), Peng *et al.* (2017) and Sweet and Eterovic (2015).



**Figure 11.** Effect of GEI and IPI on OUTPUT (controlling for time and country fixed effects)



## 6. Conclusions

Three different models were estimated in pooling and in a panel structure with control for individual fixed effects and time. Evidence suggests that, in models (4) (5) and (6) in pooling, the entrepreneurship and intellectual property ecosystem positively affects the global innovation ecosystem.

The magnitude of the impact of the entrepreneurship ecosystem on the innovation ecosystem is greater in the lower quantiles, while the effect of the intellectual property ecosystem is greater in the higher quantiles. This is curious, since the upper quantiles of the innovation ecosystem depend more on the effect of the intellectual property ecosystem than the entrepreneurship ecosystem for the generation of global innovations. When we include a covariate of innovation inputs (model 5), there is an effect on the global production of innovative assets.

However, when we control for fixed individual and time effects in the model (4), the results indicate that the entrepreneurship and intellectual property ecosystems does not affect the countries' innovation ecosystem.

When we include the covariate of innovation inputs (model 5), it impacts together with the entrepreneurship and intellectual property ecosystem in the production of innovation in countries at specific quantiles. Furthermore, the effect remains when the model is estimated (6), which excludes innovation inputs.

In addition, the combination of a more robust entrepreneurship and intellectual property ecosystem and the relative increase in innovation inputs have not been efficient enough to generate a growing innovation environment for countries at all levels. In general, the application of the quantile regression method makes it possible to show precisely the non-linearity between the variables.

These results reveal the need for more effective policies to reverse the sterile results of the entrepreneurship and intellectual property ecosystem in innovation production. The structure of the entrepreneurship ecosystem and intellectual property regimes need to be improved so that creative efforts, skills, aspirations in conjunction with intellectual property protection are consistently rewarded with a large generation of intellectual assets.

This study contributes by providing evidence that the ecosystem of entrepreneurship, intellectual property and innovation needs to be improved. The construction of healthy ecosystems is a necessary condition for entrepreneurs, within an environment of protection of intellectual property, to increase the flow of innovation production in countries efficiently.

The present investigation has limitations as the study is restricted to the general results of the entrepreneurship, intellectual property and innovation ecosystem measured by the indexes. Our results refer to a relatively short period. The results are directly linked to the way the indexes are constructed and the indexes do not capture certain characteristics of ecosystems. Innovation outputs monitor legally protected innovations, but may not capture the real generation of innovations introduced by countries as well, for example, innovations in services, organizational, cultural production, among other aspects.

However, the GEI, IPI and GII constitute a strategic research source that generates relevant information for the management of entrepreneurship, intellectual property and innovation ecosystems. It is a useful database for decision makers. Another important aspect is that this work demonstrates the contribution that entrepreneurship and intellectual property can have on the



production of innovation in countries, creating valuable information at a global level, with important use for policy makers.

We also emphasize that the evidence shown in this article must be contrasted with additional studies. As a suggestion for future work, alternative methodological approaches may inspire future research on the topic.

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## APPENDIX A

**Table 9.** Geometric Growth Rate of Variables<sup>1</sup>

COUNTRY	IPI	GEI	GII	INPUT	GDP	OUTPUT	COUNTRY	IPI	GEI	GII	INPUT	GDP	OUTPUT
Algeria	5.64%	-4.77%	-0.66%	2.30%	0.37%	-7.60%	Malaysia	7.91%	0.06%	-1.86%	0.06%	3.89%	-4.64%
Argentina	5.14%	-8.57%	-1.76%	1.95%	-0.89%	-7.46%	Mexico	7.91%	-3.07%	-1.30%	0.47%	1.52%	-3.97%
Australia	7.35%	-1.48%	-2.28%	-0.17%	0.95%	-5.52%	Morocco	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
Brazil	9.76%	-11.12%	-0.78%	1.34%	-2.16%	-4.44%	Netherlands	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
Brunei Darussalam	14.55%	3.76%	-0.84%	2.44%	-1.71%	-11.41%	Nigeria	6.02%	-7.89%	0.24%	4.58%	-0.66%	-6.11%
Canada	11.09%	-0.34%	-0.83%	0.53%	0.87%	-2.83%	Pakistan	24.4%	10.6%	5.1%	8.8%	3.5%	-0.5%
Chile	5.60%	-2.00%	-2.89%	-0.38%	0.49%	-7.03%	Peru	8.95%	-4.70%	0.44%	2.48%	1.74%	-3.90%
China	13.20%	5.97%	3.65%	4.12%	6.36%	3.15%	Philippines	17.1%	-4.5%	14.6%	6.5%	5.1%	27.9%
Colombia	7.54%	-8.14%	-2.42%	-0.19%	1.49%	-6.50%	Poland	19.02%	3.06%	-0.82%	0.76%	3.95%	-3.22%
Costa Rica	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	Russian Federation	6.82%	-5.95%	-1.09%	2.04%	-0.75%	-5.88%
Ecuador	16.00%	-6.36%	-4.46%	-0.95%	-1.18%	-10.68%	Saudi Arabia	-3.1%	4.6%	-3.9%	-0.7%	-2.7%	-10.8%
Egypt	7.7%	-5.0%	1.1%	1.9%	2.0%	0.0%	Singapore	7.42%	-6.34%	-0.44%	0.02%	2.37%	-1.10%
France	7.86%	-0.07%	0.30%	0.89%	1.02%	-0.49%	South Africa	4.27%	-5.72%	-2.33%	0.30%	-0.25%	-6.87%
Germany	10.23%	1.07%	0.17%	1.79%	1.35%	-1.82%	Spain	18.6%	3.5%	-1.7%	0.2%	2.7%	-4.4%
Hungary	19.0%	27.0%	-1.0%	2.9%	4.4%	-5.6%	Sweden	16.85%	-3.57%	-0.12%	0.52%	1.07%	-0.89%
India	14.70%	-0.20%	3.64%	5.91%	6.50%	0.43%	Switzerland	10.51%	6.63%	0.47%	1.26%	0.45%	-0.39%
Indonesia	10.68%	5.48%	-0.07%	3.48%	3.70%	-5.24%	Thailand	14.35%	1.07%	0.35%	1.90%	2.47%	-1.81%
Ireland	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	Turkey	11.10%	-7.60%	-0.57%	2.07%	3.73%	-4.13%
Israel	14.22%	7.19%	3.22%	1.85%	1.72%	4.99%	Ukraine	5.15%	-6.94%	0.61%	1.03%	-1.32%	0.13%
Italy	19.83%	10.40%	-0.75%	0.31%	1.56%	-2.09%	United Arab Emirates	8.55%	-3.15%	1.27%	0.33%	2.50%	3.44%
Japan	10.45%	1.87%	0.31%	0.48%	1.16%	0.12%	United Kingdom	8.31%	1.61%	-0.44%	0.38%	1.47%	-1.47%
Jordan	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	United States of America	7.42%	0.53%	0.67%	1.29%	1.56%	-0.14%
Kenya	3.1%	7.7%	0.2%	3.3%	2.4%	-4.3%	Vietnam	14.03%	-2.52%	0.35%	2.27%	5.32%	-1.88%
Korea, Republic of	12.42%	2.85%	-0.32%	1.27%	2.45%	-2.45%							

Source: Authors (2019). Note: 1- The growth rate was calculated according to the availability of data for each country in the period.

## APPENDIX B

### MODEL 4

**Table 10.** Quantile regression results using pooled data (lagged variables)

GII	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9
IPI	-0.0049 (0.121)	0.0912 (0.143)	0.0891 (0.123)	0.1301 (0.106)	0.3121*** (0.105)	0.7694*** (0.135)	0.5955*** (0.154)	0.4407*** (0.153)	0.2132* (0.121)
GEI	0.2780* (0.153)	0.4248** (0.161)	0.4284*** (0.137)	0.3357** (0.140)	0.2921** (0.125)	0.3168 (0.191)	0.3075* (0.163)	0.1194 (0.160)	0.2322* (0.122)
GDP	0.0674 (0.124)	-0.0894 (0.113)	-0.0452 (0.101)	0.0622 (0.094)	0.0662 (0.079)	-0.0238 (0.081)	-0.0465 (0.073)	0.0106 (0.076)	-0.0715 (0.054)

Source: Authors (2019). Asterisks denote the significance level: \* 10%; \*\* 5%; \*\*\* 1%. Robust standard errors are given in parentheses.

**Table 11.** Quantile regression results controlling for time and country fixed effects (lagged variables)

GII	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9
IPI	0.7885 (0.501)	0.4419 (0.394)	0.5886 (0.403)	-0.2327 (0.685)	1.0783 (0.883)	-0.3749 (0.510)	-0.2291 (0.369)	-0.3495 (0.437)	-0.0838 (0.154)
GEI	0.1877 (0.144)	0.0622 (0.075)	-0.0572 (0.188)	0.0081 (0.223)	-0.0564 (0.261)	0.2119 (0.166)	-0.0279 (0.217)	0.2069 (0.193)	-0.1188 (0.122)
GDP	-0.5414 (0.526)	-0.2433 (0.235)	0.5589 (0.491)	0.2190 (0.865)	0.1718 (0.573)	-0.5061 (0.549)	1.1329 (0.750)	-0.1202 (0.239)	0.1088 (0.120)

Source: Authors' own (2019). Asterisks denote the significance level: \* 10%; \*\* 5%; \*\*\* 1%. Robust standard errors are given in parentheses.

### MODEL 5

**Table 12.** Quantile regression results using pooled data (lagged variables)

OUTPUT	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9
LOGIPI	-0.5732* (0.300)	-0.2624 (0.212)	-0.1500 (0.216)	0.0885 (0.285)	0.5178** (0.223)	0.6449*** (0.204)	0.4890** (0.230)	0.3526 (0.234)	0.3058* (0.155)
LOGINPUT	3.3159*** (1.067)	2.4783*** (0.544)	2.0661*** (0.543)	1.5843** (0.638)	1.7856*** (0.624)	1.2082* (0.608)	1.7408** (0.696)	1.0212 (0.688)	0.0982 (0.268)
LOGGEI	0.1044 (0.326)	0.2173 (0.256)	0.2254 (0.288)	0.3998* (0.237)	0.1750 (0.274)	0.2698 (0.257)	-0.0119 (0.236)	0.2676 (0.240)	0.2834* (0.164)
LOGGDP	-0.5177** (0.239)	-0.4432*** (0.147)	-0.3299** (0.154)	-0.3521** (0.154)	-0.4519** (0.171)	-0.2547** (0.115)	-0.2710** (0.120)	-0.3174** (0.139)	-0.0972 (0.071)

Source: Authors' own (2019). Asterisks denote the significance level: \* 10%; \*\* 5%; \*\*\* 1%. Robust standard errors are given in parentheses.

**Table 13.** Quantile regression results controlling for time and country fixed effects (lagged variables)



OUTPUT	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9
LOGIPI	0.5491	1.8207*	0.7586	-0.0115	-0.5629	-0.2898	-0.3717	0.2002	0.6329
	(0.507)	(1.065)	(0.584)	(0.651)	(0.705)	(0.756)	(0.354)	(0.250)	(0.451)
LOGINPUT	0.8527	0.0130	-0.0357	0.4236	1.0674*	1.6432*	0.2955	-0.2205	0.7687
	(0.747)	(1.179)	(1.140)	(1.258)	(0.568)	(0.868)	(0.305)	(0.272)	(0.563)
LOGGEI	0.0478	-0.0353	-0.0843	0.1321	0.3173	0.4658*	-0.1210	-0.2420	-0.6049
	(0.102)	(0.297)	(0.133)	(0.235)	(0.204)	(0.244)	(0.132)	(0.233)	(0.364)
LOGGDP	-0.6701	-1.5895	0.8059	1.8009*	-0.9778	-2.2535*	0.3735	0.4641	0.1383
	(0.607)	(0.969)	(0.662)	(1.005)	(0.615)	(1.296)	(0.402)	(0.448)	(0.388)

Source: Authors' own (2019). Asterisks denote the significance level: \* 10%; \*\* 5%; \*\*\* 1%. Robust standard errors are given in parentheses.

## MODEL 6

**Table 14.** Quantile regression results using pooled data (lagged variables)

OUTPUT	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9
IPI	0.0771	0.2237	0.2552	0.3992	0.8680***	0.8818***	0.8304***	0.5528***	0.3250**
	(0.240)	(0.240)	(0.219)	(0.252)	(0.187)	(0.188)	(0.195)	(0.199)	(0.156)
GEI	0.6781**	0.6461**	0.5829**	0.6740***	0.4840*	0.4788**	0.2894	0.4443*	0.3004*
	(0.322)	(0.238)	(0.261)	(0.204)	(0.261)	(0.228)	(0.238)	(0.231)	(0.160)
GDP	-0.1731	-0.1857	-0.1153	-0.1875	-0.2663*	-0.1292	-0.0902	-0.2113**	-0.0870
	(0.291)	(0.185)	(0.175)	(0.156)	(0.158)	(0.102)	(0.107)	(0.100)	(0.069)

Source: Authors' own (2019). Asterisks denote the significance level: \* 10%; \*\* 5%; \*\*\* 1%. Bootstrapped standard errors are given in parentheses.

**Table 15:** Quantile regression results controlling for time and country fixed effects (lagged variables)

OUTPUT	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9
IPI	0.5723	1.8211*	0.7576	-0.0000	-0.5339	-0.2453	-0.3636	0.1943	0.6537
	(0.524)	(1.067)	(0.585)	(0.661)	(0.715)	(0.780)	(0.345)	(0.246)	(0.457)
GEI	0.0156	-0.0358	-0.0829	0.1161	0.2770	0.4038	-0.1322	-0.2337	-0.6339*
	(0.092)	(0.284)	(0.134)	(0.235)	(0.191)	(0.224)	(0.139)	(0.226)	(0.369)
GDP	-0.4775	-1.5866	0.7978	1.8965*	-0.7368	-1.8825	0.4402	0.4143	0.3119
	(0.455)	(0.959)	(0.522)	(1.026)	(0.522)	(1.178)	(0.454)	(0.403)	(0.396)

Source: Authors' own (2019). Asterisks denote the significance level: \* 10%; \*\* 5%; \*\*\* 1%. Robust standard errors are given in parentheses.

# **Analysis of Factors Affecting Capital Structures in Companies Listed in Indonesia Stock Exchange Period 2010-2014**

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## **Abstract**

*This research aims to analyze the factors that affect the capital structure of companies listed on the Indonesia Stock Exchange in the period 2010-2014. The variables studied were profitability, sales growth, asset structure and company size. This research is a comparative causal study. The data used is secondary data obtained from the site [www.idx.co.id](http://www.idx.co.id). The population in this study are all companies listed on the Indonesia Stock Exchange in the period 2010-2014. The sample selection is done by using purposive sampling method, so that as much as 1089 observational data are obtained. Analysis of the data used is multiple regression analysis. The results of this study indicate that the variable profitability, asset structure and firm size significantly influence the capital structure. The magnitude of the coefficient of determination (Adjusted R Square) is equal to 0.104. This means that 10.4% of the dependent variable that is capital structure can be explained by four independent variables namely profitability, sales growth, asset structure and company size. While the remaining 89.6% is explained by variables or other causes outside the model.*

**Keywords:** Capital Structure, Profitability, Sales Growth, Asset Structure, Company Size.

## **Introduction**

One of the company's goals is to increase the value of the company. Increasing company value can be done through funding decisions. Determination of funding decisions includes several considerations, namely whether the company will use funding sources that come from internal or external. Sources of funds originating from internal sources usually come from retained earnings and accumulated depreciation, while external sources of funds come from shareholders and debt. A good funding decision can be made by planning capital structure. Capital structure is a combination of long-term debt with equity (Fahmi, 2013: 184). A good capital structure is a capital structure where a company can use a combination of debt and equity optimally. An optimal capital structure is a capital structure that can maximize the value of the company or the price of shares (Husnan and Pudjiastuti, 2006: 263). According to Sutrisno (2013) in Hanun (2015) the determination of the capital mix in the company is important because any change in capital structure will affect the overall cost of capital which is caused because each type of capital has different capital costs. Besides that, the total capital cost will be a benchmark in making investment decisions. Many

companies in Indonesia have experienced bankruptcy due to unequal use of funding sources. One reason is excessive use of debt. As happened to the airline company PT Metro Batavia. Based on news reported from merdeka.com on Wednesday, January 30, 2013 PT Metro Batavia was declared bankrupt on January 30, 2013 on the Central Jakarta Commercial Court's decision letter No.77/Pailit/2011/PN.Niaga.Jkt.Pst. This bankruptcy was filed by one of its creditors, ILFC, because PT Metro Batavia was unable to repay debts that had matured until December 13, 2012 in the amount of US \$ 4.68. Therefore, it is important for companies to know the factors that influence capital structure so they can make the right capital structure decisions. According to Brigham and Houston (2011) in Sawitri and Lestari (2015) there are 12 factors that influence the determination of capital structure decisions namely, sales stability, asset structure, *leverage* operating, business risk, growth rates, profitability, taxes, controls, management attitudes, measures corporate and financial flexibility. Meanwhile, according to Sartono (2001) in Bhawa and Dewi (2015) capital structure is influenced by seven factors namely the level of sales, asset structure, the level of company growth, profitability, profit and tax protection variables, company scale, as well as company internal conditions and macroeconomics. Of the several factors that influence capital structure, there are four factors that often arise in research such as profitability, sales growth, asset structure, and company size. However, there are inconsistencies from the results of previous studies. Where there are factors that have been proven to have a significant effect on one study, but have no significant effect on other studies. Therefore, the title of this research is "**Analysis of Factors Affecting Capital Structure at Companies Listed on the Indonesia Stock Exchange Period 2010-2014**".

## Literature Review

### *Pecking Order Theory*

This theory was put forward by Brealey and Myers (1996) in Husnan and Pudjiastuti (2006: 278). In short this theory states that companies prefer internal funding. If external funding is needed, the company will issue the safest securities first. The issuance of securities will start from the issuance of bonds. If the funds needed are still insufficient, then new shares will be issued. According to Husnan and Pudjiastuti (2006: 278) in *pecking order theory* there is no optimal capital structure. Debt ratio is influenced by funding requirements. Specifically the company has a preference order (*hierarchy*) in the use of funds starting from retained earnings, debt, and finally the issuance of new shares.

### *Trade-Off Theory*

*Trade-off theory* assumes that a company's capital structure is the result of a *trade-off* from the tax advantages of using debt with costs that will arise as a result of using that debt Ros *et al.* (2012) in Saputri and Margaretha (2014). *Trade-off theory* predicts that companies will choose debt as a source of funds as long as the benefits of additional debt are still greater than the losses due to the use of debt. According to Brealey, et al. (2007: 24) *trade-off theory* estimates that the debt ratio will vary from one company to another company. Companies with tangible assets with low risk and high taxable profits should use more debt, while companies with high risk assets should use less debt.

**Effect of profitability on capital structure**

Profitability of the previous period is an important factor in determining capital structure. This is because companies with high profitability tend to use relatively small debt because high retained earnings are sufficient to finance most of the funding needs. This is in accordance with the *pecking order theory* which states the preference for selecting the source of funds starting with retained earnings, debt, and finally the issuance of new shares. This is consistent with research conducted by Bhawa and Dewi (2015), Zuliani and Asyik (2014) and Saputri and Margaretha (2014) showing uniform results that profitability has a significant negative effect on capital structure. Based on the description above, the researchers propose the following hypothesis:

H1: Profitability has a negative effect on capital structure

**The effect of sales growth on capital structure**

The faster sales growth, the greater the need for funds to finance expansion. According to Brigham and Houston (2001) in Siswantoro (2013) companies with high sales growth rates tend to use debt more than companies with low sales growth rates. Thus the greater the level of sales growth, the greater the level of debt. This is consistent with research conducted by Goey and Malelak (2014) and Sawitri and Lestari (2015) showing uniform results that sales growth has a significant positive effect on capital structure. Based on the description above, the researchers propose the following hypothesis:

H2: Sales growth has a positive effect on capital structure

**Effect of asset structure on capital structure**

According to Brigham and Houston (2006) in Widyaningrum (2015) a company with adequate assets or assets has a fixed term asset ratio Longer Larger will use more long-term debt because existing fixed assets can be used as collateral for debt. So it can be said that the asset structure can be used to determine how much long-term debt that can be taken by the company and this will affect the determination of the amount of capital structure. This is consistent with research conducted by Saputri and Margaretha (2014), Goey and Malelak (2014) and Margaretha and Ramadhan (2010) showing uniform results that the asset structure has a significant positive effect on capital structure. Based on the description above, the researchers propose the following hypothesis:

H3: Asset structure has a positive effect on capital structure

**The effect of company size on the capital structure**

Large companies that have been *well-established* will be easier to obtain capital in the capital market compared to small companies. The ease of access gives companies the opportunity to make loans in larger amounts so that the company can grow and have the ability to generate greater profits. Smaller companies tend to have limitations in obtaining loans from the capital market. According to Chen and Strange (2006) in Indrajaya, et al. (2011) results from many studies conclude that company size is an important factor in determining capital structure, and many studies find that large companies use more debt than small companies. This is consistent with research conducted by Goey and Malelak (2014), Wiagustini and Pertamawati (2015) and Saputri and Margaretha (2014) showing uniform results that company size has a

significant positive effect on capital structure. Based on the description above, the researchers propose the following hypothesis:

H4: Firm size has a positive effect on capital structure

## METHODS

### Population and Samples

The population in this study are companies listed on the Indonesia Stock Exchange. The sampling technique in this study is *purposive sampling*, which is a technique for determining non-random samples whose information is obtained by using certain considerations (Indriantoro and Supomo, 2002: 131). Some things that are considered in the sampling in this study are that they must meet the following characteristics. First, the company was listed on the Indonesia Stock Exchange in the period 2010-2014. If a new company is registered in that year or *delisted* in that year then the company cannot be used as a research sample. Second, the company is not a company engaged in the financial industry sector, because in general companies engaged in the financial sector have different characteristics from companies in other sectors. Third, the company has a positive capital structure.

### Definition of Operational and Measurement Variables

#### Independent Variables (X)

Independent variables used in this study include:

##### 1. Profitability (X1)

Profitability is the company's ability to generate profits in a certain period. Profitability in this study is proxied by *return on assets* (ROA) with the following formula (Nugrahani and Sampurno, 2012):

$$ROA = \frac{EAT}{\text{Total Assets}}$$

##### 2. Sales Growth (X2)

Sales growth is the percentage increase or decrease in sales from one period to the next. Sales growth is formulated as follows (Oktaviani and Malelak, 2014):

$$Growth = \frac{\text{Sales}(t) - \text{Sales}(t-1)}{\text{Sales}(t-1)}$$

##### 3. Structure Asset

Structure asset is the ratio between fixed assets and total assets. The asset structure in this study is proxied by *Fixed Asset Ratio* (FAR) which is formulated as follows (Oktaviani and Malelak, 2014):

$$FAR = \frac{\text{Fixed Assets}}{\text{Total Assets}}$$

##### 4. Company Company

Size is the size of operations carried out by the company in running its business. To measure the size of the company formulated as follows (Nugrahani and Sampurno, 2012):

$$Size = \ln(\text{Total Asset})$$

### Dependent Variable (Y)

In this study the dependent variable is the capital structure. Capital structure is a combination of a company's long-term debt to the company's equity. The capital structure in this study is proxied by a *long term debt to equity ratio (LTDtER)* which is formulated as follows (Kasmir, 2012: 159):

$$LTDtER = \frac{\text{Long Term Debt}}{\text{Equity}}$$

### Data Analysis Method

In this study, the hypothesis was tested with multiple regression analysis. Before being analyzed with multiple regression, the data is tested with classical assumptions with the aim that the regression model can produce unbiased predictors. Testing classic assumptions include tests of normality, multicollinearity, autocorrelation and heteroscedasticity. After the classic assumption test, the study continued with regression analysis and hypothesis testing.

## DISCUSSIONS

### Effect of profitability on capital structure

Hypothesis test results presented in table 4.12 show a significant value of  $t$  is 0,000. This value is  $<0.05$ , which means that profitability significantly affects the capital structure. Profitability has a value of  $t$  arithmetic of 5.007 with  $t$  table = 1.962 so that  $t$  arithmetic  $> t$  table. A negative  $t$  value indicates that profitability has an inverse relationship with capital structure. Thus, H1 which states profitability has a negative effect on capital structure is declared **supported**. The results of this study are consistent with research conducted by Bhawa and Dewi (2015), Zuliana and Asyik (2014), and Saputri and Margaretha (2014) where the higher the profitability, the lower the use of debt. However, the results of this study are not in line with research conducted by Nugrahani and Sampurno (2012) which states that corporate profitability has no effect on capital structure. That is because a company that has a high level of profit allows the company to obtain some funding with retained earnings. The results of this study support the *pecking order theory* which states that the company will use internal funds first before using debt to meet funding needs.

### Effect of sales growth on capital structure

The results of the hypothesis test presented in table 4.12 show a significant value of  $t$  1.416. This value  $> 0.05$ , which means that sales growth has no effect on capital structure. Sales growth has a calculated value of 1.416 with  $t$  table = 1.962 so that  $t$  arithmetic  $< t$  table. Thus, H2 which states that sales growth has a positive effect on capital structure is declared **unsupported**. The results of this study are consistent with research conducted by Nugrahani and Sampurno (2015) and Zuliani and Asyik (2014), where ups and downs in sales growth have no effect on capital structure. However, the results of this study are not in line with research conducted by Oktaviana and Malelak (2014) and Sawitri and Lestari (2015) which states that sales growth affects the capital structure. The insignificance of the effect of sales growth on capital structure



in this study was due to indicator measurement factors. This is because the company's growth rate cannot be measured with certainty and cannot only be seen based on sales growth.

### Effect of asset structure on capital structure

Hypothesis test results presented in table 4.12 show a significant value of  $t_{0,000}$ . This value is  $<0.05$ , which means that the asset structure significantly influences the capital structure. The asset structure has a calculated value of 7.406 with  $t_{table} = 1.962$  so  $t_{arithmetic} > t_{table}$ . A positive  $t$  value indicates that the asset structure has a direct relationship with the capital structure. Thus, H3 which states the asset structure has a positive effect on capital structure is declared **supported**. The results of this study are consistent with research conducted by Goey and Malelak (2014) and Sawitri and Lestari (2015). However, the results of this study are not in line with research conducted by Zuliani and Asyik (2014) which states that the structure of assets does not affect the capital structure. That is because large company assets can be used as collateral for creditors. Creditors may only give new debt to the company when the creditor gets a guarantee that provides certainty of protection for their interests. Guarantees that can provide certainty of protection for creditors are fixed assets owned by the company.

### Effect of company size on capital structure

The results of the hypothesis test presented in table 4.12 show a significant value of  $t_{0,000}$ . This value is  $<0.05$ , which means that the size of the company significantly influences the capital structure. The size of the company has a value of  $t_{arithmetic}$  of 0.043 with  $t_{table} = 1.962$  so  $t_{arithmetic} > t_{table}$ . A positive  $t$  value indicates that sales growth has a direct relationship with the capital structure. Thus, H4 which states the size of the company has a positive effect on capital structure is declared **supported**. The results of this study are consistent with research by Goey and Malelak (2014), Wiagustini and Pertamawati (2015) and Saputri and Margareta (2014) which state that large company size will increase or increase capital structure. However, the results of this study are not in line with the research conducted by Bhawa and Dewi (2015), Nugrahani and Sampurno (2012), and Sawitri and Lestari (2015) which states that company size has no effect on capital structure. That is because the larger the size of a company, the greater the funds needed to make an investment. In addition, companies with a larger size are considered more able to repay debt compared to smaller companies because large companies have more stable cash flow which is one of the conditions for fulfilling debt applications by creditors. This research supports the *trade of theory* which states that companies with tangible assets with low risk and high taxable profits should use more debt.

## Conclusion

Based on research conducted on 286 companies listed on the Indonesia Stock Exchange (IDX) in the period 2010-2014, the following conclusions are obtained that profitability (*ROA*) has a significant negative effect on capital structure, which means companies with high profits use relatively small debt. . A high level of profit allows the company to obtain a portion of funding with retained earnings. Sales *Growth (Growth)* does not affect the capital structure, which means ups and downs in sales growth does not affect the capital structure. The insignificance of the effect of sales growth on capital structure in this study was due to



indicator measurement factors. This is because the company's growth rate cannot be measured with certainty and cannot only be seen based on sales growth. Asset Structure (*FAR*) has a significant positive effect on capital structure which means that the greater the fixed assets, the higher the debt. This is based on the creditor's confidence in the funds invested in the company guaranteed by the amount of assets owned by the company. Company size (*Size*) has a significant positive effect on capital structure. That is because companies with larger sizes are more likely to obtain capital in the capital market. In addition, large companies have a more stable cash flow which is one of the conditions for fulfilling debt applications by creditors.

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# **EFFECT OF PHYSICAL EXERCISE ON COLORECTAL CANCER: SYSTEMATIC REVIEW**

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## ABSTRACT

*Aerobic and resistance physical exercise can activate different molecular pathways due to different intensities, duration, and mechanical loads imposed on the muscles. The activity can result in metabolic adaptations, such as increased mitochondrial mass, oxygen supply, glucose uptake, and antioxidant capacity. The method of this systematic review followed recommendations proposed by the PRISMA Statement. Were included studies that used physical exercise as an intervention in rats and mice with induced colorectal cancer. The Studies' selection was on databases: Bireme, PubMed, Science Direct, Medline, Ibecs, Lilacs, Bdenf, Binacis, Scielo, and bibliographic references selected articles. Animal models researches showed that aerobic and resistance exercise could reduce several risk factors like oxidating stress and the tumor's pro-inflammatory status. That happens due to cytokines' regulation, thereby improve organic's defenses and reduce colon inflammation.*

**Keywords:** Colorectal cancer; Physical exercise; Mice and Rats.

## 1. INTRODUCTION

According to the World Health Organization (WHO, 2018), cancer is one of the leading causes of death globally, causing 9.6 million deaths in 2018, with colorectal cancer (CRC) responsible for 1.8 million cases. This form of cancer develops sporadically, in inherited cancer syndromes cases, or based on inflammatory bowel diseases. (Weitz et al., 2005).

Although anyone can develop colorectal cancer, several factors are associated with an increased risk for a disease. Some risk factors are modifiable like diet, obesity, lack of physical activity, tobacco use, and moderate to heavy alcohol use. (Rudy and Zdon, 2000). Colon tumors usually develop through a multiple-stage process that involves histological, morphological, and genetic changes, which accumulate over time. (Koelwyn, Wennerberg, Demaria & Jones, 2015).

Tumor progression is regulated by complex and multifaceted interactions between systemic environment (host), tumor microenvironment, and cancer cells. Whether in primary or distant ectopic sites, the tumor microenvironment is affected by increased growth factors in circulation, cytokines, angiogenic factors, hormones, and other types of cells like immune cells (Simon, 2016).

High levels of inflammatory cytokines and angiogenic factors (e.g., hepatocyte growth factor, tumor necrosis factor (TNF), interleukin 6 (IL-6), and metabolic growth hormones like insulin, glucose, leptin) are associated with higher risks of recurrence and cancer-specific mortality (Freire, 2020); (Bonatelli, 2020).

Chronic inflammation has been identified as an important risk factor for carcinogenesis. Inflammation might be linking with other factors such as increasing age, increased body fat, and neoplastic risk (Simon, 2016). Serum levels of C-reactive protein, an inflammation marker, are associated with a subsequent risk of CRC, and it is believed that inflammation might be involved in the early stage of colorectal tumor growth. (Cotti et al., 2000); (From Lima & Maio, 2012).

Genes such as adenomatous polyposis coli (APC), deleted in colorectal carcinoma (DCC), protein P53, and others, have been identified as participants in the adenoma-carcinoma sequence. That is involved

with tumor genesis based on the theory of multiple-steps, in which accumulating of genetic mutations in unstable cells is the main factor causing cancer (Souza, 2010); (Cotti et al., 2000).

The beneficial results from regular exercise can be affected by the type of activity, duration, intensity, and total time practiced per week, making it complex to understand it (Pedersen, 2009).

Resistance and aerobic exercises can activate molecular pathways because of the different frequencies and mechanical loads imposed on muscles (Neves, Gonçalves & Ramalho, 2020). Aerobic exercise results in metabolic adaptations like increasing mitochondrial mass, oxygen supply, glucose uptake, and antioxidant capacity, whereas resistance exercise mainly cause an increase in muscle mass (Ballarò, Penna, Gómez & Cabrera, 2019)

Epidemiological studies have shown that regular exercise can delay the colon and bowel cancer onsets. Indeed, long-term aerobic training protects against chemically induced colon cancer (Harriss et al., 2007).

Skeletal muscle cells secrete bioactive proteins from into the cell to the extracellular medium. Proteins secretion, which is increased in response to exercise, can regulate organs' function through autocrine, paracrine, and endocrine ways. Besides, that can mediate benefits induced by exercises like metabolic improvement, anti-inflammation, and muscle building; all this is called myokine theory (Aoi, Naito, Takagi & Yoshikawa, 2013). That provides a conceptual basis for understanding the mechanisms by which exercise can influence metabolism and have anti-inflammatory effects. Skeletal muscle contraction releases myokines that work like hormones, causing endocrine effects (Pedersen, 2009).

Physical exercise can alter polyp development by improving immune system function and consequently reduce chronic inflammation. Furthermore, it can improve some cancer risk factors like immune system dysfunction, diet, obesity, insulin action, prostaglandin levels and triglycerides, antioxidant defense mechanisms (Lira, Vancini, Silva & Nouailhetas, 2008); (Da Silva et al., 2020).

Animal research models have stood out to simulate most human tumors' characteristics (Abreu, Santiago, Abreu, Ramos, Neves & Ramalho, 2020). In vivo studies with animal models are considered critical tools required to study the molecular mechanisms of colorectal carcinogenesis, test Therapeutic Approaches, prevent and translate hypotheses derived from cell models (Johnson & Fleet, 2013).

Animal models can be used for chemoprevention studies, assess immunological, chemical, and surgical therapy regimes (Pantaleão & Luchs, 2010).

CRC rodent models can be genetically modified animals like Min/ $\Delta$ APC-mouse strains, which reproduce the tumors developing from epithelial cells initiated (mutated) to cover polyp growth through tumor progression and rarely metastases. That can also be a xenotransplant model that expresses growth tumor and its metastases when it used malignant cells, forming a tumor in animal hosts. Besides, chemical models for tumor induction can be used, in which acts on normal epithelium to form carcinomas and seldom metastases, through the multiple-stage process described above (De Robertis et al., 2011)

The 1,2-dimethylhydrazine compound (DMH) and its metabolite, azoxymethane (OMA), are the two most used carcinogens substance to induce and promote colorectal cancer in rats and mice. DMH and OMA are alkylating agents injected intraperitoneally or subcutaneously over several weeks to induce the development of distal colon tumors. (Jucá et al., 2014). Most of these tumors harbor mutations in the  $\beta$ -catenin (Ctnnb1) gene, which is similar to hereditary colorectal cancer without polyposis (HNPCC)

(Thaker, Shaker, Rao & Ciorb, 2012). These mutations affect the N-terminal amino acids of the  $\beta$ -catenin gene product, making the protein resistant to regulatory degradation, stabilizing  $\beta$ -catenin, and increasing WNT signal to boost the tumor's genesis (Johnson & Fleet, 2013).

Although of the broad knowledge about genetic factors involved in developing the diseases, only frequent mutations are used. Such as APC > 70%, p53 > 60%, and K-ras > 40%, present in sporadic CRC; APC in familial hereditary adenomatous polyposis; MMR in hereditary non-polypus colorectal cancer (De Robertis et al., 2011). Genetically modified mice can recapitulate specific molecular precision etiologies relevant to human disease. (DE-Souza & Costa-Casagrande, 2018).

The animal model for cancer research is essential to develop new treatment strategies (Augusto Sobrinho et al., 2019). This study investigates the physical exercise effects of physical exercise on colorectal cancer in rats and mice, which identified and analyzed the exercise results in tumor development. Based on molecular changes' hypothesis by the physical exercise related to colorectal cancer, we proposed to carry out this systematic review study in an animal model.

## **2. METHODS**

This systematic review followed the recommendations proposed by the Cochrane Collaboration and by PRISMA Statement.

The Picot strategy was used to define the research question and the inclusion and exclusion criteria (an acronym for Patient, intervention, comparison, Outcomes or outcomes, and study type).

### **PICO**

PATIENT: rats or mice with induced colorectal cancer

INTERVENTION: physical exercise, physical activity, aerobic exercise, anaerobic exercise, and combined exercises.

CONTROL: sedentary animals with induced colorectal cancer.

OUTCOME: result rate (positive and negative) to exercise on cancer, the result of exercise on tumor development

TYPE OF STUDY: Preclinical randomized controlled study carried out with rats and mice.

### **Eligibility criteria**

Studies that assessed the resistance training effects were included based on the following criteria:

- a) Animal studies with induced colorectal cancer.
- b) Intervention research in which resistance and aerobic exercise training were used as a single. Intervention or as a part of the intervention.
- c) Control research in which includes a group that did a physical exercise of different intensity or another form of exercise or a non-exercising control group.
- d) The result from research in which have been reported results about the development of colorectal.
- e) Randomized clinical trial (RCT) published on the study design.



**Exclusion criteria**

Studies that used drugs, diet or another intervention beyond physical exercise were excluded.

**Search sources**

Selection of studies was on the databases: Latin American and Caribbean Center for Health Sciences Information (Bireme), Medical Literature Analysis and Retrieval System Online (Pubmed), science direct, Medical Literature Analysis and Retrieval System Online (Medline), Spanish Bibliographic Index in Health Sciences (Ibecs), Latin American & Caribbean Health Sciences Literature (Lilacs), Nursing Database (Bdenf), Bibliografía Nacional en Ciencias de la Salud Argentina (Binacis), physiotherapy Evidence Database (Pedro) and Scientific Electronic Library Online (Scielo). Besides, it searched for references studies already published about the subject, and there was no restriction of language or year of publication.

The search was carried out until December 2019 and followed combinations of medical subject heading terms (MeSH) descriptors: Colorectal cancer; Physical exercise; Mice and Rats.

**Colorectal cancer:** (Colorectal Neoplasm) OR (Neoplasm, Colorectal) OR (Colorectal Carcinoma) OR (Carcinoma, Colorectal) OR (Carcinomas, Colorectal) OR (Colorectal Carcinomas) OR (Colorectal Cancer) OR (Cancer, Colorectal) OR (Cancers, Colorectal) OR (Colorectal Cancers) OR (Colorectal Tumors) OR (Colorectal Tumor) OR (Tumor, Colorectal) OR (Tumors, Colorectal) OR (Neoplasms, Colorectal)

AND

**Physical exercise:** (Exercises) OR (Physical Activity) OR (Activities, Physical) OR (Activity, Physical) OR (Physical Activities) OR (Exercise, Physical) OR (Exercises, Physical) OR (Physical Exercise) OR (Physical Exercises) OR (Acute Exercise) OR (Acute Exercises) OR (Exercise, Acute) OR (Exercises, Acute) OR (Exercise, Isometric) OR (Exercises, Isometric) OR (Isometric Exercises) OR (Isometric Exercise) OR (Exercise, Aerobic) OR (Aerobic Exercise) OR (Aerobic Exercises) OR (Exercises, Aerobic) OR (Exercise Training) OR (Exercise Trainings) OR (Training, Exercise) OR (Trainings, Exercise).

AND

**Mice:** (Mus) OR (Mouse) OR (Mus musculus) OR (Mice, House) OR (House Mice) OR (Mouse, House) OR (House Mouse) OR (Mus domesticus) OR (Mus musculusdomesticus) OR (domesticus, Mus musculus) OR (Mice, Laboratory) OR (Laboratory Mice) OR (Mouse, Laboratory) OR (Laboratory Mouse) OR (Mouse, Swiss) OR (Swiss Mouse) OR (Swiss Mice) OR (Mice, Swiss). rats (Rat) OR (Rattus) OR (Rattusnorvegicus) OR (Rats, Norway) OR (Rats, Laboratory) OR (Laboratory Rat) OR (Laboratory Rats) OR (Rat, Laboratory).

**Studies selection**

It followed two phases beyond eligibility criteria: Phase I - Two independent reviewers selected studies through reading the titles and abstracts that were selected to phase II at least one of the reviewers; Phase II – Complete selected articles analysis by both reviewers.



**Data extraction**

Two independent reviewers accomplish data extraction, using a standardized form that fills: authors, year of publication, training protocol description used on the intervention (volume, intensity, frequency, study duration), strength measures and results, alters in colorectal cancer status, comparison group description, assessment times, study results and authors' conclusions.

**Bias risk**

RoB tool for animal intervention studies (SYRCLE's RoB tool). This tool is based on the Cochrane RoB tool and has been adjusted for aspects of bias that play a specific role in animal intervention researches. The resulting RoB tool for animal studies contains ten entries:

1. Was the allocation sequence generated and appropriately applied?
2. Were the groups similar at the beginning of the study, or were they adjusted for confounding factors in the analysis?
3. Has the allocation appropriately been hidden?
4. Were the animals randomly housed during the experiment?
5. Did the caregivers and/or researchers go blind to know what intervention each animal received during the experiment?
6. Were the animals selected at random to evaluate the results?
7. Did the result appraiser go blind?
8. Were incomplete results data appropriately handled?
9. Are study reports exempt from selective results reports?
10. Was the study free of other problems that could result in a high risk of bias?

These entries are related to selection bias, report bias, detection bias, attrition bias, performance bias, and other biases (Hooijmans Rovers, De Vries, Leenaars, Ritskes, Hoitinga & Langendam, 2014)

Two independent reviewers performed the bias risk and studies' methodological quality assessments. When necessary, the reviewers' disagreements were resolved through discussion and consensus, or even through a third reviewer. The total score ranges from 0 to 10 points, with a score of 6 or higher considered high quality; RCTs with less than six were considered low quality.

**Summary measures**

Results were put in Summary Tables that contained seven entries with study data about author and year, objective, intervention group, control group, induction type, and results about tumor development comparison between treated and control groups.

**3. RESULT**

A total of 1722 studies were found through an electronic database search, of which 1225 were selected for titles and abstracts analysis, of which 1182 were excluded for not fulfill the eligibility criteria requirements. As a result, 43 abstracts were selected and assessed to a full reading. After full-text evaluations, 13 studies were selected.

Figure 1 shows the steps taken to selected and the reasons for excluding some studies.

In Tables 1 and 1.1, the Cochrane RoB Tool assesses the bias risk in the included studies by addressing the following bias types: selection bias, performance bias, attrition bias, detection bias, and reporting bias.

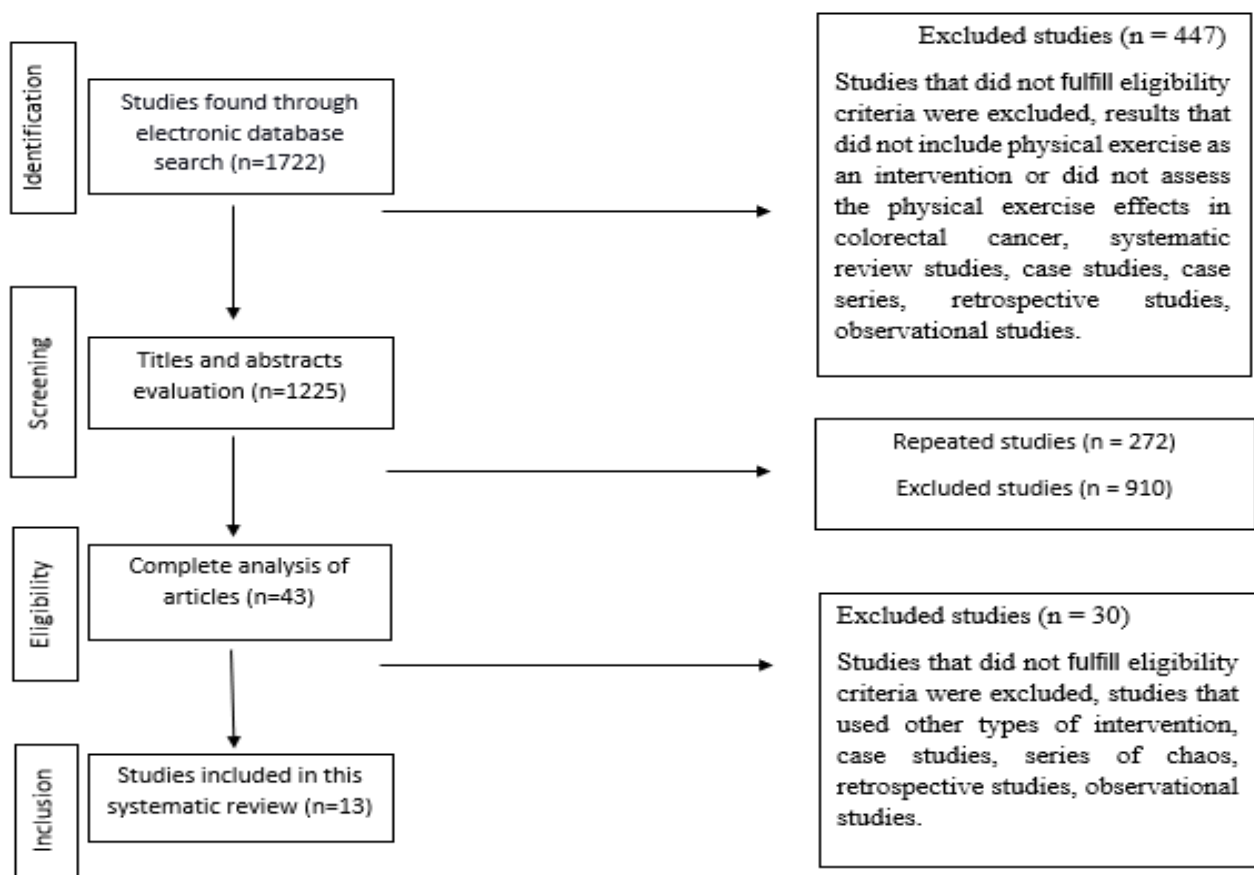
Bias risk graphs 1 and 1.1 show the authors' judgments about each item bias risk, represented as a percentage.

In Table 2 and 2.2, The characteristics of included studies are described, following the items: author, year of publication, study design, study subjects, division of groups, analyzed variables, and results.

**Figure 1:** Shows the steps are taken to selected and the reasons for excluding some studies.

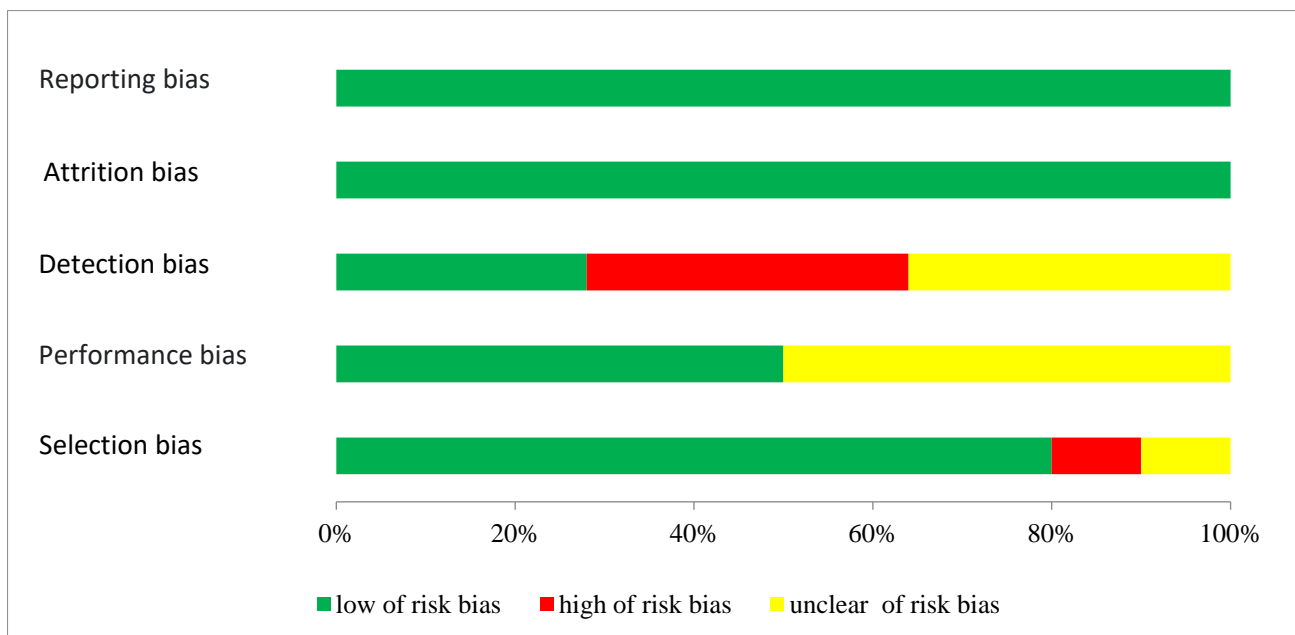
**Table 1 Summary of bias risk':** Note the authors' judgments about each item of bias risk for each included study. Risk assessment of bias in studies with rats.

Study 1	Study 2	Study 3	Study 4	Study 5	Study 6	Study 7
Lunz et al., (2008)	Demarzo et al., (2004)	Kaori et al. (2017).	Demarzo et al.,(2008).	Bandaru et al.,(1998)	Fuku et al.,(2007)	Thorling et al., (1993)



1.	Yes	Yes	Yes	Yes	Yes	Yes	Yes
2.	Yes	Yes	Yes	Yes	Not	Yes	Yes
3.	Not	Unclear	Yes	Yes	Yes	Yes	Unclear
4.	Yes	Yes	Yes	Yes	Yes	Yes	Yes
5.	Unclear	Unclear	Unclear	Unclear	Unclear	Unclear	Unclear
6.	Yes	Yes	Unclear	Not	Not	Not	Yes
7.	Unclear	Yes	Unclear	Unclear	Not	Unclear	Not
8.	Yes	Yes	Yes	Yes	Yes	Yes	Yes
9.	Yes	Yes	Yes	Yes	Yes	Yes	Yes
10.	Yes	Yes	Yes	Yes	Yes	Yes	Yes

**Graph 1 of bias risk:** note the authors' judgments about each item of bias risk in all included studies with rats.



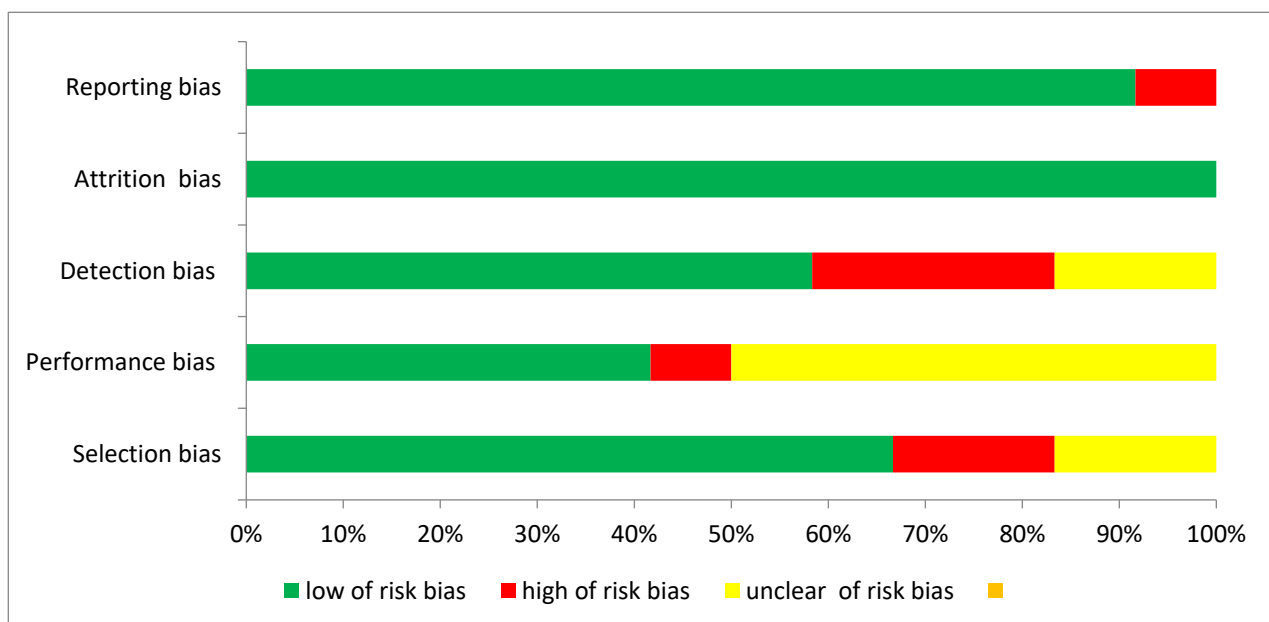
In the selection bias, study 5 didn't describe if the intervention and control groups were or weren't similar at the beginning of the experiment. Study 1, 2, and 7 didn't present enough details to set if the intervention allocations could have been predicted before or during the subscription. In the bias of performance, all the studies presented uncertainties about the researchers blinding of knowing which intervention itch animal received. In the bias of study detection, 1 and 3 presented uncertainties, and 4, 5, and 6 didn't describe if the animals were or weren't randomly selected for results evaluation and which methods and measures were used to select the animal, for blinding the results evaluations of knowing which intervention itch animal received. In the bias of attrition, all of them described the results data integrity for

the main itch result. In the bias of the report, all the studies presented selective results report and how it was examined, and what was found.

**Table 1.1 Summary of bias risk':** Note the authors' judgments about each item of bias risk for each included study. Risk assessment of bias in studies with mice

	Study1	Study2	Study3	Study4	Study5	Study6
	Wataru et al.,(2010)	Kristem et al.,(2008)	Kelly et al., (2017)	Aoi et al.,(2013)	Colbert et al., (2000)	Frajacomo et al.,(2015)
1.	Unclear	Yes	Yes	Unclear	Yes	Yes
2.	Yes	Yes	Yes	Not	Not	Not
3.	Yes	Yes	Unclear	Yes	Yes	Yes
4.	Yes	Yes	Yes	Unclear	Yes	Yes
5.	Unclear	Unclear	Not	Unclear	Unclear	Unclear
6.	Yes	Yes	Yes	Yes	Yes	Yes
7.	Unclear	Not	Not	Unclear	Not	Yes
8.	Yes	Yes	Yes	Yes	yes	Yes
9.	Yes	Yes	Yes	Yes	Yes	Yes
10.	Yes	Yes	Yes	Not	Yes	Yes

**Graph 1 of bias risk:** note the authors' judgments about each item of bias risk in all included studies with mi. In the selection bias, the study 1 and 3 didn't describe how and if the groups of intervention and control were or weren't similar at the beginning of the experiment, studies 4, 5, and 6 didn't describe the criteria used to compare and judge if the intervention and control groups were or not similar at the beginning of the experiment. In the performance bias, all the studies didn't describe with clarity the measures used to blind caretakers and researchers to know which interventions itch animal received, and if the animals were or not randomly selected for results evaluation and which methods were used to select the animals if there is any. In the detection bias, studies



2, 3, 4, and 5 didn't present all the measures used to blind results evaluators of knowing which intervention itch animal received. In the attrite bias, all of the studies described the integrity of the results data for itch main result, attrite and exclusion of analyses included. In the reporting bias, all of the studies presented selective results of what was examined and found.

**Table 2:** Characteristics and results of studies included in rats in this review.

Author, year	Objective	Subject	Intervention group	Control group	Kind of induction	Results
Lunz, Peluzi, Dias, Moreira, Natali, (2008).	To check the effects of aerobic training regime of long term swimming of different intensities in the colon carcinogenic process	Male Wistar rats .	3 swimming groups in different intensities During 35 weeks by 20 min/day, 5 days/week. G1=0% of the body weight (n=12) G2=2% of the body weight (n=12) G3= 4% of the body weight	Sedentary control group ( N = 10)	In the second week of experiment, all the rats received 4 subcutaneous injections of 40mg/Kg of weight body of 1,2-dimethyl-hydrazine (sigma, EUA), two injections in the first week and two in the 2nd week, in nonconsecutive days	The swimming training didn't affected the tumor multiplicity (GC: $2,30 \pm 0,58$ ; GE1: $2,09 \pm 0,44$ ; GE2: $1,27 \pm 0,19$ ; GE3: $1,50 \pm 0,48$ ) or size (GC: $1,78 \pm 0,24$ ; GE1: $1,81 \pm 0,14$ ; GE2 : $1,55 \pm 0,21$ ; EG3: $2,17 \pm 0,22$ cm) The number of small ACF (ACF $\leq 3$ ) in the EG2 also was significantly reduced compared to GC ( $61,00 \pm 5,98$ vs. $85,00 \pm 4,73$ crypts, respectively)
Demarzo , Garcia (2004)	To check the influence of the exhaustive exercise in colon carcinogenesis in rats not trained.	Ratos Wistar males 30 days after the birth	Swimming exercise group until the exhaustion with weight a equivalent to 2% of it (n=8)	Control (n=8) was maintained in a small chamber with 3cm of water	Only injection of 1,2- dimethyl-hydrazine (50 mg/Kg of body weight)	The number of focus in the exercise group was $10,85 \pm 3,20$ by microscopic field and $3,72 \pm 0,70$ in the control group. The LAC number increasing in the exercise group was statistically significant ( $P < 0,01$ ). Most of the ACF appeared in the middle and distal colon in both groups.
Kaori et al. (2017).	To investigate the mechanism that can explain the high-intensity physical exercise efficiency in the reduction of colon cancer, with a focus on the acid and cysteine-rich secreted protein (SPARC)	344 Fischer male rats 4 weeks old	Training in high-intensity swimming, 12 sections of the 20s, with 16% of its body weight, a pause of 10s, between the exercise sections for five days/week during four weeks. (n=8). Swimming training of low intensity 2.	Sedentary control group (n=8)	Subcutaneous injection of 1,2-dimethyl-hydrazine 20mg/Kg of body weight 1 a week, for 2 weeks.	The ACF numbers were less significant in the high-intensity group compared with the control group ( $P < 0,05$ ). The number of LAC seem in the high intensity ( $14 \pm 10$ ) were significantly low compared to control groups ( $23 \pm 14$ ) ( $P < 0,05$ ). The SPARC protein levels of the high-intensity trained rats were significantly higher than the seen in the other control groups. ( $P < 0,05$ )

Demarzo et al., (2008).	To confirm the existence of the early inhibitory effect efficiency of the exercise against the colon carcinogenesis, studying the proliferation of the epithelial cells and check the exercise influence in the COX-2 expression.	Male Wistar rats, 30 days after the birth	Group 2 (n=8), eight weeks of swimming training, 5 days/week. Group 4 (n=8), 8 weeks. Swimming training, 5 days/week + DMH injection, first week they swam for 15 min. daily. The second week, 50 min., then 10 min. until the 6 <sup>th</sup> week 90min.	Sedentary group 1 (n=8). Sedentary group 3 + DMH injections (n=8)	dimethyl-hydrazine DMH (50mg.Kg – body weight)	The physical training attenuates the increase related to DMG in the epithelial cells proliferation and in the COX-2 expression in the rat's colon mucosa. However, this increase was significantly attenuated in the training group G4 (P<0,01). Similar results were seen related to COX-2 expression.
Bandaru, Reddy, Sugie, Lowenfel s,(1988)	To investigate the volunteer exercise effect in the colon carcinogenesis induced by OMA in male rats F344	F344 male rats	Volunteer wheel exercise, free access + OMS (n=27) Volunteer wheel exercise (n=12)	Sedentary + OMS (n=27) sedentary (n=12)	OMA for 2 weeks with a doses level of 15mg/Kg.	The incidence and multiplicity of colon adenocarcinoma were significantly inhibited P < 0,05 in the exercise group when compared to the sedentary, but the incidence and multiplicity of colon adenomas weren't affected by the exercise.
Fuku, Ochiai, Terada, Fujimoto , Nakagam a, Tabata, (2007)	We examined the running machine training effects in the induction of the aberrant crypts focus (ACF)	F344 rats, 4weeksold	Running training in the running machine (N=19) for 120 min. d- (two sections of 60 min separated by 10 min of rest, 5 days a week, for 4 weeks.	Sedentary control (N=19)	Subcutaneous injection of 1,2-dimethyl-hydrazine DMH, 20mg/Kg of body weight, once a week, during 2 weeks.	The number of rats ACF of the training group was significantly less than seen in the control group (P < 0,05). The total CA number was also considerably less in the training group than the control group (P < 0,05). However, the proportion of AC/total ACF, which indicates the medium size of induced ACF, didn't differ significantly between training and control groups (2,9 ± 0,2 vs. 2,9 ± 0,7, P> 0,10).



Thorling, Jacobsen, Overvad, (1993).	To evaluate the exercise effect the intestine tumor development in Fischer male rats after the exposition to the azoxymethane	Fischer male rats	Exercised in the running machine, 2km a day in useful days, 38 weeks after the induction by azoxymethane	Sedentary control (n=16)	3 subcutaneous injections of azoxymethane, 15mg/kg of body weight.	After 38 weeks, significantly fewer rats in the exercise group developed neoplasm in the colon mucosa.
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**Table 2.1:** characteristics and results of studies included in mice in this review.

Autor, ano	Objetivo	Sujeitos	Grupo Intervenção	Grupo Controle	Tipo de indução	Resultados
Wataru et al., (2010)	To investigate the exercise effect in colon tumorigenesis associated with iNOS and COX-2	Balb mice (8weeks old)	OMA group with running exercise (n=2-) in the running machine regular 3 weeks, during 6 weeks Speed of 15m/min until 30min to 20m/min (n=20)	Sedentary group (n=20)	Dose of 12,5mg/Kg of body weight, once a week, during 2 weeks.	Compared to the sedentary group, the exercise group presented a significant reduction in the ACF and AC number $p<0,05$ . The injection of OMA sharply increased the expression of mRNA of iNOS in the colon, while the regular exercise suppressed this elevation.
Baltgalvi, Berger, Peña, Davis & Carson, (2008)	To determine if the exercise changes the polyps signaling related to inflammation and growing.	Mice <i>Apc</i> <sup>Min/+</sup> males 3,5 weeks.	Exercise (n= 20) run in the running machine 18 m/min; 60 min/dia; 6 days/week; 5% of degree), totalizing 9 weeks.	Sedentary control (n= 20)	Mice with a mutation without 850 codon sense in the gene <i>Apc</i> ( <i>Adenomatous polyposis coli</i> ) predispose the small and big intestine adenomas.	Nine weeks of running machine training produced a decrease of 35% in positive cells for macrophages, F4/80 in the polyps; ( $P= 0,010$ ). The protein COX-2 total didn't change with physical training ( $P= 0,835$ ). The exercise didn't have an effect in the accumulated by $\beta$ -catenin in polyps with a low number of focus ( $P= 0,275$ ) or in a bug number of focus ( $P= 0,420$ ;
Kelly et al., (2017)	To examine the genetic background effects (tension), volunteer exercise (wheel run), and its	Mice lineage (C57BL6 A/J, C57BL6/J, C58/J, KK/HIJ, I/LNJ)	G1= (n=15) female, itch one on the six lineages G2= (n=12) males A/J and (n=12) females, 5 weeks of access	Sedentary (n=x)	2injectionsof OMA	Between exercise, conditions indicated that the access to a running wheel or whatever moment had a significant reduction statistic in the tumor numbers in relation to any exercise ( $P<0,03$ ). The regression analyses revealed the

	number interaction in the intestine tumor's number and size.	With approximately 8 weeks old	to a running wheel before induction, 5 weeks of access to the wheel after induction.			distance wheel of functioning to a significantly proportion of variance in tumor number ( $R = -0,646, R^2 = 0,418, P = 0,044$ ).
Aoi et al., (2013)	To identify new myosin to contribute to the prevention of colon.	Null SPARC mice (B6; 129S-Sparc <sup>tm1Hwe</sup> / J) and savage mice.	Group 1= 6 weeks of regular exercise, Group 2 = only exercise section.	Sedentary mice.	Azoxymethane (AOM)15 µg/kg	ACF and AC were made in null SPARC mice treated with AOM of the savage mice. The exercise didn't have an inhibiting effect. More ACF and were made in null SPARC mice treated with AOM than in savage mice, and the exercise didn't have an inhibiting effect.
Colbert, Davis, Essig, Ghaffar, Maye, (2000).	To examine the effect of physical training in the development of the polyp in a mutant mice strain induced predispose to multiples intestine neoplasm.	Male heterozygous mice C57BL/6 J-Min/n+ and female C57BL/6 of 3 weeks old.	Running (11 males +11 females N= 22) exercise in the running machine 60 min in the growing speed of 18 to 21 m min, for 7 weeks.	Sedentary (10 males, 6 females n=16)	Induced with etil-nitrosureia mice, and predispose to multiples intestine neoplasm.	Combined analyses between female and male didn't revealed exercise effect over small intestine polyps effects(P= 0,50), colon (P= 0,17) or total intestine (P= 0,44). There wasn't a difference between sedentary and exercised in the female to any intestine location(P> 0,05). There was a tendency to less polyps in excited male mice in the colon(P= 0,06), small intestine (P= 0,08) and total intestine (P= 0,06).
Frajacom o et al., (2015)	To demonstrate that physical exercise is a protector against colon carcinogenesis.	BALB male mice with interleukin 10 (IL-10)	Aerobic group (n, MNNG=8) Aerobic group (not exposed, n=8) 5 days swimming without during 56 days, 20 min. (first week.) to 60	Exposed sedentary MNNG (S,n= 6) Not exposed sedentary (n=6).	N-metil-N'-nitro-N-nitrosoguanidina (MNNG).5 mg mL <sup>-1</sup> ;intrarectal deposit of 100 µL; twice by week, during 2 week.	The training with aerobic exercise was related to a significant increase in IL-10 levels between carcinogen agents exposed mice (p<0,001). The aerobic training reduced the colon dysplastic lesions in 36% of the sedentary group exposed to carcinogens agents (P<0,05). This protector effect wasn't seen between trained mice in

min (3rd week)	IL-10 resistance exposed to
resistance group	carcinogens agents development
(n= 8) 80 stair	20% more of dysplastic lesions
inclination; 1	that its antecedents of (C57/BL6
cm space	(1,68 ± 0,91) vs IL-10 <sup>-/-</sup> (8,69 ±
between the	8,3 total displasm for m2 )) (P=
steps and high	0,01,);
of 50cm) 7	
climbing for	
2min to	
recovering.	

#### 4. DISCUSSION

The results presented that light and moderate-intensity physical exercise were capable of reducing tumor development but didn't prevent its emergence, presenting that the exercise can be an allay in colorectal cancer treatment. Found results indicated that the physical exercise generated a direct response in growing circulants factor, cytokines and angiogenic factors, hormones and several other kinds of cells which have the potential of tumor development, immune cells included, presenting possible responses of physical exercise over the tumor development.

A study of Lunz, Peluzi, Dias, Moreira, and Natali (2008) presents that different intensity of swimming exercise didn't reduce the colorectal cancer development compared to the control group; only the 2% intensity reduced the cancer development, but not against DMH induced tumors, these results suggest that the intensity of the exercise makes a central in this process, even below the anaerobic threshold.

Bandaru, Reddy, Sugie, and Lowenfels (1988) also presented in their study the volunteer wheel exercised animals when compared to the sedentary animals, the colon adenocarcinoma, induced by OMA, incidence, and multiplicity were significantly inhibited, but the colon adenoma incidence and multiplicity weren't affected by the exercise.

The exercise promotes the physiologic adaptation in the homeostatic control circuit; with it, such adaptations stimulate the systemic surroundings reprogramming, potentially characterized by availability, mobilization, recruitment, retention, and function of kinds and/or specific cell of molecule alterations. The exercise activates a diversified network of transcription factors, kinases, and coregulator proteins that culminate in genic expression alterations that raise the mitochondrial biogenesis and stimulate the skeletal muscle metabolic reprogramming (Koelwyn, Quail, Zhang, White & Jones, 2017); (Brown, Winters-Stone, Lee & Schmitz, 2012). Regular exercise reduces the levels of glucose and insulin, elevates the levels of corticosteroids hormones and of anti-inflammatory cytokines, and raises the receiver's expressions of insulin in the cells that fight cancer. (Spinola, Souza Manzzo & DaRocha, 2012).

Fuku, Ochiai, Terada, Fujimoto, Nakagama, Tabata, (2007). The low intensity running training inhibits the development initiation of ACF aberrant crypts focus of the DMH colon induced.

ACF aberrant crypts are the first identifiable neoplasia lesions in the carcinogenic colon model. The ACF progression to polyp and, posteriorly, to cancer is parallel to the accumulation of several biochemistry alterations and mutations, in which a small fraction of ACF evolves to colon cancer (Alrawi et al., 2006); (Gupta Pretlow & Schoen, 2006).

The exercise can change the events to the tumor initiation modifying the carcinogen activation, specifically improving the cytochrome P450 system and the selective enzymes by way of carcinogen detoxification, including, among others, transferase-S-glutathione. Besides, the exercise can reduce oxidative damage, increasing the level of an antioxidant enzyme variety, improving the DNA and intracellular proteins repair systems (Silva, Sivieri & Rossi, 2009).

Thorling, Jacobsen, and Overvad (1993) study, after 38 weeks, significantly fewer rats of the exercise group develop colon mucous neoplasia. The precocious beginning of the physical exercise execution decreases the inflammation; it protects against several kinds of cancer and increases the life expectancy of natural-age mice (Nilsson et al., 2019).

Demarzo e Garcia (2004) presented that only an exhaustive exercise section was associated with an increased number of aberrant colonic crypts in rats not trained treated with DMH when compared with the control group animals. The resisted and aerobic exercise can activate different metabolic ways due to the different intensities and mechanical loads imposed on the muscle. In fact, aerobic exercise results in different metabolic responses, resulting in an increase of mitochondrial mass, oxygen contribution, glycose capitation, and antioxidant capacity (Galle, Martella & Bresciani, 2018). Exhaustive swimming exercises originate from tissue damage, regardless of the trained condition, according documented by similar levels of muscle lipid peroxidation and mitochondria integrity loss, and reactive species found in trained and not trained exhausted rats (Ferraresso, 2010).

The oxidative stress reflects an unbalance between the species production that is reactive to oxygen and adequate antioxidant defense. This adverse condition can take it to cellular and tissue damage in the components, and it is involved in different physiopathology conditions, including aging, exercise, inflammatory, cardiovascular and neurodegenerative disease, and cancer (Pingitore et al., 2015).

High oxidative stress and the function of immune depression can make de colon carcinogenesis easier. Besides the regular physical exercise have many health benefits well establish. The exercise effect over immune functions, like macrophages and lymphocytes, suggests that middle-intensity exercise get better the immune function, while exhaustive exercise promotes immune suppression (Nieman & Wentz, 2019); (Carini et al., 2017).

Kaori et al. (2017) study. It presented that the intermittent swimming of high intensity reduced the number of ACF induced bay DMH in the rat's colon, suggesting the high-intensity training can be a preventive effect in colon cancer. The results also suggest that the secreted protein, acidic and full of cysteine (SPARC), a myosin whose expression is regulated by intensity related sings of 5'-monophosphate-adenosine kinase activating protein (AMPK), can interfere in the effect of the high-intensity physical training in the prevention of colon cancer.

The SPARC, also nominated osteonectin or basement membrane-40, is a matrix-associated protein that provokes alterations in the cellular form; it inhibits the cellular cycle progression and affects extracellular

matrix syntheses (Brekken, 2000). In some tissues, it seems to have tumor suppressor properties by check inhibition of some kinds of cancer growing. In the skeletal muscles, the SPARC in the colon cancer with chemotherapy reduced sensibility, and it presented that the resistant reversion to therapy could be achieved through the positive regulation of SPARC expression or of the exogenous exposure in higher levels of SPARC. (Cheetham et al., 2008); (Wang et al., 2014).

AMPK is a protein complex/Ser kinase protein/Thr highly preserved, which is another potential candidate to regulate autophagy through the maintenance of energetic homeostasis. The molecular mechanism of AMPK regulates the autophagy is usually assumed by the inhibition of the mTOR, which actuates in the initial step of autophagy, that regulates it negatively. Recent discoveries presented that the AMPK activation is critical to the biosynthetic activity maintenance of the cancer cells (Liu et al., 2019); (Hart et al., 2015).

Demarzo et al. (2008), in this exercise results, reduced the colonic expression of the cycle-oxygenase-2 (COX-2). It is known that colonic carcinogenesis is associated with the COX-2 expression increasing that takes to excessive production of prostaglandin E2. The physical training exerts notable anti-proliferative and anti-inflammatory effects in the rats' colonic mucosa, suggesting that this can be an important mechanism to explain how the exercise protects de colon cancer (Lunz, Moreira & Viana, 2006).

About 85% of the colon and rectum present elevated levels of COX-2. Literature reports suggest that the polymorphism in an only nucleotide (SNP) in the gene COX-2 could be capable of modifying the enzyme function and, this way, amplify the risk of an individual to develop colon cancer (Cossio, Costa, Fernandes, Laranjeira, Fernandes & Poli-Frederico, 2017).

The exercise significantly inhibits the COX-2 activity, taking to pro-inflammatory cytokines suppression and redox status alterations. The found result presented that the exercise prevented morphologic alterations triggered by high fat, reducing the COX-2 expression in the proximal and distal intestine (Campbell et al., 2016); (Eberhart, Coffey, Radhika, Giardiello, Ferrenbach, Dubois, 1994); (Lee, Yang, Huang, Huang, Kao & Chen, 2015).

Chronic inflammation is connected to de development of several cancers. The intestine inflammation induces carcinogenic mutagenesis and promotes colorectal cancer beginning (Chen, Pitmon & Wang, 2017). The inflammatory environment has many similarities with the tumor microenvironment, suggesting the implication that the same mediators in the chronic intestine inflammation and in colorectal carcinogenesis. Many inflammatory mediators were found positively associated with colorectal adenomas prevalence (Lucas, Barnich & Nguyen, 2017).

The result of Wataru et al. (2010) regular exercise suppressed the genesis of aberrant crypts focus in the colon by azoxymethane. The azoxymethane injection raised the expression of nitric oxide syntheses (iNOS) in the colon, while the regular exercise suppressed this raising. The COX-2 wasn't changed by the OMA or by the exercise. The tumor necrosis factor alfa (TNFa) was reduced by the exercise in the colon and in the plasma.

iNOS is an enzyme predominantly expressed during inflammatory reactions. However, the syntheses of large quantities of nitric oxide (NO) by the iNOS have been demonstrated in the physiopathology process, as acute or chronic inflammation and tumorigenesis. The iNOS gene expression

enhanced to production is probably the mechanism that contributes to the increasing of the exercise-induced cytolysis (Gochman et al., 2012); (Bellafiore, Battaglia, Bianco & Palma, 2019).

According, the exercise increases the mRNA expression of the alpha X receptor transporter and of the ATP ligation cassette, and it reduced to inducible synthase nitric oxide (iNOS), the cyclooxygenase-2 (COX-2), the tumor necrosis factor alfa (TNFa). The protein iNOS is modulated by a moderate-intensity exercise (De Castro et al., 2019).

In the study by Kristen et al. (2008) the physical exercise reduced the macrophage number in the polyps by 35%. In relation to the apoptosis, the exercise reduced by 73% of the positive cells number to terminal marking (TUNEL). The exercise reduced the macrophage number in the polyps by 35%. The original hypothesis proposed that the macrophages were involved in the anti-tumor immunity; there is clinical and experimental substantial evidence that, in most of the cases, these macrophages associated with tumor (TAM) increase the tumor progression to malignity. The tumor-promoting functions of macrophages in the primary local include the support to angiogenesis associated with the tumor, invasion of promotion, migration, and tumor cells intravasation, as the suppression of the anti-tumor immune response. (Rosa, Bicudo & Vaisber, 2012). The macrophages also potentiate sowing and the establishment of the metastatic cell and play a role in the tumor initiation when the inflammation is a causal factor (Qian & Pollard, 2010). The Kelly et al. (2017) volunteer exercise before or during the OMA treatment resulted in a significant reduction in the tumor numbers, but in exercise before the OMA explosion, it had no effect.

Exercise used studies as an intervention in animals as tumors presented potential changes in the tumor physiology. It was demonstrated that the exercise reduces the incidence and multiplicity and the growth of the different kinds of xenograft, chemically induced, or genetically induced, emerging mechanistic effects of exercise, including bloody vascularization and perfusion, immune function, tumor metabolism, and cross conversation between muscle and cancer (Pedersen, Christensen & Hojman 2015).; (Ruiz-Casado et al., 2017).

Aoi et al., (2013) in mice, an only exercise section increased the SPARC expression and secretion in the skeletal muscle in rats and humans. Besides that, in an azoxymethane mouse model with induced colon cancer, regular low-intensity exercise significantly reduced the crypts aberrant focus formation in savage mice, but not in SPARC-null mice. Besides that, the regular exercise improved the apoptosis in mucosa colon cells, and it increased the cleaved forms of caspase-3 and caspase-8 in savage mice, but not in SPARC-null mice.

The caspase-3 promotes the tumor growing, providing a pro-angiogenic microenvironment. Besides that, the dying cancer cells promote the restocking of tumor cells after chemotherapy. In human patients with colon cancer with low levels of activated caspase-3 had a long time of disease-free survival.

Studies presented that the caspase 3, 8, and 9 levels expression are useful prognoses factor in cancer-related to the digestive system, especially in colorectal cancer (Liu Saber & Haisma, 2019) ( Asadi et al., 2018).

Colbert, Davis, Essig, Ghaffar, Maye (2000). There were no significant effects in the exercise in males and females combined in the small intestine, colon, or total intestine polyps. When separately analyzed, however, there were total polyps in the excited male group than in the control males, although



the difference hasn't been statistically meaningful. The aerobic training reduced the number of colon dysplasia lesions by 36% compared to the sedentary group exposed to cancer agents. This protector effect wasn't seen in resistance trained mice.

The exercise induces adaptations in multiples cell processes in the skeletal muscle, including metabolism, angiogenesis, and immune regulation. The depletion of the ATP and NADH levels elevate the AMP: ATP and NAD<sup>+</sup>: reasons NADH, activation several metabolic sensors, including the NAD (SIRT1) dependent sirtuin deacetylase one protein and kinases as the activate kinase protein by AMP (AMPK), ERK1/2, p38 MAPK, and kinase N-terminal (JNK) (Abreu, Leal-Cardoso & Ceccatto, 2017). These metabolic sensors activate the alpha receptor co-factor activated by one alpha peroxisome proliferator (PGC1alpha), that regulates the mitochondrial protein expression coded in nuclear and mitochondrial genomes by the interaction with several factors in the transcription, as the activated receptor by peroxisome proliferator (PPARgamma), receptor alpha-related to estrogen (ERRalpha), ERRgamma, nuclear respiratory factor 1 (NRF1) and NRF2. The NRF1 also increases the mitochondrial transcription factor to tumor metabolism. (Koelwyn et al., 2017); (Yu et al., 2013).

## **5. CONCLUSION**

Based on the experimental studies in found animal models, suggest that the resisted and aerobic and resistance exercise training can reduce several risk factor, as, reducing the systemic pro-inflammatory condition, induced by the tumor, reducing oxidative muscle stress and muscle damage, improving the anti-inflammatory system through the regulation of cytokine network, strengthening the defenses of the immune system and helping to keep the suitable body weight, reducing the cyclooxygenase3 expression, related to the colon inflammation. With this, it presents the practical importance of physical exercise to colorectal cancer prevention and treatment. The suggested exercise and physical activity demonstrate the need for hypothesis refinement that only will be achieved with well-directed and controlled experimental studies. Once that the colorectal cancer protection by the exercise and physical activity is considered convincing by the found evidence. It becomes fundamental that the new studies involving exercise and CC seek to explore the biologic mechanism of protection, so, this way, can be possible to understand the mechanism deeply of the exercise in colorectal cancer, and to do the prescription and practice of physical exercise that is directed specifically to colorectal cancer prevention and treatment.

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# **PLAY AS AN INDICATOR OF PRESCHOOL CHILDREN'S SOCIAL SKILLS IN THE CONTEXT OF EDUCATIONAL DIAGNOSTICS**

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## **Abstract**

*The task of kindergarten teachers is to support the development of preschool children with respect to their potential. In order to do this, they need to know every single child including their development potential, limitations, interests, needs, etc. The information about children in kindergarten is acquired by means of educational diagnostics throughout the whole day.*

*The authors intend to present a TACR project, which involves the development of an online instrument for the purposes of educational diagnostics in kindergarten. In this way, the team of investigators respond to the current needs of educational practice, where educational diagnostics appears to be a weak part of the educational process. This may have a negative effect on the effectiveness of the education process. An integral part of the development of the online tool is practical verification in through a series of partial steps. In the paper the authors present one of the areas that will be monitored in the online application—evaluation of interpersonal relationships in the context of children's play. The concept itself is based on educational theory and educational practice and reflects the current trends in education and the requirements of educational practice.*

**Keywords:** Child, play, social skills, educational diagnostics, school readiness, online application.

## **1 INTRODUCTION**

At present, one of the topical issues is the quality of preschool education in the context of children's readiness for compulsory education. This quality is related to the effort to decrease the number of children with postponement of compulsory education and also to the introduction of compulsory preschool education in 2017 and the variant form of home preschool education one year prior to enrolment in compulsory school education. As suggested by the authors' previous research studies [1] and the results presented by the Czech School Inspectorate (referred to as CSI), educational diagnostics is one of the weaknesses of preschool education. Available research studies show that kindergartens have systems in place to assess the children's progress, but they are not always able to use them in children's development. The determination of an educational diagnosis in order to achieve the key competences and expected outcomes, and the educational process itself do not often match the current knowledge about the child. Therefore, this fact is in contradiction with the current trends and requirements in education—emphasis on individualization. The intended online application is designed as a professional support of the teacher for the purposes of educational diagnostics. The application does not in any way lead to schematization, as is often the case with record sheets of higher or lower quality. On the basis of the partial steps, the team of

investigators are developing a scheme for the evaluation of the child's development and progress in compliance with the outcomes defined by the preschool curriculum. The paper presents the process of verification of the evaluation of interpersonal relationships in the context of children's play.

## 2 PRESCHOOL AGE—THE AGE OF PLAY

In the life of the child, the preschool period is sometimes identified as the age of play, which is the dominant activity of this significant period. Play offers inexhaustible opportunities and is a source of new stimuli, interactions and social contacts. During play, children are spontaneous, use their knowledge, skills, emotions, etc. Play is an important activity for preschool children as it affects their development but also for the teacher as a source of information about the children.

Should play have the qualities defined above, appropriate conditions must be provided, but this does not apply just to material conditions. High-quality play is an indicator of the quality of the teachers' work, their creativity, knowledge of the children, empathy, ability to listen, ability to use play in a natural and peaceful way to assess the children's development using educational diagnostics and taking into consideration their individual peculiarities [2].

The current preschool education is based on the personality-oriented model. This concept involves individualization in education, which is understood as a way of differentiation in the education of children in the context of a social unit—in this case the class—where internal, content-based and methodological differentiation takes place with respect to the peculiarities and needs of each individual. In this context, Opravilová says, *"The individual approach is nothing extra, it is neither a privilege nor a punitive measure. It is simply attention and consideration of the uniqueness of each child, the art of approaching the child in a way that best suits the child, and the ability to choose tailored educational strategies"* [3].

## 3 PROFESSIONAL COMPETENCES OF KINDERGARTEN TEACHERS

The current concept of the system of education requires a well-defined continuity of the educational levels. Kindergarten is the entry level and the first educational system that children are exposed to. In an analysis of research studies, Provázková Stolinská emphasises the broad competences of kindergarten teachers [4]. Kindergarten teachers should have the necessary competences including the following: *educational and didactic, course-specific, diagnostic and informational, social, psychosocial and communicative, managerial and normative, professional and personality-cultivating* [1]. The level of these competences is reflected in the quality of the educational process. The authors of the present paper believe that the diagnostic competences are related to the entire educational process. The teacher designs and performs interim as well as final evaluation, which is then reflected in the teacher's further education work. The teacher monitors all activities in terms of their compliance with the relevant criteria, for example view of the child whose individualization is supported, view of the group of children whose friendships and sense of belonging are supported, etc. The continuous monitoring and evaluation of educational reality becomes the basis for further support and development of the child, elimination of problems and adequate interventions [1].

The results of CSI are consistent with our findings and suggest that the situation in the area of educational diagnostics in Czech kindergartens is not very good.

CSI suggests the following:

*"Systematic monitoring of individual educational progress has been a long-term weakness in education, because in most of the cases (56%) educational diagnostics did not reach the required level and therefore*

**did not support individualized education.**

*“At the same time it was observed that a large part of the education was well organized (66.5%) but a considerable part of the teachers failed to take into consideration the children’s individual capabilities, skills and interests (47.4%). This situation is related to inadequate use of educational diagnostics in determining the educational objective.*

*“An alarming finding is that almost half of the schools failed to develop a comprehensive system that would monitor the children on a regular basis and define specific evidence-based conclusions for the children’s individual development in the future. CSI’s statistics show that educational diagnostics and the preparation of an individualized educational offer have in the long term been the most problematic areas in preschool education.”*

(Annual report of the Czech School Inspectorate for 2018/2019)

The results suggest problems especially in classroom work. Kindergartens produce their own school educational programmes, according to which the teachers plan their educational activity, prepare the educational offer, but do not always reflect the specific needs of the children. This may be caused by a number of factors including problems in the area of continuous educational diagnostics, which is used by the teacher to evaluate the child in terms of progress and overall development in the context of compulsory preschool education and school readiness.

## 4 PLAY AND ITS ROLES IN THE ASSESSMENT OF CHILD DEVELOPMENT

Play is generally defined as follows: “A form of activity that differs from work or learning. People like to play throughout life, but in preschool age play has a special position—it is the dominant type of activity. Play has a number of aspects: learning, exercising, emotional, motional, motivational, creative, imaginative, social, recreational, diagnostic, therapeutic” [5].

The present paper is based on the concept of developmental psychology: “Play is an activity (physical or mental), which is performed just because it is pleasing and brings satisfaction on its own, without an external objective, irrespective of whether the activity itself is pleasant or strongly unpleasant” [6].

Play is a source of many opportunities to support peaceful development of the child in completely natural conditions. At the same time, it reflects the level of the child including the following aspects: physical (level of gross, fine and graphomotor skills), mental (speech, thinking, creativity, etc.) and social (relationships with others, observance of rules, ability to reach agreement, respect for others, etc.)

Play has been addressed by many professionals and a number of theories have been formulated. Some of these authors are for example Comenius, Spencer, Hall, Groos, Piaget.

**J. A. Comenius** referred to the importance of children’s play, which should be supported by the adult and in no way should be restricted or prevented because play supports “physical activity and mental freshness” [7].

**J. Piaget** considered play in the context of children’s cognitive development. According to the author, the development of thinking helps create more complex play, which facilitates the development of complex ways of thinking. Play helps children develop more complex forms of thinking, especially when they try to understand the principle of things that they interact with. During play, children use speech which is linked with thinking [8].

Piaget distinguished the basic periods of intellectual development, which he linked with the level and type of children’s play:

- Sensorimotor stage (6 months to 1.5–2 years, sensorimotor and motor play;

- Preoperational stage (2–7 years), (symbolic play);
- Concrete operational stage (7–11 years), abstraction, development of superordinate concepts;
- Formal operational stage (12–) [8].

In the preschool period, Piaget defined symbolic play, which is generally considered the top of children's play. Through symbolic play, children transfer an activity of an object to a substitute object. These objects then represent specific symbols, and this is the principle of assimilation, which is the basic function of symbolic play [8].

Through symbolic play children reinforce their experiences, repeat what has been experienced and come to terms with reality, which may often be incomprehensible and stressful. Play is also significant in the process of satisfying the child's emotional and intellectual needs. Symbolic play is a reflection of play pretence and role adoption [9, 10].

**L. S. Vygotsky** also emphasised the rapid development of play in the preschool period. According to the author, this is related to the emergence of new needs and motives, which are based on the currently unattainable tendencies and desires of a permanent nature. At this point, play comes in as a means of their imaginary realization. Naturally, the effect of play is not just quantitative but mainly qualitative. As Vygotsky suggests, it is "the leading activity which creates the zone of proximal development, during which children perform activities at a higher level, and where the crucial functions for the future are formed." Especially role-play is an important source in the development of preschool children's symbolic representation, self-regulation, activity planning, communication and imagination. By supporting play by the adult, the world of children is slowly getting closer to the world of adults, without depriving children of their childhood [11].

## 5 IMAGINATIVE PLAY IS AS AN INDICATOR OF CHILDREN'S SCHOOL READINESS IN THE AREA OF SOCIAL SKILLS

Qualitative research design

**Research question:** *Can imaginative play be used to evaluate interpersonal relationships in the context of school readiness?*

**Aim of the research:** By means of video recordings analyse and evaluate the use of imaginative play for the purposes of educational diagnostics as an indicator of school readiness in the area *The child and the other person* [12].

For the purposes of a qualitative (micro)analysis of children's imaginative play, the authors used **the video recording method**.

**Subject of evaluation:** Imaginative play of children in compulsory preschool education involving 5 girls and 5 boys (5–7 years of age).

**Observed events:** Behaviours in the context of the expected outcomes defined by FEP PE [12].

The videos were taken in three kindergartens in both heterogeneous and homogeneous classes. The total footage was 270 minutes.

The information from the videos was written in record sheets on the basis of a predefined category system, the purpose of which was to identify the events (event sampling).

In the present research, the authors focused on those events that were relatively easily accessible with a low degree of deduction.

At first, the recordings were checked for the types of play.

**Table 1:** Play by types of activities

Play	Type of activity—group of 5 to 7-year-old children
Imaginative, theme play	<p>Stories from life, TV stories, etc.:</p> <p>Dominated by playing household, using especially the playing corner, combined with constructive play (building houses, rooms, etc.)</p> <p>Playing traffic (combined with constructive play)</p> <p>Playing soldiers combined with constructive and fictional play</p> <p>The play was mostly of a social nature.</p> <p>The play was controlled by intrinsic motivation, the children made their own choice. Only a small proportion of play was induced by the teacher.</p> <p>The teachers' intervention in the course of play was very low, only in the case of stagnation to help develop the content.</p>
Constructive play	<p>Making of a specific product:</p> <p>Dice, LEGO building blocks (towns, vehicles, etc.)</p> <p>The following activities were also observed:</p> <p>Drawing (individual and collective work)</p> <p>Painting (individual and collective work)</p> <p>Gluing, cutting (individual)</p> <p>Puzzle, dominoes.</p>
Fictional play	<p>This category included play with musical instruments accompanied by movement interpretation (piano, flute, rhythmic instruments)</p> <p>This type of play is overlapped with imaginative and theme play.</p> <p>Sporadic occurrence. The types of play were of a social nature.</p>
Physical activity play	<p>The following types of play were observed:</p> <p>Physical activity improvisation</p> <p>Tag</p> <p>Climbing frame</p> <p>Also these types of play were of a social nature. The teachers tended to regulate these types of play for safety and noise reasons.</p>
Computer-based play	In the present study this type of play was not observed.

The most frequent types of play included imaginative and constructive play. Imaginative play was usually conducted in groups of 3–4 children. In children aged 5–7 years, the researchers observed different levels of play in terms of its elaboration. In groups of children aged 5–7 years the play was developed and the children showed their emotions, often accompanied by minor conflicts related to rejection of roles, submission, agreement, etc. In heterogeneous groups, especially girls were observed to care for younger children, which often resulted in manipulation.

### **Evaluation of interpersonal relationships**

The basis for the evaluation of interpersonal relationships is FEP PE [12], section The child and the other person.

The aim of the teacher's educational efforts in the area of interpersonal relationships is to stimulate the child in creating relationships with another child or adult, strengthen, enrich and cultivate their communication and ensure that these relationships are well kept [12].



The intention mentioned above is specified in detail by means of partial educational objectives, by following which the teacher works to achieve the expected outcomes, which essentially show whether the child is prepared for starting compulsory education in this area.

Observed events—expected outcomes (what is usually achieved by a child at the end of preschool period) [12]

- 1) Establish contacts with adults entrusted to take care, overcome shyness, communicate appropriately with the adult, respect him/her,
- 2) Understand common ways of expressing emotions and moods,
- 3) Naturally and freely communicate with other children, establish and maintain friendships with children,
- 4) Refuse a communication s/he is uncomfortable with,
- 5) Be aware of their rights in relation to each other, be able to grant the same rights to others and respect them,
- 6) Understand that all people (children) have the same value despite being different (looks and behaves differently, knows or does not know different things, etc.) and that personal or personality differences are natural,
- 7) Exercise their individual needs, wishes and rights with respect to the other (to defend their positions or opinions, to respect a different view or opinion), to accept and enter into compromises, to solve a conflict by agreement, cooperate with others,
- 8) Respect established and understood rules of mutual co-existence at home, in kindergarten, in the public, comply with game rules,
- 9) Respect the needs of another child, share toys, utilities, snacks, divide a task with another child, etc.
- 10) Understand what the other wants or needs, meet the other halfway (behave sensibly and considerately towards a weaker or hurt child, have regard to the others and sympathize with them, offer help, etc.),
- 11) Defend another child against acts of violence, maltreatment, humiliation, etc.
- 12) Behave cautiously when confronted with unknown children, older or adult people, if necessary ask for help (for themselves or for another child).

The information written in the record sheets related to the children's behaviours were then matched with the outcomes in order to find out the extent to which play can be used in the online application for the purposes of evaluating children's progress.

**Table 2:** Record of events during imaginative play

<b>Occurrence</b>	<b>Imaginative play— record of observed events</b>
(1) Very often	1, 3, 4, 7, 8, 9, 10
(2) Sometimes	5, 11, 12
(3) Never	2, 6, 13

The record suggests that most of the expected outcomes appeared with varying quality and quantity levels.



Due to the large number of records, the paper provides an overview in terms of the occurrence of the observed events.

Table 3 shows a part of the records relating to interpersonal relationships.

**Table 3:** Example of records

<b>Occurrence</b>	<b>Evaluation of the outcomes in the context of the observed play</b>
(1) Very often	<p>The children were able to communicate, some problems related to the ability to respect the other person in communication, the children respected the teacher although they showed different reactions to the teacher's instructions, especially in the case of reprimand the children's behaviours differed (termination of play, focus on a different play, shame, but also acceptance of the teacher's instructions)</p> <p>Older children, especially in relation to younger children, were attentive, particularly when the younger children entered the classroom, they helped them join the play, especially girls showed a caring and perhaps overly protective approach that could pose a risk</p> <p>Older children were able to cooperate with others, agree on a play, respect the agreed rules, accept roles, etc., even for a longer period of time</p> <p>Occasional problems occurred mainly in the case of sharing a toy, but also sharing roles, where the teacher had to intervene and regulate the play</p> <p>During the play, the children tried to push through their wishes and opinions, which resulted in occasional conflicts; it was sometimes problematic for the children to accept compromises suggested by the teacher</p> <p>The children were able to communicate freely with other children.</p>
(2) Sometimes	<p>If the children did not like the opinion or plan of their classmates, they terminated the communication, ignored the classmates or started playing with a different toy</p>
(3) Never	<p>Understand that all people (children) have the same value despite being different (looks and behaves differently, knows or does not know different things, etc.) and that personal or personality differences are natural</p> <p>Behave cautiously when confronted with unknown children, older or adult people, if necessary ask for help (for themselves or for another child)</p> <p>Be aware of their rights in relation to each other, be able to grant the same rights to others and respect them</p>

The example of the record of the events clearly shows that play provides the teacher with the required information about the child in the area of interpersonal relationships. Section (3) shows the outcomes that were not evaluated due to the lack of adequate behaviours.

The authors of the paper believe that even these skills can be evaluated through play, for example if the teacher introduces new themes and content in the play, for example through model situations.

## Discussion

School readiness includes the child's characteristics that are related to the external social factors and to the learning process. School readiness is evaluated in the cognitive area, which focuses on the development of perception, imagination, attention, memory, thinking. The other domains are somatic and work-related, where focus is for example on the child's ability to take responsibility for a task and work on the task for some time.

The last important component is the emotional-social area. This domain is related to the subject of the present research with an emphasis on interpersonal skills.

“Kellmer Pringle emphasises the importance of human relationships for the child with a particular emphasis on feelings (love, safety, appreciation, acknowledgement). Similarly, Vygotsky, Bruner and Piaget attribute great importance to interpersonal relationships. According to Vygotsky, higher functions develop especially as a result of social interaction [13].

In the research, the authors have confirmed the significance of imaginative play in the evaluation of school readiness in the context of interpersonal relationships. Virtually all of the expected outcomes can be not only developed and evaluated through play but can also be used to monitor the children's progress and make changes in their behaviour. It appears that for the purposes of educational diagnostics in the context of the upcoming online application it is necessary to describe in more detail some of the expected outcomes (especially 2, 6, 13) in terms of the children's desirable behaviour, and at the same time propose other activities for evaluation.

## **6 CONCLUSIONS**

The analysis of the video recordings has shown that play can be used for the evaluation of the expected outcomes in the area The child and the other person (interpersonal) in the context of school readiness. For the purposes of the authors' project, which is the development of an online application, the present research has identified a series of observed events and their most frequent manifestations, i.e. the basic evaluation indicators. At the same time, there is a need for clustering of the expected outcomes. The results will now be implemented in the online application—educational diagnostics instrument—and tested by the teachers. According to the teachers' comments, adjustments will be made.

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# **Student Performance Prediction Based on a Framework of Teacher's Features**

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## **Abstract**

*Teachers teaching skills are essential to motivate students' engagement in online educational environments, where students and teachers interact with each other, generating a large amount of educational data. However, to the best of our knowledge, there is no previous study that takes advantage of the huge quantity of teachers' behavioral data to predict students' performance. To fill this research gap, we elaborated a theoretically based framework of teacher's characteristics, that guided an automatic data collection of teachers' behaviors to predict students' performance. The implementation of a computational prediction system applied the Random Forest classifying algorithm, which achieved better performance, according to AUC metric, when compared to other algorithms. Two exploratory case studies were conducted to investigate the efficiency and efficacy of the framework of teacher's features in Goiás Judicial School EJUG teachers in Brazil. The results from the case studies shown that the framework is effective to predict students' performance. This work contributes to distant education, enabling monitoring teachers' actions aiming students' academic best achievements.*

**Keywords:** Teaching skills; students' performance; prediction system;

## **1. Introduction**

Nowadays, distance education emerges as a tool for the democratization of educational opportunities and enables the emancipation of the individual in the social context. The flexibility of space and time are characteristics of great social relevance in the field of distance education. However, online teaching modality requires changes in habits of both teachers and students. There are several reasons that can hinder or decrease the learning rate on distance learning platforms, amongst them the following stand out: student evasion, teachers without adequate training, inadequate time management and lack of interaction between teacher and students (EAD, 2019).

Maximizing student performance and teaching quality is a challenge in distant education. Several attempts at systematic associations between the attitudes of educational policy makers and student results have been made, however, few positive results have been found (Kukla-Acevedo, 2009). Thus, the researchers' attention shifted to in-class context, looking for correlations between teachers' actions and the academic achievements of their students.

The teacher assumes a crucial role throughout the learning process, since without the proper pedagogical accompaniment, the education process is not complete (Kyriakides & Christoforou, 2013). The teacher must organize the flow of knowledge in order to allow independent study, as well as observe the individual behavior of students. The teacher of online courses should be a mediator in the learning process, as their attitudes can directly influence the students' school performance.

The growing offer of online courses has raised some questions about the quality of teaching in distance education courses. To improve students' results, in online courses, teachers must get used to the distance learning environment. (Canales & Maldonado, 2018) found that the teachers' professional experience had a strong influence on students' grades. The mastery of technological tools can be seen as a challenge for some teachers of distance education courses, therefore, teachers must be trained to develop their activities in virtual learning environments (VLE) (Comi & Argentin, 2017). The teacher's teaching style in online teaching environments is also seen as an obstacle, (Naimie & Siraj 2012) identified that modern and innovative assessments had a positive impact on students' grades. It is essential that the teacher offers means for students receive feedbacks (Ngang & Yie 2015).

From a technological point of view, educational platforms are required pedagogical tools in distance learning. From the data stored in educational databases and with the aid of appropriate technological resources, it is possible to reveal valuable information about the teaching environment under analysis. Educational Data Mining, EDM, is a technological resource that assists in converting raw data, collected from educational systems, into useful information that can be used to improve the quality of distance education.

Given the above-mentioned, in this research, we theoretically developed a set of teachers features and their corresponding behaviors, based on features encountered on the literature and Andragogy principles, that can influence the performance of their students. Based on this theoretical framework, a student performance prediction system, applying EDM techniques, was implemented, allowing the teacher's behavior to be monitored and regulated if necessary, depending on the student's performance prediction.

## **2. Related Works**

The development of frameworks approaching teaching features has been the subject of some previous research. (Powell et al. 2014) members of iNACOL and The Learning Accelerator (TLA) motivated by an interest in understanding the roles of teachers in semi-face-to-face courses, brought together a committee of managers and specialists in mixed courses to answer the following question: "What are the main characteristics of teachers in successful mixed learning environments?" The product of this committee's work was a framework of competencies recommended for teachers of semi-presential courses at iNACOL. The framework was designed to be dynamic, as new information on teaching practices is incorporated into the framework. The framework is structured in four general categories of teaching characteristics, the following categories: Mentalities, Qualities, Adaptive Skills and Technical Skills. The teachers' mentality is linked to their motivation, belief, behavior and actions regarding their educational missions. The category of qualities relates personal characteristics and patterns of behavior that are linked to the adaptation of the teacher to new forms of teaching. Adaptive skills list teachers' characteristics in solving problems,

proposing solutions and adapting to new teaching methodologies. Technical skills list characteristics related to the experience of teachers in carrying out their duties.

Adeosun et al. (2013) developed a framework of cognitive, affective and professional characteristics that are desirable in a good teacher. The set of attributes was selected based on questionnaires applied to students, trainees, teachers and teacher trainers in Nigeria's education system. The framework brings together cognitive, affective and professional characteristics of effective teachers in Nigeria. In the context of the re- search, effective teachers were those with a high capacity to inspire and influence student learning. From the questionnaires applied to students and teachers, 27 attributes were identified related to the professional qualities of teachers, such as: Organization, punctuality, experience, motivation. 25 cognitive skills were listed, for example: potential for problem solving, resilience, self-reflection and verbal communication. Among the affective characteristics, 24 were listed, namely: cooperation with colleagues, emotional control, responsibility for their actions, impartiality, among others. However, the authors were unable to conclude whether these characteristics are capable of directly influencing the quality of teaching. For fifteen years, Walker (2018) collected information from university students on teachers' attitudes and behaviors that they considered to be most efficient and that contributed effectively to their professional careers. From the information collected, Walker (2018) formulated a framework with twelve characteristics of the teachers that positively affected the students' school performance. The results found by the authors suggest that the most effective teachers have the following characteristics: optimism, technical training, positive expectations for their students, creativity, they perform fair assessments, are accessible, convey security to their students, are compassionate with their students, have good sense of humor, respect students, have the ability to forgive and admit their mistakes.

The investigation of teachers' behavior in relation to students' performance was the subject of academic research. However, no previous work has correlated the characteristics of teachers with the guidelines of Andragogy, therefore, this is the theoretical contribution of this work for the advancement of behavioral studies considering teachers. The technological contribution of this work is enlightened as follows.

The main educational tools found in the market were developed to help teachers to monitor performance and predict results for students only. (Chiang & Brinton, 2020) developed the *Zoomi* tool that uses artificial intelligence techniques to increase course completion rates, improve course effectiveness and increase student participation. *Zoomi* is an educational management tool that aims to understand the individual needs of students to meliorate their fulfillments, and, consequently, to improve the achievements of the educational institution. The Blackboard Predict tool developed by (Chasen & Pittinsky, 2020) aims to provide educational institutions with a means of identifying students at risk, adapting resources to student's needs. *X-Ray Learning Analytics* is an open source tool created in 2005 by (Miller et al., 2020) to support education centers and companies to understand and diagnose students and teacher's needs. The tool also provides the prediction of students drop out and the generation of detailed reports on student behavior. All the tools found in the literature and available on the market focus on students and provide services to support teachers and educational managers on monitoring students for decision making. The technical contribution of this work concerns the advancement of the state of the art, by the creation of an educational prediction tool under a perspective of monitoring teacher characteristics for educational interventions.

### 3. Methodology

The data selected for a case study was collected from the Goiás Judicial School (EJUG), which is a judiciary educational department linked to the Goiás Court of Justice (TJGO). EJUG maintains an active Moodle implementation to provide professional training for TJGO (EJUG, 2017) magistrates, lawyers and other employees. Each record in the analyzed data set represents a student and each record attribute stores information about the student's behavioral actions in a given course. The behavioral actions of students involve participation and student contributions in the course. The analyzed data were collected from 2015 to 2019. The total of records from the EJUG data set is 2752.

According to Fayyad (1996), the classification method is one of the main data mining techniques used in the "real world", having been applied to problems of: fraud detection, investment market, marketing actions and record categorization. In the context of this work, the classification method will also be used to categorize students at risk according to the behavior of teachers, regarding the good teaching practices present in the framework.

To choose the best classifier algorithm for the selected data set, a performance analysis of the main classifiers was conducted with the help of the WEKA Experimenter tool (Weka, 2020). The performance of the main classification algorithms was assessed by WEKA data analysis tool. The performance of the algorithms of the following classification strategies was evaluated: decision trees, decision rules, neural networks, linear regression and Bayesian networks. The classification strategies should seek the largest number of correct classifications possible, this metric is called accuracy, however, this metric will only reveal the real efficiency of the classification model if the data used for training is balanced. In the context of this research, no data balancing technique was applied, however, the area under the curve (AUC) performance metric was used. This is one of the alternative metrics that can be used in unbalanced data sets, as this metric reveals the proportion of wrong classifications.

Table 1. Parameters of Classifying Algorithms in WEKA.

(1) trees.J48 '-C 0.25 -M 2' -217733168393644444
(2) trees.RandomForest '-P 100 -I 100 -num-slots 1 -K 0 -M 1.0 -V 0.001 -S 1' 1116839470751428698
(3) trees.RandomTree '-K 0 -M 1.0 -V 0.001 -S 1' -9051119597407396024
(4) rules.JRip '-F 3 -N 2.0 -O 2 -S 1' -6589312996832147161
(5) rules.PART '-M 2 -C 0.25 -Q 1' 8121455039782598361
(6) rules.DecisionTable '-X 1 -S \\'BestFirst -D 1 -N 5\\' 2888557078165701326
(7) rules.OneR '-B 6' -3459427003147861443
(8) functions.MultilayerPerceptron '-L 0.3 -M 0.2 -N 500 -V 0 -S 0 -E 20 -H a' -5990607817048210779
(9) functions.SimpleLogistic '-I 0 -M 500 -H 50 -W 0.0' 7397710626304705059
(10) bayes.NaiveBayes " 5995231201785697655
(11) bayes.BayesNet '-D -Q bayes.net.search.local.K2 -P 1 -S BAYES -E bayes.net.estimate.SimpleEstimator -A 0.5' 746037443258775954

Source: Elaborated by the authors.



Table 2. Classifiers AUC value, with unbalanced data.

Dataset	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)
COURSES-5-WEEKS	0.69	0.73°	0.70	0.52•	0.71	0.53•	0.52•	0.69.	0.69	0.66	0.67
COURSES-6-WEEKS	0.90	0.94°	0.87	0.90	0.90	0.91	0.80•	0.92	0.93°	0.85•	0.90
COURSES-7-WEEKS	0.70	0.90°	0.81°	0.50•	0.78	0.77	0.53•	0.88°	0.58	0.86°	0.85°

°, • statistically significant improvement or degradation. Source: Elaborated by the authors.

The table 1 shows the parameters used in the algorithms executed in the WEKA *Experimenter* tool. As presented in the table 2 the combinatorial algorithm (ensemble) *Random Forest* reached the largest area under the curve for all subsets of data under analysis. For the data subset of the 6-week courses, the AUC value was 0.96, which is very close to the AUC value for the ideal model, which is 1.

Table 3. Student Attributes.

Module Moodle	Attributes Description
Forums	Total of participation on forums Number of posts Number of updates to publications Number of publications read Number of discussions that participated Number of responses sent Number of responses received Number of typed characters Total of published words Number of sent phrases.
Questionnaires	Total of questionnaires that participated Number of submissions Total of questions answered Total of wrong questions Time spent on questionnaires
Chats	Total chats participated Total of messages sent Number of words typed Number of typed characters
Tasks	Number of tasks performed Number of submissions Total of tasks sent late Total of saved drafts
Logs	Total of interactions Logged time



Source: Elaborated by the authors.

From the performance analysis, the RandomForests (RF) classifier was selected to generate the best classification model for classifying students. The behavior of each student, within Moodle, is described by the set of 40 attributes listed in the table 3. Each attribute was extracted or derived from one or more Moodle tables. In order to achieve the objective of predicting students' academic performance from the behavioral actions of students and teachers, a teacher class attribute was added to the set of student attributes, which will indicate whether the teacher's actions were consistent with the characteristics of framework. The teacher class attribute, indicator of the teacher's actions, is valued with the result of the teacher classification algorithm.

The data of the students, who had already completed the courses, were used to train the RF. However, due to the fact that the behavioral data of the teachers does not have a label, which allows them to be classified as practitioners or not of the good teaching practices, necessary for training the classifier, a classifier named algorithm of means was developed to perform the classification of teachers.

The *averagingAlgorithm* classifies a teacher based on the average value of the teaching attributes present in the framework, so a teacher has a certain attribute if it has a value greater than or equal to the average global, calculated based on the value of the respective attribute for all teachers. And finally, a teacher is classified as andragogic, or not, if he has at least half of the teaching attributes present in the framework. The output of the averaging algorithm is used to allow monitoring of teachers' actions within the course and to value the teacher's class attribute used in predicting student performance.

*Algorithm 1. averagingAlgorithm(R)*

*Data: Record R( $X_1, \dots, X_{31}$ ) Result: "Andragogic" or "Non Andragogic"*

*1  $X_1, \dots, X_{31}$  // andragogical attributes*

*2  $M_1, \dots, M_{31}$  // global average of each attribute*

*3  $C_1, C_2, C_3, C_4$  // Total of attributes by classes*

*4 T //total of andragogic classes*

*5 for  $I \leftarrow 1$  to 14 do*

*6   if ( $X_i \geq M_i$ ) then*

*7      $C_1 = C_1 + 1$*

*8   end*

*9 end*

*10 for  $i \leftarrow 15$  to 18 do*

*11   if ( $X_i \geq M_i$ ) then*

*12      $C_2 = C_2 + 1$*

*13   end*

*14 end*

*15 for  $I \leftarrow 19$  to 24 do*

*16   if ( $X_i \geq M_i$ ) then*

*17      $C_3 = C_3 + 1$*

*18   end*

*19 end*

*20 for  $I \leftarrow 25$  to 31 do*

```

21. if ( $X_i \geq M_i$ ) then
22    $C4 = C4 + 1$ 
23 end
24 end
25 if ( $C1 \geq 7$ ) then
26    $T \leftarrow T + 1$ 
27 end
28 if ( $C2 \geq 2$ ) then
29    $T \leftarrow T + 1$ 
30 end
31 if ( $C3 \geq 3$ ) then
32    $T \leftarrow T + 1$ 
33 end
34 if ( $C4 \geq 3$ ) then
35    $T \leftarrow T + 1$ 
36 end
37 if ( $T \geq 3$ ) then
38   return "Andragogic"
39 else
40   return "NonAndragogic"
41 end

```

The prediction functionality implementation, in this work, was performed as an extension of the software Moodle Predicta (MP) developed by (Felix 2017). Originally the MP was developed with the objective of collecting data from students in Moodle and from these data make the prediction of students failure or success. Therefore, in order to expand the functions offered by the MP, traceable data from the teachers' actions were included along with the students' behavioral data to improve the students' performance prediction.

#### 4. The teacher Characteristics Framework

The framework of teachers' attributes that impact on students' performance was built from the characteristics observed in works of academic literature and subsequently correlated and based on the characteristics required by Andragogy, which focuses on teaching environments aimed at adults such as distance learning.

The main characteristics of teachers identified in academic works are listed in the table 4. Each row in the table 4 lists a characteristic, the articles that evaluated that attribute, and what impact the teacher's characteristic had on students. The type of impact, in the context of this research, is considered: positive when students had better school performance, negative when the observed characteristics influenced the worsening of school performance, and neutral when the studies did not identify any interference of the evaluated characteristic in the academic performance of students.

To build the framework of teachers' attributes, a subset of the characteristics present was selected in the table 4, because to achieve the objective of predicting student performance from data extracted from

Moodle, it is necessary that the characteristics of the teachers are traceable within the database. The table 5 presents the set of characteristics of the teachers who were selected to compose the framework, based on previous academic studies.

Andragogy focuses on teaching adult students. Andragogy guidelines were included in the framework based on the following propositions: distant education courses focus on young and adult students the precepts of Andragogy are present in decree Number 2.494/MEC, that institutes distance education in Brazil and analyzed data were collected from courses offered to adult students.

According to (Knowles, 1980) the four attributes desired by modern andragogy are: self-direction, previous experience of the learner, applicability of activities and motivation. In short, teachers must guarantee self-direction to their students, the courses taught must address the students' previous experiences, activities must contextualize with the students' professional activities and the teacher's motivation must reflect on the students' motivation.

Table 4. Characteristics of teachers and Impact on Students.

Feature	Positive Impact	Negative Impact	No Impact
Experience	(Canales & Maldonado, 2018)  (Clotfelter & Ladd, 2010)  (Sant'ín & Sicilia, 2018)  (Çakır & Bichelmeyer, 2016)		(Shukla et al., 2018)  (Stes & Maeyer, 2012)  (Azigwe & Kyriakides, 2016)
Formation	(Shukla et al., 2018)		(Çakır & Bichelmeyer, 2016)  (Chu & Loyalka, 2015)  (Canales & Maldonado, 2018)  (Sant'ín & Sicilia, 2018)  (Clotfelter & Ladd, 2010)
Motivation	(You & Dang, 2016)  (Lee & Longhurst, 2017)		(Çakır & Bichelmeyer, 2016)
Communication	(Ngang & Yie, 2015)	(Zakharov & Carnoy, 2014)	
Leadership	(Ngang & Yie, 2015)  (Passini & Molinari, 2015)  (Sant'ín & Sicilia, 2018)		(Naimie & Siraj, 2012)
Teaching Style	(Ngang & Yie, 2015)  (Cordero & Gil-Izquierdo, 2018)  (Naimie & Siraj, 2012)  (Choi & Yang, 2011)	(Cordero & Gil-Izquierdo, 2018)  (Comi & Argentin, 2017)	

	(Kyriakides & Christoforou, 2013)		
Time Management	(Azigwe & Kyriakides, 2016) (Kyriakides & Christoforou, 2013)		
Assessments	(Naimie & Siraj, 2012) (Zakharov & Carnoy, 2014)		
Skills in IT	(Comi & Argentin, 2017)		(Lee & Longhurst, 2017)
Training	(Golob, 2012)		(Akiba & Liang, 2016) (Zhang & Lai, 2013) (Stes & Maeyer, 2012)
Self-efficacy	(Mojavezi & Tamiz, 2012) (Friedrich & Flunger, 2015)		
Nonverbal Behavior	(Passini & Molinari, 2015) (Chaudhry & Arif, 2012) (Abdellah, 2015) (Kyriakides & Christoforou, 2013)		

Source: Elaborated by the authors.

Table 5. Teaching Attributes: Academic Literature.

Feature	Description
Assessments	Represents the assessment model applied by teachers.
Training	It concerns professional development.
Communication	Represents the level of interaction between student and teacher.
Teaching Style	Refers to the applied teaching methodology.
Experience	Translates teaching experience.
Formation	Reveals academic background: Undergraduate and Postgraduate
Time Management	It concerns the time dedicated to students.
Leadership	Ability to guide students.
Motivation	Teacher's ability to stimulate students.

Source: Elaborated by the authors.

Table 6 correlates the characteristics of teachers according to Andragogy with the attributes of the 5 table and represents the framework of teaching characteristics, which impact on student performance, which is used in the context of this research.

Table 6. Teacher Characteristics Framework.

Andragogic Characteristics	Characteristics from the Literature in Distant Education
Assessments	Assessments Teaching style Experience Communication
Self-directivity	Time Management Assessments Motivation
Previous Experience	Evaluations Teaching style Communication Experience
Motivation	Motivation Communication Teaching style Leadership

Source: Elaborated by the authors.

Table 7. Correlation of the attributes of the Framework with the data extracted from Moodle.

Andragogical Characteristics	Characteristics of Correlated Literature	Extracted Attributes
Self-directivity	Time Management	Average time of available tasks Average quiz time available Average survey time available Average feedback time available
	Assessments	Number created tasks Number of created quizzes
	Motivation	Number books created Number of wikis created Number of scorms created Number of images used Number of videos used Number of audios used Number of pdf's used Number of office documents used
Assessments	Teaching Style	Total of submissions made in quizzes Total of submissions made on tasks Total of submissions made in feedbacks

	Assessments	Average quiz score Average grade of tasks
	Experience	Average grade for the question: what is the importance of the course for professional life?
Previous Experience	Assessments	Average grade for the question: does the course interest me?
	Communication	Number of chats created Number of forums created
	Teaching Style	Number of workshops created
Motivation	Motivation	Total of hours logged
	Communication	Number posts on forums Number tasks corrected
	Teaching Style	Number feedbacks created Number surveys created
	Leadership	Average grade for the question: does the teacher encourage my participation?

Source: Elaborated by the authors.

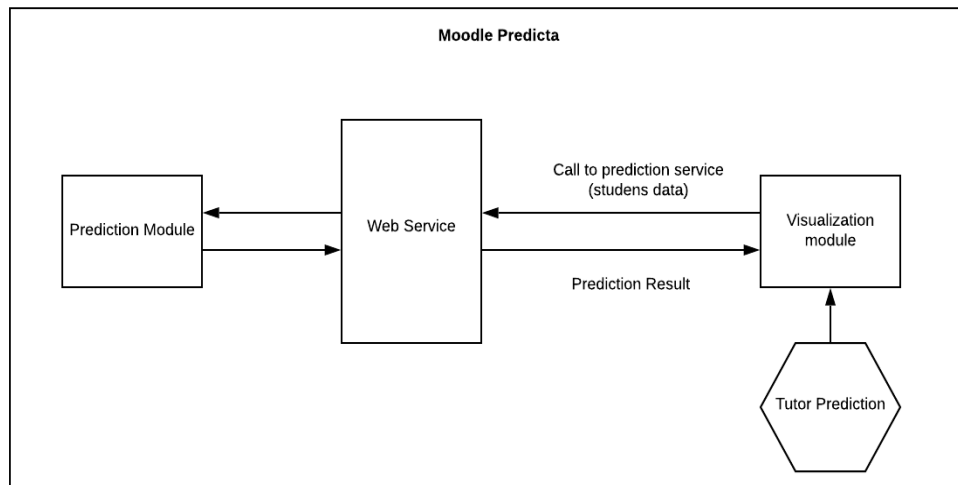
The table 7 shows the correlation between the characteristics of the framework and the data extracted from Moodle. Each andragogical attribute is associated with a set of teaching characteristics and each teaching attribute has been correlated with one or more data extracted from the Moodle database used in EJUG.

## 5. Moodle Predicta Extension

The Moodle Predicta extension was developed in a modularized way, with the visualization module designed to present the results in a user-friendly way and the prediction module responsible for all tasks involved in the classification process of students and teachers.

The complete operation of the MP extension is shown in the figure 1. The visualization and prediction modules communicate through the services interface provided by Web Service. The client, in a web browser, accesses the visualization module and makes prediction requests. Each prediction request is accompanied by a set of data, from the student to be classified, which are passed on to the prediction service that performs the classification and sends the result to the visualization module, again. With the prediction result in hand, the data is formatted and presented to the user, using friendly results presentation resources available in the data visualization.

Figure 1. Internal view of MP Extension



Source: Elaborated by the authors.

### 5.1 The Visualization Module

The visualization module is responsible for presenting statistical and graphical reports, which allow course administrators to monitor the progress of students and teachers, starting from the extension of the MP. The tool can produce reports for each of the main Moodle modules, which are: forums, questionnaires, tasks, chats, logs and time.

Figure 2. Forum activity reports

Forum: Avisos				
Forum: Avisos				
Topic: AVISOS				
Posts: 1 Authors: 1 Readings: 18	<b>2.86%</b> users published	<b>31.43%</b> users read	Post Tutor: 2 Read Posts: 2 Replies Sent: 1 Forum Participation: 1 Published Words: 236	<b>Most common terms in the topic:</b> unidade, 3,, participar, final,, maria tutora, irá, dia, deixar, conteúdo, curso
Forum: Fórum temático da unidade 3				
Topic: Fórum temático da unidade 3				
Posts: 1 Authors: 13 Readings: 379	<b>37.14%</b> users published	<b>94.29%</b> users read	Post Tutor: 10 Read Posts: 25 Replies Sent: 9 Forum Participation: 1 Published Words: 150	<b>Most common terms in the topic:</b> mudança, criança, direitos, crianças, proteção, expressões, forma, rede, adolescentes, adolescente

Source: Elaborated by the authors.

The Forum activity report (figure 2) displays all discussion topics created by the teacher, as well as the number of posts, readings, proportion of students who accessed the topic, number of words typed by the teacher, among other information. The teacher's participation in forums is related to the attributes: teaching style, communication and feedback. According to Table 4, such attributes can impact students' performance, which justifies the importance of behavioral analysis of teachers in social interaction environments, such as forums.



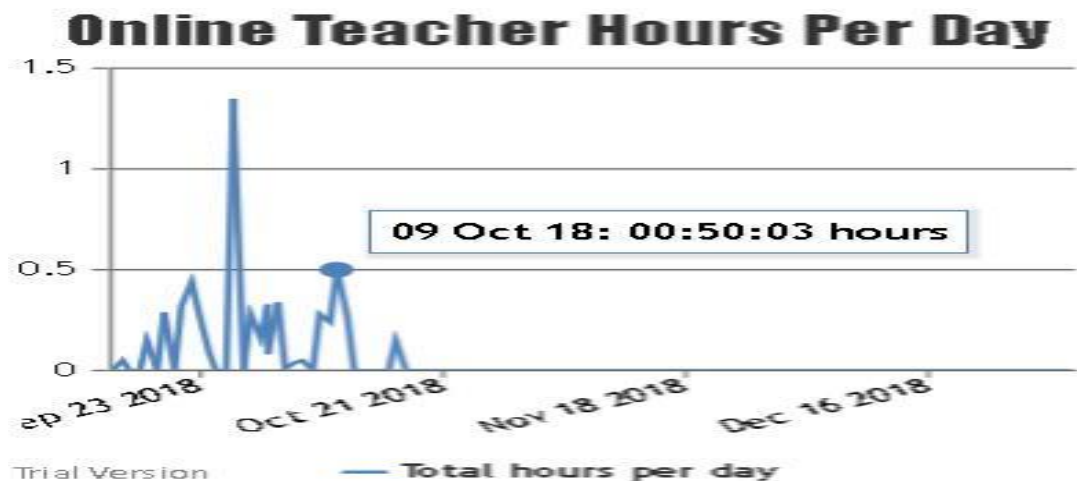
Figure 3. Quiz Reports.



Source: Elaborated by the authors.

Questionnaires, quizzes, and tasks are common assessment modalities in distance education courses. These activities are important tools for verifying students' learning and, also, for feedback to the teacher, as the students' grade reveals whether the teaching process is taking place satisfactorily. Another important function of evaluations is to check the possibility of the student dropping out. The tasks are closely linked to the characteristics: assessments and teaching style. Figure 3 shows how supervision of quizzes created by EJUG educators is done. For each question, the number of hits and errors is calculated, the results are displayed graphically.

Figure 4. Teacher Time Dedicated to the Course.

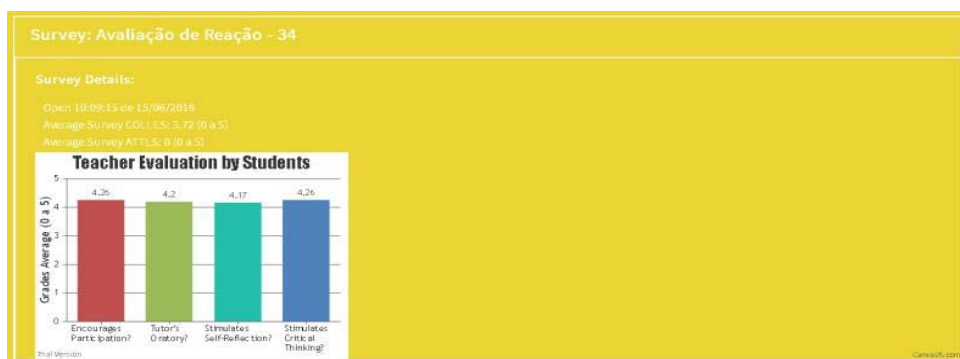


Source: Elaborated by the authors.

The logs feature presents, in detail, each teacher action within the course. All students' steps are recorded by Moodle, and this makes it possible to monitor, in a chrono-logical way, the actions of teachers in the system. From the data of logs the Time Management report was created, which is clearly linked to the time management characteristic of the framework of teaching attributes. The figure 4 shows the total time that the teacher remained active in Moodle and graphically shows the time spent for the course, daily.

In order to check the teachers' alignment regarding the andragogical assumptions, the Surveys and Feedbacks submodules were created, which are responsible for presenting the teacher and course evaluation, carried out by the students. The Surveys are questionnaires, predefined by Moodle, which asks students a series of questions about the teacher's behavior in the course under evaluation. Feedback questionnaires are created by teachers, and generally address topics about the quality of courses and teaching. The figure 5 shows the general average of the evaluations that students made regarding the teacher and the way the course is conducted by the teacher.

Figure 5. Survey: Teacher Evaluation



Source: Elaborated by the authors.

The average grades presented in Figure 5 allow to evaluate the andragogical attributes self-direction, experience, motivation and applicability, desirable in adult education. Self-directivity can be assessed by teacher's stimulus to participation, self-reflection and critical thinking. In order to assess the value of the students' previous knowledge, the average of the students' grades was calculated: The course content interests me? Motivation was measured from the following question: Does the teacher encourage my participation? The contents of the activities and evaluations, as provided by Andragogia, should privilege issues that reflect on the students' professional activities. To assess this criterion we use the notes for the question: Is what I am learning important for my professional activities?

Figure 6. Feedback Questionnaire.

**Feedback: Avaliação de Reação**

**Vision: Issues and Statistics**

Open 16:50:00 de 28/03/2012 to 21:00:00 de 31/12/1969

**Question 2:** Possui experiências anteriores como aluno a distância.  
 Alternatives: >>>>> [Discordo completamente] [Discordo em parte] [Não concordo nem discordo] [Concordo em parte] [Concordo plenamente]

**Question 3:** Possui nível de conhecimento adequado em informática (internet, editor de textos e planilhas).  
 Alternatives: >>>>> [Discordo completamente] [Discordo em parte] [Não concordo nem discordo] [Concordo em parte] [Concordo plenamente]

**Question 4:** Possui conhecimento prévio do conteúdo.  
 Alternatives: >>>>> [Discordo completamente] [Discordo em parte] [Não concordo nem discordo] [Concordo em parte] [Concordo plenamente]

**Question 5:** Há associação dos conteúdos estudados aos conhecimentos anteriores.  
 Alternatives: >>>>> [Discordo completamente] [Discordo em parte] [Não concordo nem discordo] [Concordo em parte] [Concordo plenamente]

**Question 7:** A linguagem utilizada no material foi adequada.  
 Alternatives: >>>>> [Discordo completamente] [Discordo em parte] [Não concordo nem discordo] [Concordo em parte] [Concordo plenamente]

**Question 8:** A qualidade do material didático disponibilizado foi adequada.  
 Alternatives: >>>>> [Discordo completamente] [Discordo em parte] [Não concordo nem discordo] [Concordo em parte] [Concordo plenamente]

**Question 9:** Houve adequação dos exercícios e avaliações ao conteúdo das aulas.

Source: Elaborated by the authors.

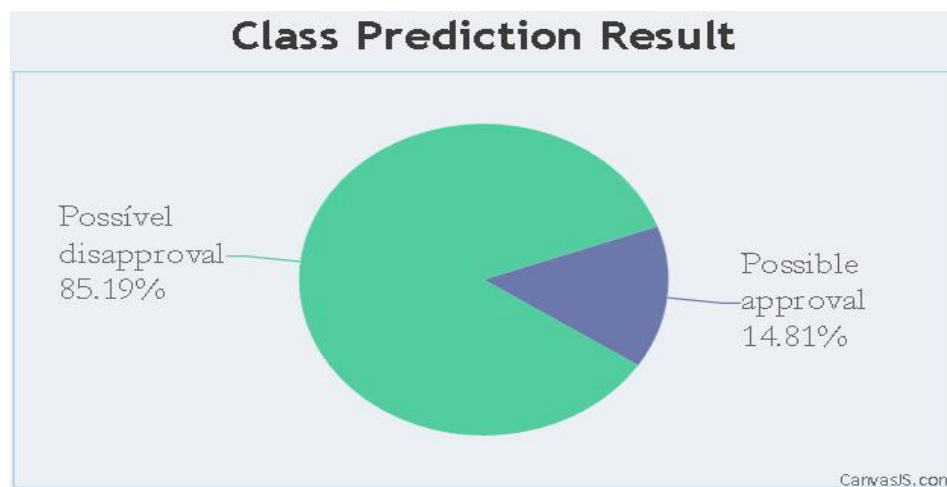
The figure 6 shows an excerpt from a feedback questionnaire created by the teacher, in order to obtain information that can improve the quality of the course, in general. The independent character of these

questionnaires makes generalized analyzes difficult, how-ever, it shows the teacher's complicity with the quality of the course and with the exchange of experience and expectations between students and teacher.

## 5.2. The Prediction Module

The MP extension is a web tool developed based on the client-server architecture. The figure 1 shows the architecture and communication flow of the MP extension. To use the WEKA algorithm library, the prediction module was developed as a desktop tool. To allow communication, between the visualization and prediction modules, a web service was developed to provide the prediction service.

Figure 7. Prediction Visualization in the Course Context.

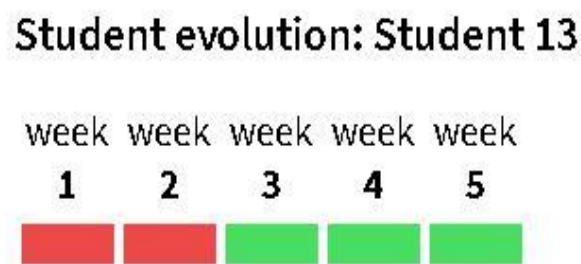


Source: Elaborated by the authors.

### 5.2.1 Students Prediction

The prediction of success or failure of students can be viewed from two perspectives: the course and the students. In the context of the course the prediction is computed from the percentage, total, of students classified as pass and fail, the proportions of each class of students are displayed on a sector chart. Each sector represents the percentage of each class and the union of the sectors represents the total number of students in the class. The figure 7 shows how the results of the students' performance prediction are presented to users.

Figure 8. Visualization of Prediction in the Student Context.



Source: Elaborated by the authors.

From the students' point of view the prediction is presented in the form of the student's evolution during the weeks of the course. The figure 8 shows the student's behavioral trajectory over the course of 5 weeks. The red rectangles signal the weeks when the student's performance compares to the performance of previous students who failed. The green colored rectangles synthesize the information that in the respective weeks the students had satisfactory school performance and consistent with the behavior of students who passed the courses.

### 5.2.2 Teachers' Prediction

The behavioral prediction of the teachers was performed with the implementation of the averaging algorithm, the data of the teachers are then sent as an input parameter to the algorithm, after execution, the algorithm returns the teacher's classification as: "Andragogical" or "Non Andragogical".

Figure 9. Visualization of Teacher Classification.



Source: Elaborated by the authors.

The visualization of the evolution of the teacher's behavior, in relation to the good teaching practices of the framework, during the course is presented graphically according to the teacher's classification obtained in the execution of the averaging algorithm. The figure 9 shows how the teacher's behavioral actions are represented in the MP extension. In the figure 9 it is noted that in three weeks the behavior of the teacher was not consistent with the characteristics present in the framework, and that only for two weeks the teacher demonstrated the desired characteristics for teaching adult students.

Therefore, based on the classification and visualization of data offered by this tool, managers of educational institutions can easily observe the behavior of teachers and propose different approaches to maximize the quality of teaching.

## 6. Conclusion

The popularization of distance education has stimulated studies on the behavior of students and teachers, with the objective of maximizing students' school performance. Teachers' skills are fundamental in the

teaching process and consequently in the students' academic achievements. Therefore, in order to guarantee the quality of teaching, distant education managers and teachers must be aligned with the best teaching practices and used to virtual learning environments.

To assist educational managers and teachers to maximize students' school performance, in this research we developed a system for predicting student performance from a framework of characteristics of good teaching practices. To perform the prediction of students' performance, behavioral data from students and teachers were used, stored by Moodle Platform. The data collected by the Moodle educational database were analyzed using EDM techniques. The prediction of approval, or disapproval, of the students and the classification of the teachers, regarding the good teaching practices, were carried out with the application of the main techniques and methods of classification available in the mining of educational data.

The teachers' characteristics framework was built in this research from the correlation between the main teaching attributes related to the students' good performance and the desired teaching characteristics in youth/adult education. The teaching attributes were listed through a systematic review of the literature about teaching characteristics that can impact students' school performance. The desired teaching characteristics in the teaching of adult students were extracted from the definitions of Andragogy.

To conduct this research, the Moodle database used by EJUG was used. Through a classifier performance analysis, the best classifier for the EJUG data set was selected. The performance metric used to compare the classifiers was the size of the area under the curve (AUC). According to this metric, the best classifier model was generated by the RandomForest algorithm.

In the development of the MP extension, carried out in this work, information on the didactic actions of the teachers in the prediction of the students' performance was included, in addition to implementing the classification of the teachers according to the good teaching practices present in the framework. The teacher's classification was performed by submitting the behavioral data, extracted according to the characteristics present in the framework of teaching attributes, to the averaging algorithm. The prediction of the students' performance was implemented based on the students' behavioral data together with the data that synthesize the didactic actions of the teachers.

Assisting educational managers and teachers to improve the quality of online teaching was the main objective of this work, based on the assumption that the teachers' behaviors affects students' behaviors, and, consequently, their performance, helping to reduce failure and dropout rates. We provided a teachers' behavioral classification and prediction, according to good teaching practices, adding to the improvement of distance education, especially with regard to the student-teacher relationships and course management. Based on the results of our research, it is possible to make evidence-based academic, managerial and administrative decisions in distant education. For this reason, the present work contributes to the development and improvement of tools and techniques for distance courses management.

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## **THE SUBJECTIVITY OF THE TRANSEXUAL BODY IN CINEMATOGRAPHIC WORKS**

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## **Abstract**

*Transsexuals are individuals who feel out of place in their own bodies, facing constant conflicts between identity and biology and still face barriers and social prejudices. The subjectivity approach present in transsexual bodies assumes relevance in the contemporary scenario to foster discussions of gender, prejudice and social inclusion, through the problem of dominance of the body. This article aims to identify the subjectivity present in the transsexual body presented in the cinematographic works Transamérica and The Danish Girl.*

**Keyword:** TRANSGENDER, BODY, CINEMATOGRAPHIC WORKS

## **1. INTRODUCTION**

The second half of the 20th century is marked by significant changes in society, mainly in the conception of man, who assumes the role of the sovereign subject of his life, endowed with his own wishes and individual issues. At this time, the standards that in the past provided solid references for locating individuals are in doubt and new personal identities are emerging that need to be supported and integrated into society.

In this scenario, gender studies emerge as a result of the libertarian struggles started in the 1960s, with feminist movements that aim at the recognition of women in society and equal rights between the sexes. In Brazil, the field of gender study began in the 1970s and 1980s, also around discussions of issues of the female condition in society.

The movement of transgender individuals, as well as feminists, results from an important social evolution in the search for equal rights present in contemporary society. Body modifications reveal to be a central point for countless individuals declared in the transgender category, since they look for natural attributions for a given gender with the objective of combining physical body and its identity.

Cinema takes on the role of enabling a favorable scenario to foster discussions regarding gender issues. This article aims to identify, in cinematographic works, the subjectivity of the transgender body and, in this perspective, the films Transamérica and The Danish Girl were chosen, which directly address the theme proposed in the study in which the main characters are transsexuals and experience the experiences of women individual and social barriers in relation to the body itself, in gender identity and decide to perform sex resignation surgery.

## **2 METHODOLOGY**

To explain the phenomenon suggested in this project and achieve the proposed objectives, a qualitative and bibliographic research will be carried out. Qualitative research understands that people share experiences and give them different meanings, in order to study these meanings Chizzotti (2013) highlights that the term qualitative implies a dense sharing with people, facts and places that constitute research objects, to extract from this interaction visible and latent meanings that are only noticeable with sensitive attention. After this training, the author interprets and translates in a text, zealously written, with

scientific insight and competence, the patent or hidden meanings of his research object. According to Gil (2002), bibliographic research is based on ready-made material, with scientific books and articles as main sources. The bibliographic research is done from the survey of theoretical references already analyzed, and published by written and electronic means, such as books, scientific articles, web site pages. For Fonseca (2002) any scientific work begins with a bibliographic search, which allows the researcher to know what has already been studied on the subject.

### **3 THEORETICAL FOUNDATION**

#### *3.1 Body in contemporary times*

The construction of human identity happens mediated by the use of the body, from the movement of walking to the primary forms of social interaction are grounded by the bodily senses. Throughout history, man has gone through the constant search to change and dominate the three elements to which human flesh is subjected: aging, disease and death.

The body is always immersed in a web of powers that dictate prohibitions and obligations, constraints that determine its gestures and attitudes and that delimit and invest its exercise and practices, mechanisms of building the intelligible body in a political field of utility-docility. This is "discipline", a system of subjection that creates a 'knowledge' about the body that is not exactly the science of its functioning, and a control of its forces that is nothing more than the ability to overcome them: this knowledge and this control constitutes what could be called the political technology of the body (FOUCAULT, 1987).

According to Birman (2014) the body is the most eminent anthropological record in which the malaise of the present is stated, capable of generating constant concerns and dissatisfaction. The body assumes a position of supremacy in the contemporary world because it is the only good of the citizen, since, according to him, all the others have disappeared or been relativized. Thus, aspects related to health and aesthetics, in order to improve quality of life and longevity, are prioritized.

For Breton (2012) the significant body is an efficient and living cultural fiction that can be understood in the social network of meanings, even when there are ruptures in physical relations with the actor's world in the face of pain, illness and unusual behaviors.

The body thought in front of the social mirror tries to understand contemporary phenomena that influence human behavior in relation to bodily aspects. (BRETON, 2012).

It is always imagined that something must be done so that the body performance can improve, as this is always below the desired level. We always feel at fault, failing to do everything we should, considering the multiple possibilities offered for body care. Anyway, we are always guilty, albeit slightly, and in a frank position of debt in relation to this. (BIRMAN, 2014, p.69).

The individual decision to act on the body can be characterized as a freedom shaped by countless influences, mainly the sociological burdens, the ambivalence of time, the social condition and the social actor's own history. The generation that dominates the body lives the incessant search to remodel physical

aspects and faces constant frustrations when it does not reach the ideal standards of beauty. (COUTO; GOELLNER, 2012, p. 15).

Birman (2014) points to a style of being of modern individuals, characterizing the acceleration of the subject, hyperactivity assumes a constant, in which individuals act on impulse, without thinking.

Couto and Goellner (2012) argue that control of one's own body over appearance is a means of reducing uncertainty by seeking symbolic limits as closely as possible. Modern life surrounds man with complex social conflicts at work and in the family environment, and the issue of worshipping the body enables the feeling of control and dominance.

The fact that he is the master of his own body comes up against the irreducibility of the inheritance and history of parents. The individual refuses to see his body as a root of identity to which he belongs and resort to plastic surgery to reformat his body, the most common ones include breast prostheses and liposuction. (COUTO; GOELLNER, 2012).

For Breton (2012, p. 92) "The body is the interface between the social and the individual, between nature and culture, between the physiological and the symbolic; therefore, the sociological or anthropological approach requires particular prudence and the need to accurately discern the object's boundary".

Foucault (1987, p. 117-119) points out that during the classical era, the body is discovered as an object and a target of power that can be manipulated and trained to obtain better results and, at this moment, the human body enters a machinery that scans it, dismantles and recomposes it. Discipline organizes, transforms and improves the body, as well as extending bodily forces, it also forms docile and submissive bodies.

The institution of the discipline requires some rules that establish the presence of the fence, that is, the space must be heterogeneous in relation to others and closed in itself, the rasterization of individuals who need to occupy their specific place in the space, the organization of rules specific to the institution and establishing the position of the body in the queue, being classified in the geographical space it occupies. (FOUCAULT, 1987)

Bio-power devices seek to obtain a certain body docility, installed in human organisms to train them in order to feed the gears of factory production and the ranks of national armies. Docile bodies come to serve certain economic and political interests. The configuration of the modern capitalist economic policy has clear interests that are easily identified, but the anonymity of the personalities involved is preserved. (SIBILIA, 2015). Also according to the same author:

This formatting of modern bodies was complex, too, because it had a double physiognomy: the process must combine a series of stimuli and repressions at the same time, in a difficult balance that was always in danger of being challenged. On the other hand, bodily forces were increased, developed and stimulated, to be used in economic terms of utility. (SIBILIA, 2015, p 33).

The strategies adopted, while aiming at the development of human capacities through the application of a set of training and qualifications, also needed to decrease the energies of these bodies in order to keep them obedient to the system of repression. The main objective of capitalism was to convert

the bodies and times of individuals into productive force, inspired by the model of industrial machines. (SIBILIA, 2015).

The vision of man as a machine allows for relative perfection to the body and is stimulated by the constant offer of tele-computing devices and services, from the ubiquitous cell phones to portable computers with internet access. The use of virtual technologies enhances and multiplies human possibilities, as it breaks the spatial barrier and cancels geographical distances without the need for physical displacement. (SIBILIA, 2015; BRETON, 2013).

In a critical analysis in relation to technological development and impacts on bodies, Breton (2013) highlights that body resources have never been so in disuse as they are today, mobility and physical resistance are little explored in routine human activities that are increasingly developed by the machines.

Cyberculture frees the individual from the identity injunction, exempts him from being accountable, suspends his ontological identification with the body. The individual plays with his virtual identities, without problems of conscience, and even with joy. The body is no longer the irreducible place of the feeling of identity, it is one of them, and undoubtedly the most uncomfortable due to the limits it always brings to memory at the last moment, where the Internet user believed he had gotten rid of it. (COUTO; GOELLNER, 2012, p 27)

Breton (2013) states that anatomy is no longer a destination and at any time man can change his physique using the current model as a reference. The body design industry is developing significantly and, currently, when visiting plastic surgeons' offices, it is possible to choose among the options those most suited to the patient.

### *3.2 Subjectivity of transsexual individuals*

Gender studies represent the power structure that is established in relationships that are regulated and reproduced according to the requirements of standards that meet certain social interests. Butler (2003) cites the legal formation of language and politics that the subjects represent are the effects of a representational political version that produces subjects with gender traits determined in accordance with a differential axis of domination, or presumably produces them male.

Gender identity or expression includes how a person identifies himself. The human being can identify with his birth sex (male or female, male or female), with the opposite gender to his biological or present characteristics of both types.

In the definition of gender, the classification points out that the cisgender is the individual who identifies with the biological sex with which he was born and the transgender is a person who was born with a certain biological sex, and in some way does not identify with his body.

The transsexual is included in the transgender category and can be a man or woman who identifies with the opposite gender. Many transsexuals feel as if they were born in the wrong body. To adapt to the gender with which they identify, these people undergo hormonal treatments to achieve the desired appearance, modify the voice and, with psychiatric authorization, perform sexual reassignment surgery and other surgical interventions that are necessary.

The transsexual is an individual who has the feeling of belonging to sex contrary to their genetic condition, that is, who does not identify with their biological genitals and socio-cultural attributions (Peres & Toledo, 2011). In the definitions established by Harry Benjamim (1966) it also includes the question of the desire to perform sex reassignment surgery as an inherent factor for all transsexuals.

Transsexuality can be male or female, the male transsexual is anatomically a man, but he feels like a woman since childhood and the female transsexual is a woman who feels intimately like a man, also since childhood. In both cases, it is as if the person belongs psychologically to one sex, with the image equivalent to that of the opposite sex.

Regarding the physical body, Breton (2013) states that transsexualism is configured in a technological artifact, built through surgical and hormonal intervention based on the individual's will to restructure his body on other aspects of gender. The transsexual is an almost caricature symbol of the feeling that the body is a form to be transformed. (BRETON, 2013).

Transsexuals are people who experience psychological discomfort with their antagonistic sex, obsessively wishing to have their bodies readjusted to the opposite sex they believe they have. For them, the sex change operation is an obstinacy, and at no time behaves according to their biological sex.

The authentic transsexual does not recognize himself as homosexual, having an aversion for his genitalia, both from the point of view of his anatomical conformation and its functionality, distinguishing himself from homosexuals, in which the genitalia plays an important role.

Highton points out that the transsexual represents emblematically a subject who presents an eloquent and defined contrast between the physical element, that is, the external sexual characteristics, and those of a psychic nature. This leads to an anxious search for a correspondence between physical appearance and behavior, habits, gestures, customs, gestures and attitudes in general, which are those of sex that they really feel and deeply experience in their daily lives. This tendency, aiming at their own sexual identity, leads transsexuals to undergo genital surgery, although it is irritating and unbearable, to "replace" them with those that match their psychological state and their ways of life.

Transsexuality is not a sexual orientation, but a question of gender identity.

The old identities, which have stabilized the social world for so long, are in decline, giving rise to new identities and fragmenting the modern individual, hitherto seen as a unified subject. The so-called "identity crisis" is seen as a broader process of change, which is displacing the central structures and processes of modern societies and shaking the frames of reference that gave individuals a stable anchorage in the social world. (HALL, 2006, p.7).

Since the identity changes according to the way the subject is challenged or represented, identification is not automatic, but can be gained or lost. It has become politicized. This process is sometimes described as constituting a change from an identity (class) policy to a difference policy (HALL, 2006). According to Hall (2006), we can understand that identity is a representation of who we are, and it is changeable by the way we show it.

The game of social changes raises issues that reaffirm the lack of a master identity that can be classified exclusively by social interests in relation to the classes and the range of issues that need to be



observed from the feminist, black and national liberation and identification has become politicized (HALL, 2006).

The individual subject and its identity that liberate from traditional and stable structures for the birth of the sovereign individual that has its singularities, distinctive and unique. (HALL, 2006).

Subjectivity as ways of being and being in the world. The human being stands out for its elastic contours that change from different cultural traditions. Subjectivity is built on the collective framework and has forms that are steeped in an intersubjective culture. Personal experience can be strongly influenced by others and the world. Culture directly influences our way of being (SIBILIA, 2016)

The author (Sibilia, 2016) reports that subjectivity can be studied in three broad dimensions which are: singular dimension, which includes the individual trajectory of being, the universal dimension, which encompasses all the characteristics of the human species and the particular or specific dimension which aims to detect elements common to some subjects, but not necessarily inherent to all human beings.

“Subjectivity is conceived as what is constituted and is transformed in the relationship it has with its own truth. There is no theory of the subject independent of the relationship with the truth ”. (FOUCAULT, 2016, p. 13)

Subjectivity is an expression of our relationship with the world, through history, the most immediate way of building this relationship is expressed through the body formed by the organic aspects and the individual's historicity. The body involves the physical aspects and the entire relationship of the subject to the world.

Subjectivity permeates the different forms of consciousness of the subject, the identity formed by the psychic experiences, the moral, the political and intellectual conscience. From the development of different areas of consciousness, man becomes a subject that is characterized by the awareness of thoughts and responsible for their actions. (GHIRALDELLI JUNIOR, 2000).

According to González-Rey (2003), the notion of subjectivity is a complex and pluridetermined system, affected by the very course of society and the people who make it up, within the continuous movement of social networks that characterize social development. In this movement, knowledge is produced about the psychic, systemic, dialogic and dialectic processes that recognize the human being as an individual who, for the author, has the capacity to overcome the immediate, directing himself to the realization of his own projects. We emphasize, in this definition of subjectivity, the presence of a notion of subjectivity that supposes the ability to mediate and project itself in the future through an ideal, that is, a creative being, master of his destiny and with the possibility of inventing himself .

Subjectivity is a complex and pluridetermined system, affected by the very course of society and the people who constitute it within the continuous movement of the complex networks of relationships that characterize social development (GONZÁLEZ-REY, 2003, p. IX).

Butler (2003) highlights that to build a solidarity of identity, a division is introduced in the subject through the distinction between sex and gender. Originally created to question the formulation that biology is destiny, the distinction between sex and gender meets the thesis that, although sex seems intractable in biological terms, culturally constructed gender: consequently, it is not even the causal result of sex , nor as apparently fixed as sex. Thus, the subject's unity is already potentially challenged by the distinction that opens space to gender as a multiple interpretation of sex.



If gender is the cultural meanings assumed by the sexed body, it cannot be said that it stems from a sex in this or that way. Taken to its logical limit, the sex / gender distinction suggests a radical discontinuity between sexualized bodies and culturally constructed genders. Assuming for a moment the stability of binary sex, it does not follow that the construction of "men" applies exclusively to male bodies, or that the term "women" interprets only female bodies. Furthermore, even if the sexes seem not problematically binary in their morphology and constitution (to which it will be questioned), there is no reason to suppose that the genders must also remain in number two. The hypothesis of a binary gender system implicitly encloses the belief in a mimetic relationship between gender and sex, in which gender reflects or is restricted by sex. When the constructed status of gender is theorized to be radically independent of sex, gender itself becomes a fluctuating device, with the consequence that men and men can, with equal ease, mean both a female and a male body, and a woman and a female. both a male and a female body. (BUTLER, 2003 p.24 and 25)

### *3.3 Cinematographic works - Transamérica and The Danish Girl*

The American film *Transamérica* is a drama released in 2005, under the direction of Duncan Tucker and starring Felicity Huffman, who plays the character Bree, a transsexual woman who faces the journey of gender transition with the realization of the reassignment surgery. sex. The plot of the story revolves around the conflicts and paths followed by Bree to achieve his dream.

The feature film presents situations of dualism and self-knowledge, focusing on the complexity of accepting a transsexual in today's society, based on their internal conflicts and situations of family and society rejection. The film approaches Bree as an individual, seeing herself in a context in which not everyone accepts her, and how she decides to show herself to the world, the symbolic construction that triggers being a woman, through the intonation of voice, clothes, way of sitting and use of the bathroom.

A week before surgery, Bree obtains the necessary authorizations to follow her route, but discovers that she has a son, Toby, a 17-year-old boy, previously unknown. Bree's psychologist forbids her to undergo surgery without resolving the matter. Then, Bree travels to New York to find the boy, who is under arrest and pays bail to release him.

Upon meeting her son Bree does not claim to be her father, but a church missionary. Initially Bree shows disgust about Toby's way of life. He lives in a tiny, filthy and messy apartment. During their trip, the relationship changes and begins to be affectionate. Until the moment Toby sees that Bree has male genitals. Toby is silent and then they give a ride to a hippie who assault them. Taking each other's car and favorite objects.

After the assault, they arrive at Bree's parents' home, where he is only recognized by Stanley (birth name). We come across a traditional and moralistic family that does not allow Stanley to have a more friendly relationship with her body. After a fight between Bree and Toby, Toby leaves the house.

After Toby's disappearance, the film goes straight to Bree's surgery, which is visited by the therapist. On this visit, Bree cries a lot and reports the pain in the physical body, the psychological conflicts triggered from the moment she meets her son, the love that touched her and the difficulty of being away from him. Bree is touched by the experience of motherly love.

The film ends with Toby's visit to Bree, but no longer in the dimension of a teenager and rebel, but of a son, and at this moment Bree feels complete and receptive to her son.

In *Transamerica*, Bree's position as Tody's mother or father was built primarily, by the unexpected news of having a child and in the face of getting to know him better, the difficulties he faced throughout his life with his mother and stepfather and affirming the relevance of their reception. The fact that the sexual is not restricted by the superficiality of the performances, because nobody is what he seems to be, and in that the characters of *Transamerica* demonstrate in a spectacular way. Bree builds the subjectivity of being a woman by exposing her clothes, she assembles and protects herself in her clothing, giving her characteristics that build her as a woman within her social niche.

The film *Transamérica* addresses several situations that are commonplace in the life of a transsexual, the family prejudice faced by Bree, who goes so far as to tell Tody that she has no family, at the same time, in desperation she returns to seek her parents again, always with the intention of be accepted and understood in its uniqueness.

The issue of sex change, made possible by surgery, the long process of medical follow-ups for approval, the financial cost of the procedure, the intense invasion of the body, the pain, the expectation that at the time of leaving Bree surgery will be complete and yet , conflicts accompany it.

### *3.4 The Danish girl*

The film *The Danish Girl* stars Eddie Redmayne (who plays the character Einar Wegener and his transformation to Lili Elber) and Alicia Vikander (Gerda Gottlieb) and directed by Tom Hopper. It is a film adaptation of the book of the same name, *The Danish Girl* tells the story of Lili and her discovery, acceptance and transition as a transsexual woman. Einar Wegener, the girl's christening identity, was a notorious Danish painter who made a name for himself in Europe during the 1910s and was married to the beautiful and also artist Gerda Gottlieb, his lifelong partner.

In the film, Einar's first identification as a woman appears when his wife, needing to finish a painting, asked her husband to put on the model's socks and sneakers, who would not appear on the day in question. At this moment, feminine instincts emerge in Einar that, due to the repression he faced in the past, he left internally asleep. This moment is crucial for Einar to perceive himself as someone else, and then begins to dress as a woman and adopt the name of Lili for Gerba is also a transforming instant, because when painting Lili, he finds the inspiration and the right element that transform his performance as a painter, giving her prominence and professional recognition.

The plot presents the plot of the two characters, Gerba and Lili, the personal comforts faced by both in facing Einar's transsexuality. For Einar, the difficult question of looking at the male body and the comfortable feeling experienced when wearing women's clothing and being recognized as a woman, even desired by the opposite sex, as the case started at the party of artists in which for the first time appears in society like Lili and ends up kissing a guy she knows. They continue to meet at various times throughout the film.

Gerba's character is represented as a strong and daring woman for the time. She wears a dress that shows her ankles and took the initiative to invite the future husband to go out and to give the couple the first kiss. She comes to be defined as shameless by Einar, who has a special charm for his wife's

personality. At the beginning the film shows a couple with well-tuned intimate desires and Gerba's desire to be a mother. In the course of the plot, Gerba faces intense internal conflict at the moment when she notes that Lili's transformation is something more than a joke to pose as muse in her paintings. After realizing that Einar is not happy and feels out of place in his own body, Gerba is the biggest supporter to resolve the issue.

At first they resort to treating disorders, but both realize that Lili has no mental insanity. In a second moment, Gerba goes after Einar's childhood friend in which a kiss took place to seek explanation. Gerba encourages Lili to see a doctor for transformation and accompanies Lili on the first appointment. During the visit to the doctor, the two affirm that Lili is a woman in a male body. Gerba supports Lili in sex resignation surgery, but feels the conflicts of letting the loved one assume her new identity, in which she finds herself excluded.

Having decided on a sex change, Lili is preparing to perform the first sex resignation surgery and has Gerba's unconditional support and undergoing a series of surgeries that would make her, in her words, she defines herself as a “woman completely”. Lili cannot resist the complications of surgery. At the end of the film, Gerba appears, visiting the place that inspired the paintings and the wind blows strong, taking Lili's scarf and Gerba says “let it fly”.

The Danish Girl narrates to life not only an emblematic figure, but in a way, the still harsh reality of thousands of people who go through countless problems every day because they are simply who they are. She is Danish, but also Brazilian and global and the film, makes us reflect a little on this harsh reality and reflect on the welcome that society needs to have to include and guarantee them integrated and whole as they choose to be.

## CONCLUSION

The study allowed for reflections related to changes in paradigms on gender issues and the relevance of society to welcome transgender groups allowing access to rights and the dignity of choice. For the construction of a community life more free from disturbances and tensions, individuals need to have sufficient satisfaction and in order to have a more satisfactory individual existence, the social structure must be organized in a way that relieves tensions, disturbances and conflicts.

The way of being of contemporary subjects is transformed from the movements that took place in the 60s that challenged the form of family constitution, political power and division of tasks of men and women in society, giving rise to forms of subjectivity. The transsexual movement reaffirms a new meaning of being to transform its identity, through body construction, it does not mean just the change of sex, but a change in the individual's way of being.

The subjectivity perceived in both characters clarifies what transsexuals Bree and Lili face daily, the conflicts expressed by both when facing the body in the mirror. Dysphoria in relation to the physical and psychological leads to the decision to undergo resignification surgery, conflicts, before, during and after facing such an invasive moment in the physical body, the psychological satisfaction of reaching the desired forms.

Transsexual individuals feel incomplete in their own bodies. Some studies show that between 40 and 50% of people who are identified as transgender face drug addiction, depression and repression at some point in their lives. Identity problems are triggered by social labels that constantly refer to patterns of fitting in and reclining in their identity and exposing themselves to being recognized and accepted as a social subject in their identity.

The current society registers countless victories for transsexuals, mainly in relation to the recognition of rights, universities start to recognize the social names of their students, the public health system guarantees sex change surgery to those who want to do it. But addressing the issue at the beginning of the last century was even more difficult and, in addition to mentioning these issues in society in general, little was known about the subject, including the aforementioned sexual readjustment surgery. However, the Danish Lili Elbe became a big name because she was one of the first transsexuals on record, inspiring others from her courage.

Among some proposals that the Brazilian Government could expand its activities include sexual and gender education to teach young people and the general population the respect for human rights and citizenship of transgender individuals, approval of affirmative laws that guarantee full citizenship of the population, equating homophobia and transphobia to the crime of racism, development of public policies in the area of health, human rights, education, that provide citizen equality to the community and demand that the Police and Justice investigate and punish homo / transphobic crimes with all severity.

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# **Application of fuzzy logic at the Port of Cotonou (Benin / West Africa) in analysis of port logistics viability**

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## **Abstract**

*The Autonomous Port of Cotonou (PAC) located in West Africa has an access channel 15m deep, 11 berths, and an internal draft of 15m (maximum), and is connected with a road to serve continental countries such as Burkina-Faso, Chad, Mali, Niger and Nigeria. The PAC presents low productivity (average of 10,000,000 tons / year, 24.40% of the movement from the port of Lagos / Nigeria) in West Africa. This article aims to evaluate the application of fuzzy logic in the Autonomous Port of Cotonou (Benin) in the analysis of logistic viability. The methodology followed the fuzzy logic that is a support method for logistic decision-making, based on fuzzy rules (SBRF). It was used characteristic of Mamdani Matlab Toolbox with three membership functions (triangular, trapezoidal and Gaussian) to model the quality variables of infrastructures and services, equipment productivity, seeking a long-term way out of logistic viability. The result of logistic viability was medium term, equivalent to 13 years / 25 years; as far as the outcome of the future PAC is concerned. The logistic viability of the PAC depends on its input variables. The projection of this application was long term, at least 19 years / 25 years when the infrastructures are of good quality and the equipment is more modern and consistent with the current realities to satisfy the expectations of the customers.*

**Keywords:** Fuzzy logic. Logistic Viability. Autonomous Port of Cotonou (PAC). Benin. West Africa.

## **Introduction**

Port logistics can be defined as the set of strategic and operational means to optimize intermodal functions in the port chain, that is, an approach that makes the various operations of a port faster and more efficient. According to the various definitions, four (4) strategic elements (waiting and mooring time, the quality of port services, the productivity of port infrastructures and equipment, port costs and the port's attractiveness indexes) are indispensable and summarize the concept of port logistics.

In Africa, the port sector's main objective is to improve commercial competitiveness and reduce government spending. However, most ports in West Africa (Ivory Coast, Ghana, Benin, Nigeria, Senegal,



Togo, Guinea, Guinea-Bissau, Sierra Leone, Gambia, Liberia, Cape Verde) still have obsolete and insufficient infrastructure and handling installations. Significant growth in container cargo demand requires well-equipped container ports (Chen, Xu and Haralambides 2020). According Lourdes, María and Juan(2013), ports in West Africa have difficulties in receiving ships with a capacity of 8,000 TEUs. Chen, Xu and Haralambides (2020) affirm that despite this growth, current conditions in West Africa are far from ideal, both in terms of quantity and quality of port installations. The same authors emphasize that the reform process in African ports is complex because of certain factors that negatively influence their development capacity and affect port efficiency. For the same authors, other factors such as low port density, outdated cargo handling equipment and inept management have become real obstacles in West African trade.

Located in the central part of the West African coast, the Autonomous Port of Cotonou (PAC) is one of the most important ports in West Africa (Abidjan, Cotonou and Lomé) to serve the China-West Africa container transport system and can potentially be selected as the central port (Chen, Xu and Haralambides 2020). A central port can be developed both by expanding existing port installations and by building new installations. But investments in port capacity are large, expensive and uncertain. They also involve long construction times. Therefore, it is important to choose the timing and size of port investments appropriately to respond the growth of trade (Balliauw, 2020). Supporting this idea, Lourdes, María and Juan (2013) emphasize that the expansion of container movement, in increasingly larger ships, requires port installations to deal with large ships quickly and efficiently.

International maritime trade is still expected to expand at an average annual growth rate of 3.4% between 2019 and 2024, being driven, in particular, by the growth of cargo in containers, bulk and gas (Unctad 2018). With the significant growth of maritime trade, all ports in the world are increasingly in the process of reorganization and reconstruction with the single objective of becoming the hub to face competition from their region, like the PAC. Various modifications and extensions were made to the PAC in 1983, 1998 and 2012 to adapt to current realities. However, there are still other factors (absence of private sectors in financing and computerization of administrative procedures, high port fees), thus hampering efficiency, productivity and development. Fuzzy logic has been used in several areas in decision making. According to Von Altrock (1995); Jamshidi (1997); Cury (1999); Komarova (2000) and Goudard (2001); Maria and Gleicy (2007), the fuzzy logic is found in:

“Project management, product pricing, medical diagnostics, sales forecasting, market analysis, criminal identification, capital budgeting, business acquisition assessment, information processing, quality control and other matters involving the taking decision-making, such as movement control, production systems, environmental assessment of alternative urban and road transport projects and others ”

In port areas, Rahmawati and Sarno (2018) used fuzzy logic to detect anomalies in the handling of port containers, Wanke and Falcão (2017) analyzed the allocation of cargo in Brazilian ports using fuzzy logic. Akyuz et al. (2020) applied for analysis of the fault tree and event tree of the risk of cargo liquefaction on board the ship. Optimizing investment in port development (Allahviranloo and Afandizadeh 2008), the selection of the container port by (Onut et al., 2011), the central supply chain of the port (Loh et al., 2017),



and others, fuzzy logic was applied. This article assesses the application of fuzzy logic in the Port of Cotonou (Benin / West Africa) in the analysis of logistic viability.

### Study area location

The study area is located in Benin, a country in west Africa, in the extreme south of Cotonou ( $6^{\circ} 23'48''$  S /  $2^{\circ} 25'33''$  W, Benin). The port of Cotonou is at the same distance with the ports of Lagos (115 km) and Lomé (135 km).

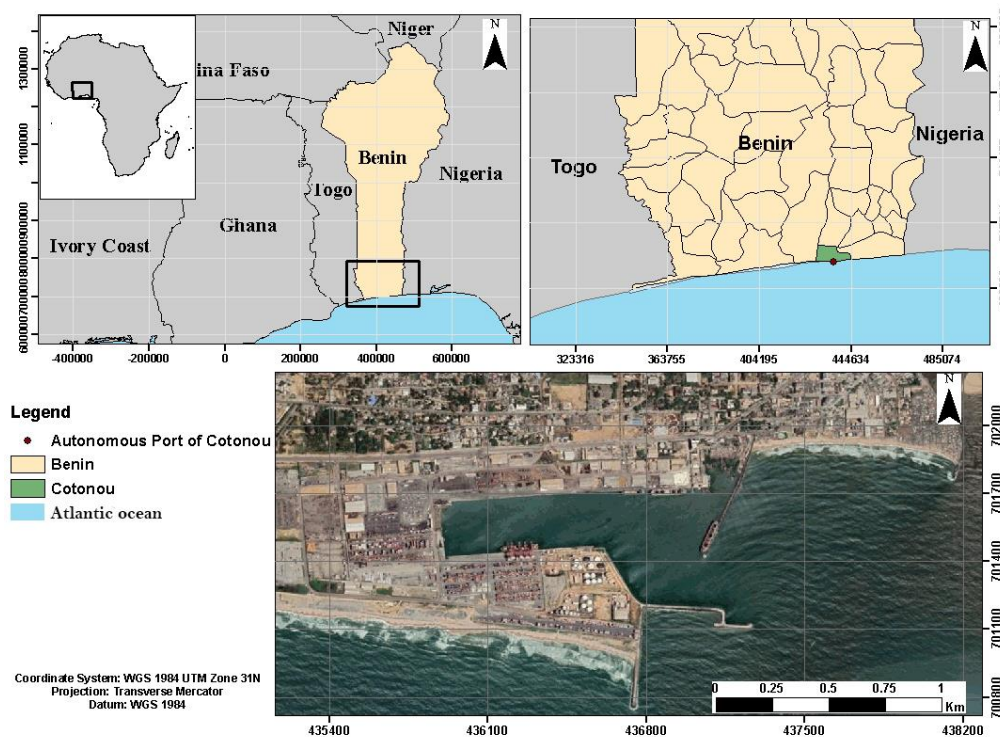


Figure 1 PAC location map, image extracted from google earth

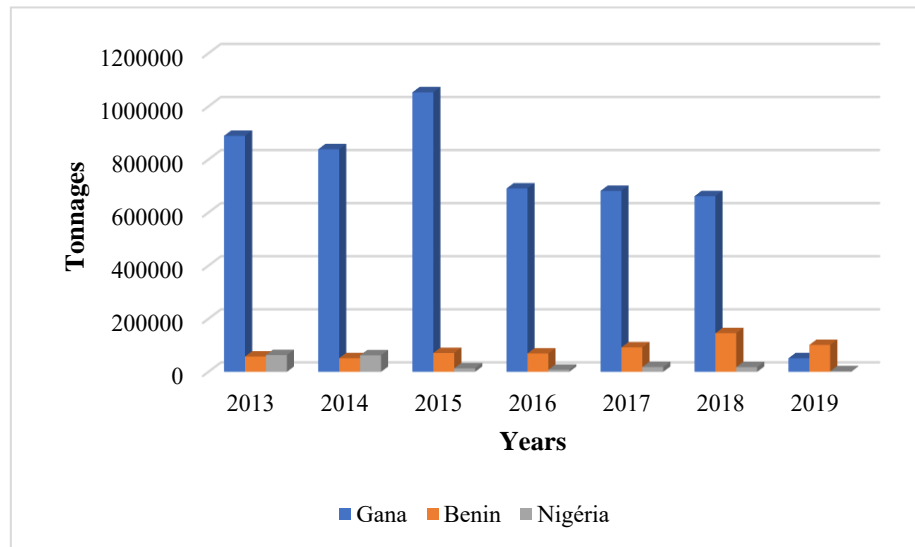
### Characteristics of the study area

The climate is tropical Aw type ( warm temperate climate with dry winter), the average temperature is  $26,8^{\circ}\text{C}/\text{year}$ , with average rainfall of  $1244\text{ mm}/\text{year}$ , and average wind of  $19\text{ km}/\text{h}$ . The waves reach a maximum height of  $2.2\text{m}$  (MARÉPECHE, 2020). The PAC is built on the barrier island, which separates Lake Nokoué from the Atlantic Ocean, representing a flat topography not exceeding  $10\text{ m}$  in altitude.

### Port situation

The Autonomous Port of Cotonou, opened in 1965, was expanded in the years 1982, 1992, 2012 and is in continuous process expansion since 2019. PAC is characterized by being a sea port and a public, industrial and commercial entity with legal entity and financial autonomy. Like other ports in the world, PAC is in the process of maintaining its financial autonomy, its logistic viability in order to satisfy the expectations of its customers. This port has a road to serve the north of landlocked countries, such as Burkina Faso, Mali, Niger and Chad. It also represents the closest transshipment port to Nigeria and Togo. This representativeness is decreasing annually, that is, the port of Lomé exceeds the PAC's performance.

According to data from Port of Lomé (Togo), Benin, Ghana and Nigeria are today countries of relay and transshipment closest to the PAC.

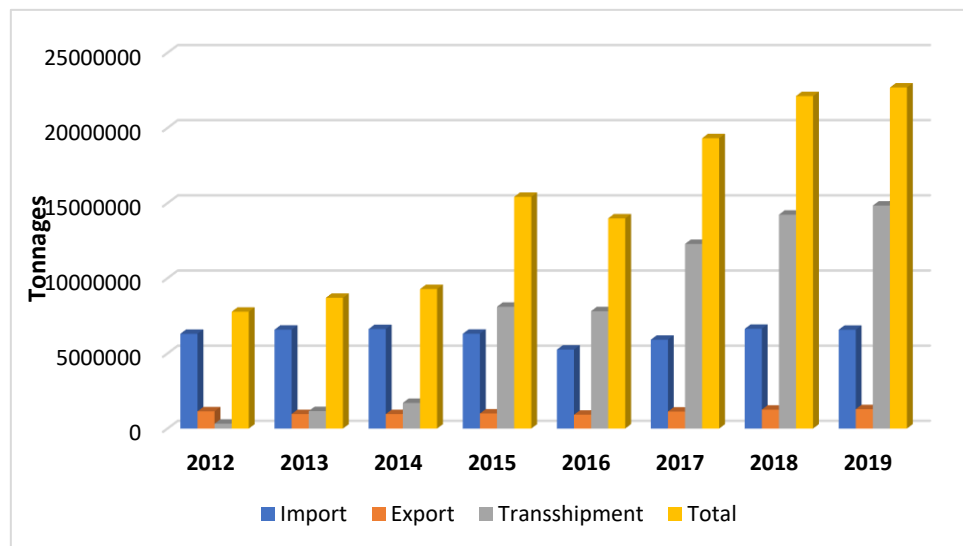


**Figure 2** Transfer and transshipment from the Port of Lomé, Source: Port of Lomé (2020)

There is a significant drop compared to Ghana and an increase compared to Benin in 2019 (Fig 2). Between 2017 and 2019, the port of Lomé handled more cargo destined for Benin and in 2019, Benin was the country with a port that received the largest cargo from Togo (101,417 tons).



**Figure 3** Total movement of imports, exports and transshipment in the PAC in the period from 2000 to 2019 (Source: Port of Cotonou, 2020)



**Figure 4** Total movement of imports, exports and transshipments at the Port of Lomé, in the period of 2012 and 2019

Source: Port of Lomé, 2020.

The total movement (import, export and transshipment) of the PAC in the period from 2000 to 2019 presents an import rate always higher than the exports, such as the other ports in West Africa, justifying a negative trade balance (fig 3). In the period of 2017 and 2019, the Port of Lomé recorded a high amount of transshipment and a low amount of import and export compared to the PAC (fig 4). The high amount of transshipment at the Port of Lomé can be justified by its depth (17m), the largest in the region, by the quality of its services and its competitive port fees.

PAC, with aging infrastructure, deficient equipment and slow port services, has difficulties in responding the demands of the hinterland. The PAC is no longer competitive with the ports of West Africa because of the high competition that exists, being cited among the latter in the list of ports in the central and west regions, and is still not attractive because of its current organizational characteristics.

**Table1** Characteristics of the Port of Cotonou and West Africa

Countries	Ports	Depth (m)	Access Channel (m)	Number of cribs	Length of stay cargo (days)	Average of number / month of ships	Average tonnage handled / year
Benin	Cotonou	10 to 15	15	11	-	85	10,000,000
Ivory Coast	Abidjan	13.5 to 16	18	21	15.70	160	22,500,000
Ghana	Tema	9; 11.50 to 16	18.2 to 19	18	18	129	22,000,000
Nigeria	Lagos	15	-	-	25	95	41,000,000
Togo	Lome	16.50 to 17	18	13	-	115	30,000,000

Source: Ports of Benin, Ivory Coast, Ghana, Nigeria and Togo

The PAC received a smaller number of ships in the last four years and has the lowest number of berths (11) and the lowest depth (10m to 15m) compared to the Port of Lomé (16.50m to 17m) and the lowest tonnage (10,000,000 tons) movimented. Thus, this port is no longer viable and can have a direct impact on the country's economy, since it generates up to 60% of the Gross Domestic Product (GDP) and contributes 80% to the mobilization of customs revenue and 45% of tax revenue (PAC , 2020).

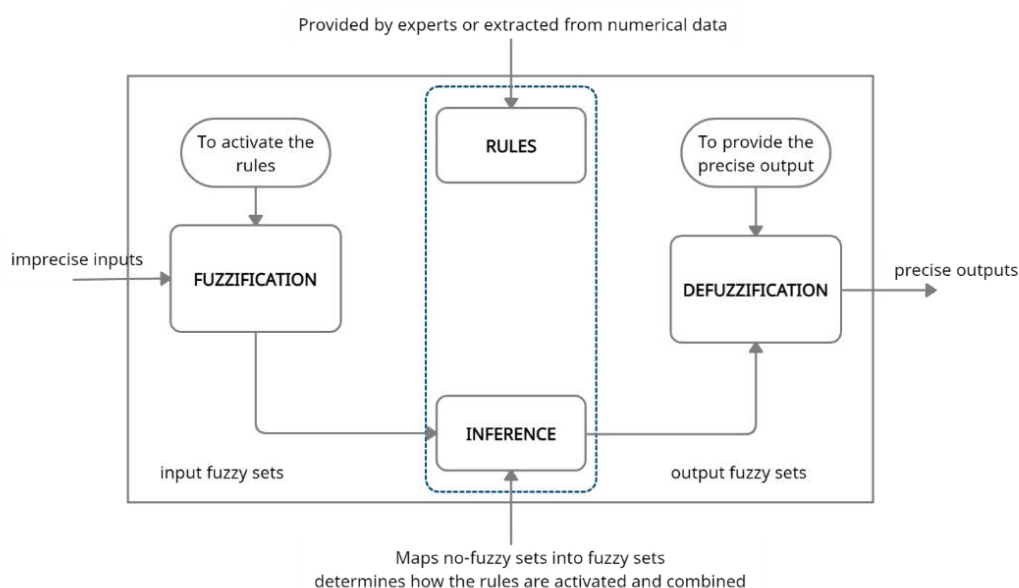
PAC has an expansion project in progress (2019 - 2023) and is subdivided into three subprojects: 1- Pier; 2- Capacity in the berths of container ships, 3- Extension of the hydrocarbon (fuel) zone and port access. After the works, the new PAC will have as main characteristics: (1) Old infrastructure replaced, access of ships adapted to market demands, depth of 15m and length per berth of 340m; (2) Container cargo, 340m vessels and 14m draft, 2 equivalent operators / competition, annual handling capacity of 1.8 to 2.0 million TEUs; (3) General cargo: modern terminals adapted to demand / dedicated and an increase in capacity; (4) Hydrocarbons: Increase in vessel capacity and storage capacity; (5) The dedicated Ro-Ro berth.

## Materials and Methods

### *Fuzzy system*

A system-based on fuzzy rules is a system that uses fuzzy logic to make decisions, generating one output for each system input. An System Based on Fuzzy Rules (SBRF) has four components or fuzzy controllers: an input processor (fuzzification), a collection of language rules, called a rule base, a fuzzy inference method and in the last phase of the process, an output processor (defuzzification), the defuzzifier converts the fuzzy output value to a value clear (fig 4) (Freitas, Peixoto and Vieira, 2013; Cabezaliand Santos, 2020).

**Figure 5** Fuzzy system.



Source: Dos Santos (2011).

The input to the system can be an accurate value (when derived from a measurement process) or a fuzzy set (when it comes from a human observer or in the form of a database, such as the questionnaires, Maria and Gleicy, 2007). To adapt the input to the fuzzy system, the fuzzification component, which is the process of transforming the input variables into degrees of relevance or certainty, performs an interpretation or qualification of the same variables (fig 5). This fuzzification process allows associating a linguistic vector to the possible values of the input parameters to assemble a fuzzy set that portrays the imprecision of the problem under analysis, that is, to perform a mapping of the input data. In the fuzzification stage there is also the activation (or combination) of the inference rules.

The fuzzy inference process consists of the integration of parameters by means of **If-Then** rules, defined according to the parameters to be used. In this module each fuzzy proposition is mathematically transformed through the techniques of fuzzy logic. Thus, the success of the fuzzy controller depends on the inference method, because the method will provide the output to be adopted by the controller from the input. The linguistic interpretation of the result is sufficient in some applications, but in others, the numerical value as an output variable is requested. In cases where numerical results are necessary, the defuzzification process must occur after the fuzzy inference. Output variables are generated inference blocks in the form of linguistic variables (fig 5).

### **Rules Base**

The rules are defined according to the parameters of ports characteristics, and what normally matches the current realities.

- **Rule 1:** IF the quality of the infrastructures is Good AND the productivity of the equipment is High AND the quality of the services is Excellent THEN the logistic viability will be for Long Term;
- **Rule 2:** IF the quality of the infrastructures is good AND the productivity of the equipment is Medium AND the quality of the services is Acceptable THEN the logistic viability will be for Medium Term;
- **Rule 3:** IF the quality of the infrastructures is Practicable And the productivity of the equipment is Medium AND the quality of the services is Acceptable THEN the logistic viability will be for Medium Term;
- **Rule 4:** IF the quality of the infrastructures is Practicable AND the productivity of the equipment is Low AND the quality of the services is Acceptable THEN the logistic viability will be for Short Term.

### **Fuzzy membership functions**

The first step in developing the logistic viability assessment system is the selection of the fuzzy inference system. Matlab Toolbox offers two types of inference systems: Mamdani and Sugeno. For a good consequence of the analysis rules, the first was chosen. Mamdani is used more often, mainly because it provides reasonable results with a relatively simple structure, and because of the intuitive and interpretable nature of the rule base (Jassbi et al., 2006).

The basic differences between Sugeno's inference method, called TSK and Mamdani's, are in the way of writing the consequent of each rule and in the defuzzification procedure to obtain the general output of the system (Barros and Bassanezi, 2010).

Matlab Toolbox offers different types of association functions that can be used in logic-based models such as triangular, trapezoidal and Gaussian etc. For this analysis, the three functions (triangular, trapezoidal and Gaussian) were chosen to facilitate decision making of port logistics viability.

## Application

### Fuzzification

The fuzzy rule, SBRF was used to analyze the PAC's logistic viability, applying the Mamdani characteristic to model the quality of infrastructures and services, equipment productivity.

Oliveira Junior et al. (2007) present an interesting way of representing controllers based on fuzzy logic by means of Matlab, a very suitable tool for the construction of mathematical systems and simulations of computational concepts. The development of a system based on fuzzy logic enters with three variables and left with one variable, started in the fuzzy environment in the Matlab tool (through the fuzzy logic in the command window).

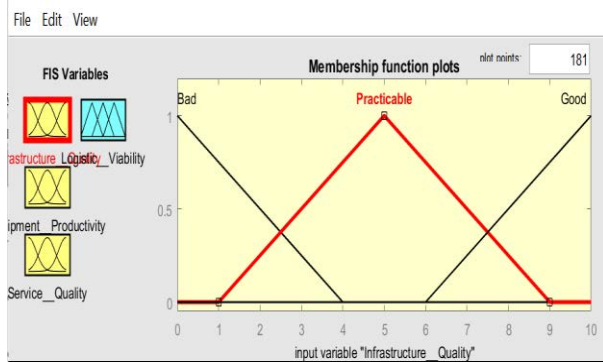
**Table 2** Linguistic variables, Evaluation universe, fuzzy sets

Situation	Linguistic variables	Evaluation universe	Fuzzy sets
<b>Inputs (background)</b>	Infrastructure Quality (IQ)	[0; 10]	[Good, Practicable, Bad]
	Productivity	[0; 50]	[High, Medium, Low]
	Equipment per hour (MPH)		
	Quality of services (QS)	[0; 10]	[Excellent, Acceptable, Bad]
<b>Output (consequent)</b>	Logistic Viability (VL)	[1, 25]	[Long Term, Medium Term, Short Term]

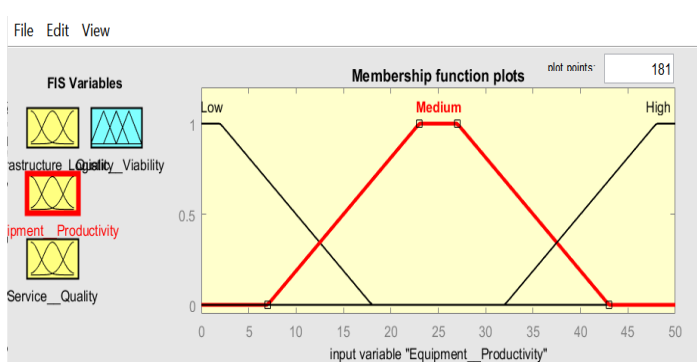
The universe of evaluation of the variable IQ [0 to 10] is considered as a grade to evaluate the quality of port infrastructure (Table 2). The quality of the infrastructures is considered bad, when the universe of evaluation is between [0, 4], that is, when the value is zero, the degree of relevance is 1 (maximum), 100% bad and when the value increases for 4, the degree of pertinence decreases to 0 (Fig 6a). When the universe of evaluation is at 2.5; it means that the degree of pertinence is at the point of maximum cloudiness between the diffuse sets bad and practicable, just as practicable and good when the universe of evaluation is at 7.5. The infrastructure is considered practicable when the universe of evaluation is between [1, 9], its maximum relevance is 5 and the good qualification starts at 6 and ends at 10 (Fig 6a).



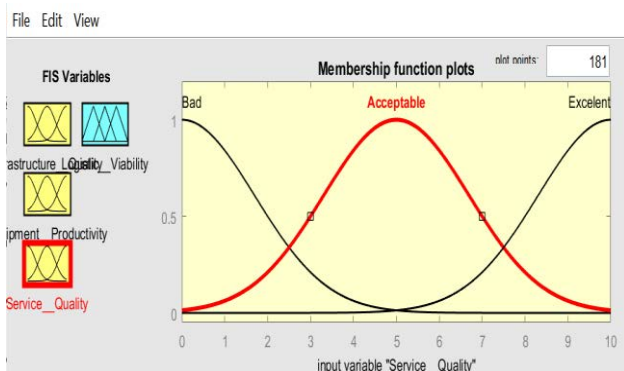
(a) Infrastructure Quality



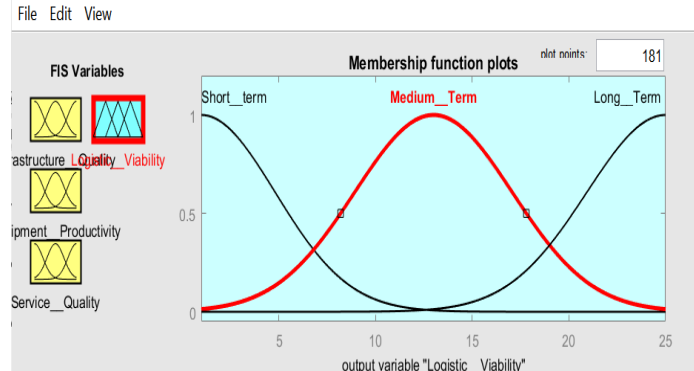
(b) Equipment Productivity



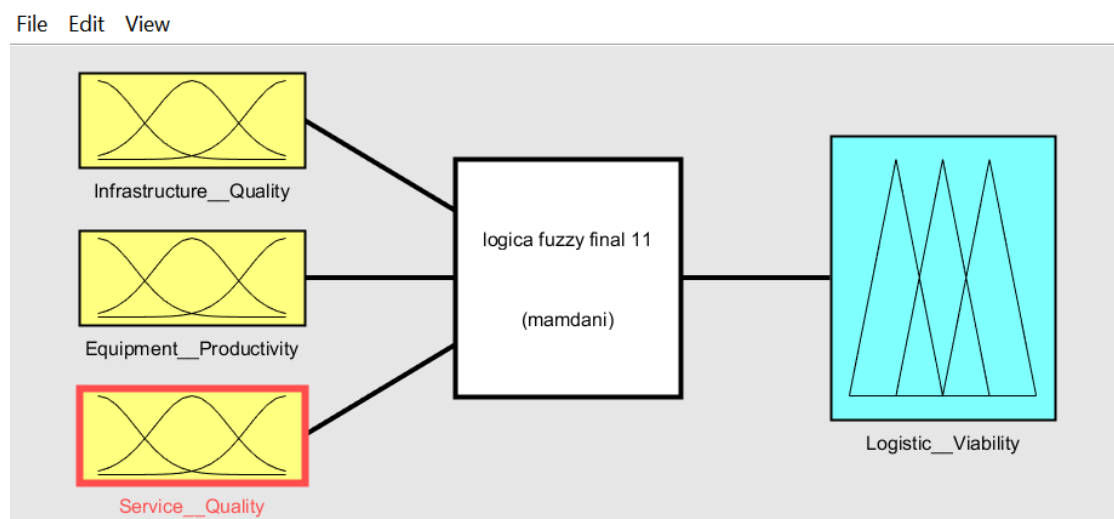
(c) Quality of Services,



(d) Logistic Viability



(e) set mapping variables fuzzy



**Figure 6** (a) Infrastructure Quality (b) Equipment Productivity (c) Quality of Services, (d) Logistic Viability (e) Input (yellow), output (blue) and set mapping variables fuzzy (white), (elaborated in matlab)

The universe of EP evaluation was defined according to the movement per hour MPH of port maintenance equipment of container ships in Africa, where it is difficult to reach the target of 50 MPH of equipment (crane or portainer) (table 2). According Lourdes, María and Juan (2013), the number of container movements per hour in Africa is between 10 and 20, compared with 25 to 30 in the main world ports or even worse when they use ship equipment with only 7 and 10 movements per hour. The EP variable is considered low, when the universe of evaluation is between [2.5 12.5], medium when it is between [12.5



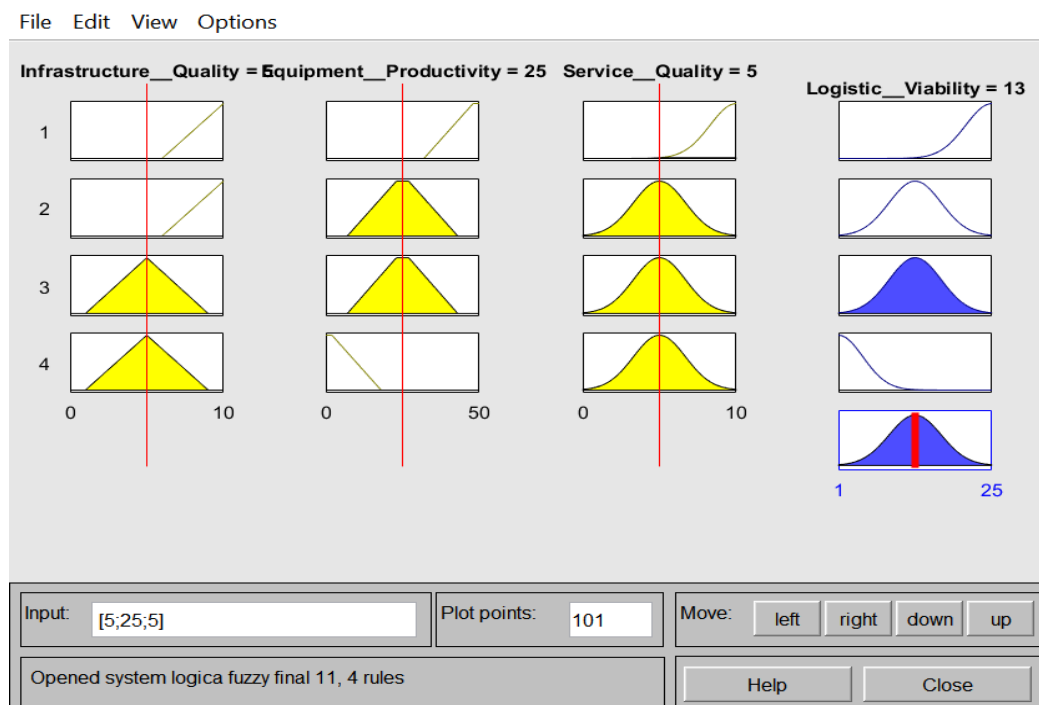
37.5] and from 38 it can be considered high (fig 6b). Between 23 and 27; the degree of relevance of the medium set is maximum, that is, between a maximum MPH of 50, if a device reaches an MPH of 23; 24; 25; 26; or 27; the degree of membership is 100% medium. 37.5 MPH is the point at which the maximum cloudiness between medium and high occurs, starting at 38 MPH, the degree of high relevance is higher than medium and can be qualified from there.

A universe of evaluation of the variable SQ [0, 10] was defined to evaluate port services (table 2). Like the IQ and EP, the SQ has 3 diffuse sets (Bad, Acceptable and Excellent). It's considered bad when the universe of evaluation is between 0 and 2.5; acceptable from 2.6 to 7.5 in which it changes to excellent (fig 6c).

The universe of evaluation of the output variable LV was defined in relation to the amortization time of the infrastructures and equipment. According to the "Metropole" Council of March 4, 2016, port infrastructure has an amortization period of 30 years. Therefore, equipment amortization is less than 30 years, with an interval of 1 to 25 years (table 2). The LV is considered short term when the universe of evaluation belongs to the interval from 1 to 7 years and between 7.1 to 19 years, the universe of evaluation changes to medium term and long term after 19 years (fig 6d).

### Defuzzification

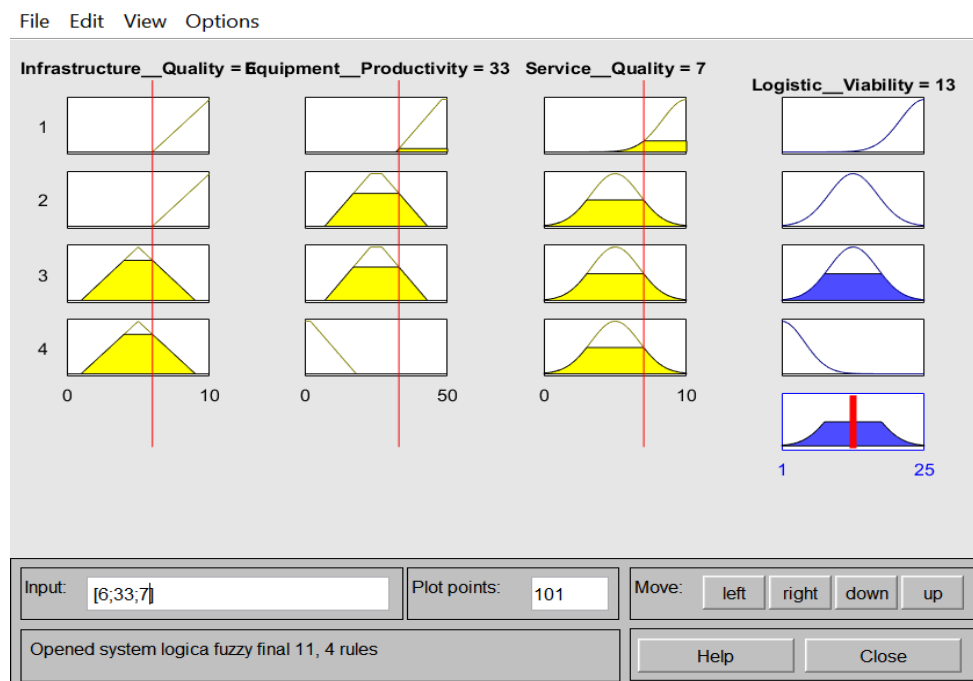
The fuzzy rules in the model based on fuzzy logic are translated after modeling in real numbers. When the inputs were real, you expect to have real output as well. The quality of the infrastructures is 05/10, equipment productivity 25/50, quality of services is 05/10 and the output of the variable logistic viability is 13/25 (fig 7a).



**Figure 7a** The Rules base and fuzzification of variables IQ, EP and SQ (yellow) and defuzzification of variable LV (Blue).

Fuzzy result for IQ = 05; EP = 25; SQ = 05, (elaborated in matlab)

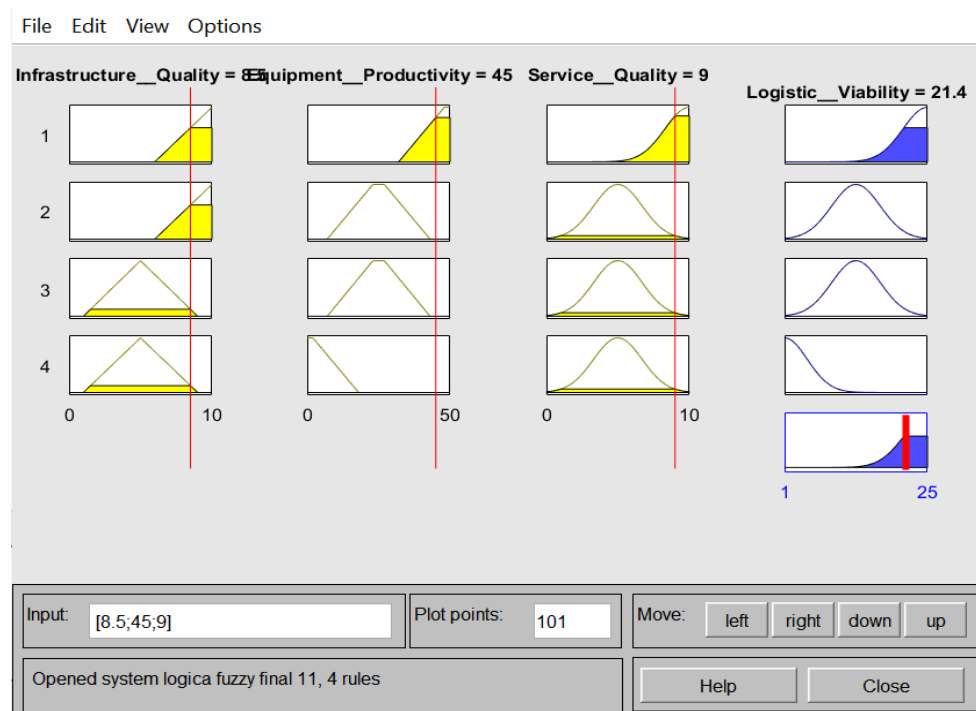
The first line corresponds to the first rule, the second line also corresponds to the second rule, and so on. Columns 1, 2, 3 and 4 are respectively for infrastructure quality, equipment productivity, service quality and logistic viability. The red bars show the numerical results after modeling (fig 7a). The red bar in the fifth row of the fourth column shows the result of the level of logistic viability in relation to the practicable infrastructure quality, medium equipment productivity and acceptable service quality in the Port of Cotonou. This red bar of the membership function of the output variable shows that the corresponding diffuse set is medium term with a maximum degree of membership (fig 7a).



**Figure 8b** Rules base and fuzzification of variables IQ, EP and SQ (yellow) and defuzzification of variable LV (Blue) b:  
Fuzzy result for IQ = 06; EP = 33; SQ = 07, (elaborated in matlab)

The infrastructure quality column increased from 5 to 6, meaning the presence of an expansion project. In other words, after carrying out the “future PAC” project, the quality of the infrastructure will increase (fig 7b). In the same way with the equipment productivity column, which changed from 25 to 33 and the quality of services went from 5 to 7. The only similarity is observed in the intersection of the fifth row and the fourth column. The result of the variable logistic viability is 13, it means an advance in the input variables of the system, it is not recognized as a major work carried out in the PAC since the south quay of the port is 15m deep, the project foresees 15m dredging for the north quay and an extension west of the port. Currently, only container vessels with a draft greater than 11m and less than 15m can dock and only at the berth (south quay), designed for the Bolloré Group. The perceived difference was with the degree of pertinence, which was totally medium term (fig 7a) decreased (fig 7b), the blue graphic level. The implementation of the project will allow ships with up to 15m of draft and longer to enter the PAC. With port equipment, no project is prepared and published on the websites of logistics companies, but it is possible after carrying out this project, that handling operators will increase the efficiency of their equipment to face the competition since the PAC, it once reached MPH 33 / portainer in 2018.

The capacity of the vessels increases annually (such as the Suezmax of 17m draft, Panamax of 12.04m, Post-Panamax of 26m, Capesize with 18.91m, Chinamax 24m, Malaccamax 20m containers) and the equipment becomes more modern with the development of maritime trade. The new project should announce a dredging to 17m or 22m in depth to receive larger ships. In some ports in West Africa, there are 17m deep ports, such as the port of Lomé (Togo), Tema (Ghana) and Lagos (Nigeria). However, shipowners are looking to reduce their stopping time at ports. This reduces the vessel's operating costs and improves the profitability of its port call. The optimization of call times could in future encourage shipowners in prioritize PAC services in the rotation of larger ships that serve several ports in the region. Specifically, if a port has the necessary extra capacity (such as good infrastructure quality, more modern and sufficient quantity handling equipment and service quality) to attract more cargo flows, as well as economies of scale as a result, this will have a price advantage over competitors and in turn attract even more cargo (Haralambides, 2002), this would converge to Long-term logistic viability (fig 8).



**Figure 8** Fuzzy result for the evaluation universe, IQ = 08.5; EP = 45; SQ = 09,( elaborated in matlab)

The input variables are more advanced, equivalent to the numerical results of each column, 8.5 or Good for infrastructure quality, 45 or Hiht for equipment productivity, 9 or excelent for service quality and 21.4 years for exit logistic viability, represented by a red bar at the intersection of the fifth row and fourth column (fig 8). With a 17m or 22m depth dredging, good infrastructure quality and the acquisition of the most modern port equipment, the level of the variable logistic viability is expected to increase in the long term.

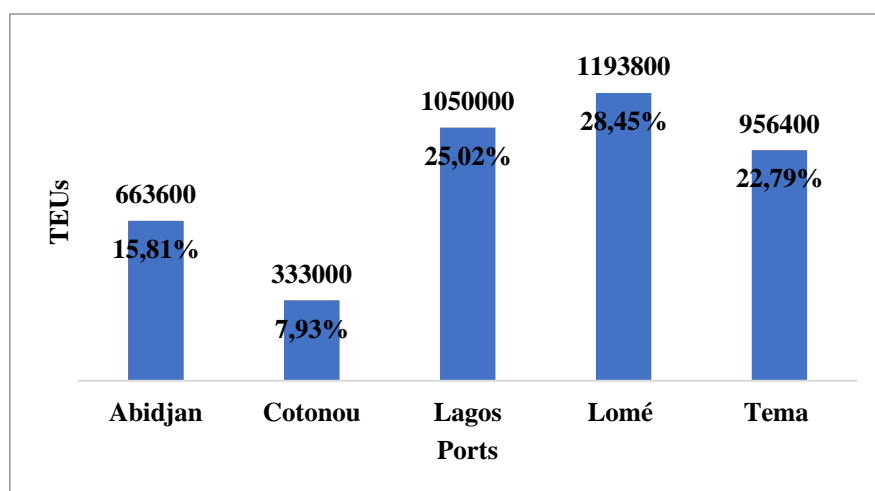
## Discussion

Port logistics is one of the main relevant activities in the port position that indicates the position and efficiency of a port and makes it an indispensable link in the port activities chain, that is, an ideal layout of

space and the coordinated development of the port. The fuzzy methodology is a good tool for analyzing and handling inaccurate decisions. Rahmawati and Sarno (2018); Wanke and Falcão (2017); Akyuz, et al. (2020); Allahviranloo and Afandizadeh (2008); Loh et al. (2017); Onut et al. (2011), among others, obtained results satisfied with the fuzzy application. The analysis of logistic viability at the port of Cotonou using fuzzy logic based on fuzzy rules and modeled on the Matlab Toolbox gave a medium term, equivalent to 13/20. This result shows that the logistic viability is linked with port IQ, SQ and EP variables.

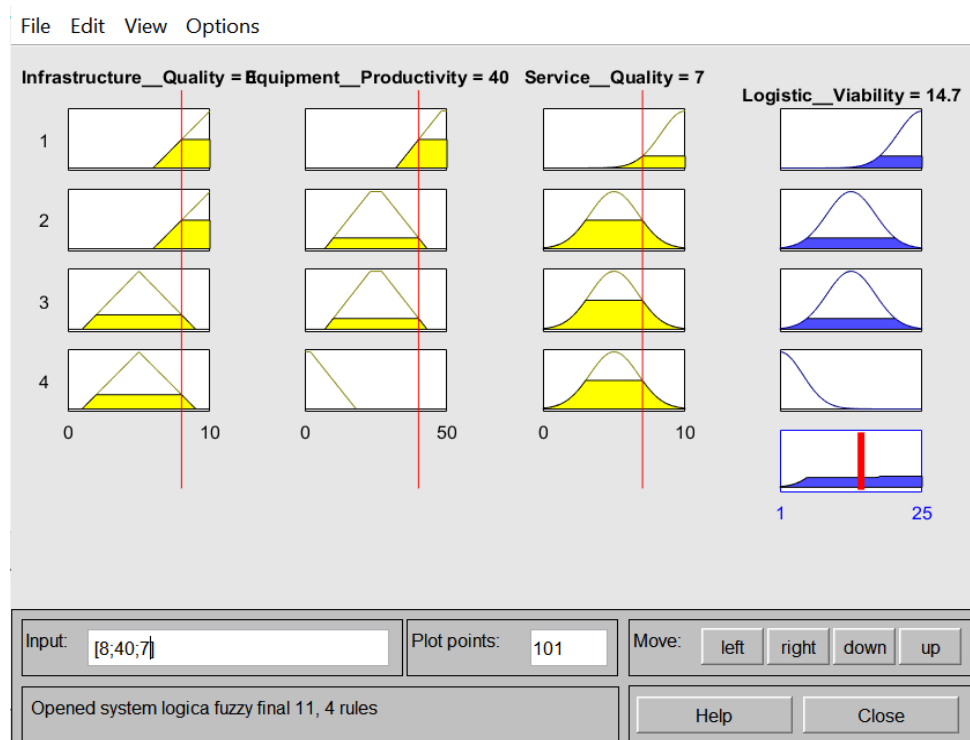
Regarding the quality of port infrastructures, PAC is making an improvement in its infrastructures, however, the result of PAC remains the same as it is today (fig 7b). This shows that there are no major improvements in the PAC's infrastructure and logistics investment project suggestions. Obsolete port equipment and the services offered have caused a decrease in the flow of ships in the port.

The access channel of the project is the same, 15m, the same number of berths (11) and port efficiency, considering that there will be no acquisition of new port equipment, and the services will be the same. If the current movement of containers at the port is 333,000 TEUs, after the project is carried out, an increase between 10% and 20% more are expected. At the same time, neighboring ports, such as Lomé (Togo) handles 1193800 TEUs (fig 9).



**Figure 9** Container movements at TEU 2017 between neighboring ports, (Ports of Cotonou, Abidjan, Lagos, Lomé and Tema)

The Port of Lomé is the hub with 1,193,800 TEUs and Cotonou is the last with 333,000 TEUs in 2017, while the maritime trade favors the unification of cargo, for more security and ease in cargo handling (Fig 9). Among the 5 ports that serve the hinterland, PAC handles less containers, which is safer and more used by ships.



**Figure 10** Result fuzzy of the current state of the port of Lomé (elaborated in matlab)

After modeling in Matlab with the current characteristics of the port of Lomé, considering the same universe of evaluation previously used with the PAC, with a quality of infrastructure 8, the productivity of equipment 40 and the quality of services 7, the result shows a viability logistics of 14.7 years close to 15 years (fig 10). This result confirms the dependence of IQ, EP and SQ on port viability. Comparing the PAC and the port of Lomé, the latter is the best in terms of characteristics.

There is innovation, adequate infrastructure of good quality, port equipment of the latest generations and excellent service in the result (fig 9). The application of the result presents a good perspective and performance in the long term of 21.4 years for logistic viability.

## Needs

The PAC must invest in port infrastructure, logistics, equipment and also in advanced technologies. The access channel must be dredged to 22m, the depth of the port also to 20m or 22m, and thus, allowing access to vessels with large size and greater draft up to 22m. On the other hand, the most modern port equipment is very useful for the efficiency of the port, that is, to provide for the acquisition of the equipment, to reduce the time of stopping at the port and attracting many ships. According to Hsu, Lian and Huang (2020), in addition to distance, containing both ocean and land, the important attributes that sea carriers consider in deciding which port calls are general infrastructure, port tariffs, port efficiency, availability and berth size. The PAC must computerize its administrative procedures for customers, improve the quality of services and establish new rates to be more competitive.

When the realization of the data find difficulties because of the current infrastructure, it would be better to propose a new project for a second port, specialized for container ships (more advisable), with installation

of most modern equipment. As a consequence, there is an increase in the PAC's chance to have a greater participation in the Beninese economy and in the port to establish long-term logistic viability.

## **Conclusion**

The best ports in the world have quality port infrastructures and modern, computerized, fast, efficient and effective port equipment for all port operations, such as unloading or loading, handling and storage of products (Unctad 2018).

It was possible to perform this analysis, using the proposed methodology. The relevance of each of the variables analyzed was modeled using the fuzzy logic, in the Matlab fuzzy Toolbox. The analysis of PAC's logistic viability using the fuzzy logic method shows three possibilities of a diffuse set for the port, short, medium and long term. PAC's logistic viability is linked to institutional reforms, directly related to port services. In figures 7 and 8 after modeling, port services vary from 5 to 7 and then 9 when logistic viability is long term, that is, a relevance of one of the aspects that hinders efficiency and weakens logistic viability. Certainly, a good quality port service reduces increased service costs and down time at the port. In practice, these results prove the dependence on the variable quality of port services, infrastructure and equipment productivity.

The results show that the quality of the infrastructures is 05, the productivity of equipment in motion per hour for MPH equipment is 25 and short term logistic viability, 13 years. These results come in fact that most of the equipment and most of the infrastructure does not correspond with the current reality, this summarizes the factors that are hindering the development of the PAC (fig 7a).

With the project planned for the future PAC, there is no big difference between the current state of the PAC and 3 years from now, hence the same numerical output 13 of the variable logistic viability (fig 7b). The difference arose at the north quay where, after the project was completed, the other types of ships (general cargo, oil tankers, RO-RO) with a draft of up to 15m will enter. It would no longer be just the southern quay that container ships with a maximum draft of 15m will receive. With this level, suppose that the logistics companies grow with the evolution and acquire or improve the productivity of their equipment.

The results highlight a good performance of the PAC with a good quality of the infrastructure 8.5 / 10, a good productivity of the equipment, 45 MPH and an excellent quality of service 9/10, consequence, long term logistic viability, 21.4 years (fig 8).

The fuzzy logic as a method shows the changes and realization that the PAC needs to be efficient. In addition, fuzzy logic shows good performance and can help the PAC to achieve its goals and be the hub of the region. For it to be long term, it would be better to increase the measures and characteristics of the project in order to expect a good result from the analysis (fig 8). Other possible options for the PAC to achieve long-term logistic viability is to launch the realization of a new container terminal or a new port project.

## **Acknowledgement**

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# **L. S. Vygotsky and His Theory as an Inspiration for Innovations in Education**

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## **Abstract**

*In recent years, preschool education has become an important topic in the Czech Republic. Since 1990, the system of preschool education has undergone a number of qualitative changes. A modern preschool curriculum has been created and is constantly being reviewed in line with the needs of society and educational policy objectives.*

*One of the problems of the past decade concerns the high number of pupils with postponed compulsory attendance. This has become a challenge for both teachers and researchers. One of the steps that could help was the enactment of compulsory preschool education in 2017. More attention should therefore be given to systematic preparation of children for starting compulsory education on the basis of individualization in education. However, this requires teachers to use high-quality educational diagnostics in order to ensure children's development with respect to their capabilities, interests and needs. A team of experts at the Faculty of Education at Palacký University is currently developing and validating an online application as an educational diagnostic instrument that should systematically monitor children's progress as well as highlight potential problems and eliminate them in time. In the development of the instrument, the team builds on the current trends in preschool education, a number of educational theories and the work of renowned authors (Rogers, Piaget, Bandura, etc.) An interesting and inspiring view of the development and education of preschool children is presented by social constructivism and its main proponent Lev Semyonovich Vygotsky, whose ideas and legacy are outlined in the present study.*

**Keywords:** Vygotsky, preschool education, educational theories, theoretical study

## **1. Introduction**

Lev Semyonovich Vygotsky (1896–1934) was born into a Belarusian Jewish family and, as paraphrased by Soukupová, nobody knew at that time that a “thinker with traits of a genius” was born who is sometimes called the Mozart of psychology (Soukupová, 2012, in Toulmin 1978, in Wertsch, 1985, p. 8). He grew up in difficult conditions, which certainly influenced the area of his expertise.

During his study at a Jewish Gimnasium he became interested in theatre and literature. He graduated with

a gold medal and then started studying law at a university in Moscow, which he finished in 1917. In parallel, he studied psychology, philosophy and history at Shanavsky non-state university. After graduation he returned to Gomel and worked as a history and literature teacher and contributed to the establishment of the psychological laboratory at the local teaching institute.

Vygotsky taught, gave lectures and published books. The key period in Vygotsky's scientific work was 1924, when after his presentation at the Second All-Russian Congress of Psychoneurology in Leningrad he was addressed by K. N. Kornilov, director of the Moscow Institute of Psychology, and offered a place at the institute.

The period between 1924 and 1934 is considered a highly productive time in Vygotsky's life. The period of the second half of the 1920s and 1930s was for many intellectuals a challenge for changes in education, which was also related to the high degree of illiteracy in the country. During this period, Vygotsky's team worked on speech development in children from different sociocultural backgrounds. His team included scholars such as Leontiev, Luria, Bozhovich and Zaporozhets. Vygotsky focused on children with various problems including deaf, blind or mentally retarded children. The area of defectology in Russia of that time stemmed from the problems of the country. This was contrary to western countries which focused rather on psychopathology, emotional problems and learning disorders. However, Russia faced the consequences of wars that left many orphans who became beggars and lived in groups of children with the same problems. The fight for survival changed into children's delinquency. Children were in an extremely poor health and mental condition. The system of care for children with disability was at the very beginning (Pipes, 1998, in Soukupová, 2012, pp. 47).

Vygotsky established the Laboratory of Psychology for Abnormal Childhood which later changed into the Institute of Defectology of the Academy of Pedagogical Sciences. In the last years of his life, he worked on his book *Thought and Language* but died before its publication (Vygotsky, 2017, pp. 136–139).

Vygotsky's work was subject to ideological criticism and was even banned after his death. In 1936, a party resolution *On Pedagogical Aberrations in the System of the People's Commissariat of Education* was issued. The resolution suppressed the progressive theory of Soviet psychology and pedagogy. For years, Vygotsky's collaborators were silenced.

The situation changed only in 1956 when *Selected Psychological Works* was published accompanied by A. R. Luria and A. N. Leontiev's extensive study on Vygotsky's work. In parallel, *Thought and Language* was published as a separate book of Psychology of Art. In the 1980s, Vygotsky's work was issued as a six-volume collected publication.

Vygotsky experienced the period of absolutist Russia imbued with antisemitism, the dramatic revolutionary period, the war, the period of enthusiasm and faith in a better democratic society, but also the emergence of the Stalinist dictatorship. Although Vygotsky died relatively young of tuberculosis, his legacy particularly in developmental, educational and social psychology is exceptional and relevant today.

## **2. Cultural-Historical Theory of Development**

Vygotsky is the author of a theoretical critique of biological naturalistic conceptions of man, to which he opposed his own theory of cultural-historical evolution. In order to understand Vygotsky's concept of the

zone of proximal development, one has to comprehend the principle of his cultural-historical theory of development.

### ***2.1 On the Historical Nature of the Human Psyche***

Vygotsky introduced into concrete psychological research the idea of the historicity of the nature of the human psyche. He considered the transformation of the natural mechanisms of psychological processes in the course of cultural-historical and ontogenetic development to be a necessary result of man's assimilation of the products of human culture in the process of association with other human beings around him.

He based his own research on the following two hypotheses:

1. On the mediated nature of man's psychic functions,
2. On the origin of internal mental processes from the originally external and interpsychological activity.

According to Vygotsky, the specifically human characteristics of the human psyche come into being as a result of the fact that previously direct natural processes are transformed into mediated processes thanks to the inclusion in behaviour of an intermediate link (stimulus, agent). "In the brain, simple elements are combined into a new 'unit'. A holistic process is created which can be imagined as the connections between the vertices of triangle A-B-X, where X is the peak, while the A-B connection symbolizes the formed mediated process. A-X and X-B are the elementary connections formed by the establishment of ordinary conditional reflexes. For example, in the case of mediated memorization, simple links are structurally unified through mnemotechnic X, while at other times this task is attributed to a word" (Vygotsky, 1929, in Leontiev 1966, p. 225).

The second hypothesis was expressed along with the first hypothesis. In this context, Vygotsky postulated that the mediated structure of the psychic process was originally formed in a context in which the mediating link had the form of an external stimulus. This theory made it possible to understand the social origin of the new structure, which does not arise from within, and is not self-invented, but is necessarily formed in social intercourse, which in the case of man is always mediated. The mediated structure of psychological processes always arises on the basis of the mastery by an individual human being of those forms of behaviour which originally developed as directly social forms of behaviour. The individual masters the link "stimulus—agent" which mediates the given process, whether it be a material agent, verbal concepts or, for example, symbols.

Thus, Vygotsky introduced another major theory into psychology: "The chief mechanism in the evolution of the human psyche is the assimilation of social historically developed types and forms of behaviour and their transformation into internal psychological processes" (Leontiev, 1966, pp. 224–226).

According to Vygotsky, artificially developed stimuli lead to the regulation of an individual's behaviour. In his theory, he uses the following concepts: sign, tool, cultural tool. What mediates psychological processes is referred to as a sign (for example language, numeration). The concept of sign is used as "having a meaning" in the psychological sense. People use auxiliary signs (for example, in a specific way they mark something they want to remember, Vygotsky's examples include making a notch in a piece of wood or tying a knot on a handkerchief), by doing which changes are made to the external environment. These are

changes that affect internal mental processes. People then have the ability of recall in memory and the processes of mediated remembering take the form of internal mental processes. In this way, individuals make changes to the external environment that affect their internal mental processes.

There is a double dependence between the structure of mental processes and their relationships, which results from the newly created mediated structure. The development of the relationships between these functions restructures the functions, including perception, attention and memory.

If people change the environment through their behaviour, they can also control their behaviour and their own mental processes. In this context, Vygotsky pronounced the following motto: “Natura parendo vincitur” which translates as “We can only control ourselves if we obey nature.” He also added the following Bacon’s thesis: “Nec manus, nisi intellectus, sibi permissus, multum valent: instrumentis et auxiliis res perficitur” (\*Neither the hand nor the intellect, on its own, yields much power; only through tools imbued with culture is this accomplished.) According to Vygotsky, the mediated nature of mental processes allows individuals to change the environment and thus control their behaviour, making human behaviour sensible and free (Vygotsky, 1970, p. 11).

According to Vygotsky, the mediated function is performed by sign and tool, where tool is the mediator that influences the external world, while sign is the mediator that influences the internal human world. In the same sense, he uses the term cultural tool, which changes the whole operation according to the characteristics of the tool, moves it to a higher level and extends its scope. Cultural tools affect the changes in the human psyche and consciousness. The original biologically conditioned psyche is thus transformed to culturally conditioned psyche. Cultural tools expand our capabilities and allow us to realize our potential which is latently present but otherwise inaccessible. Vygotsky introduces the idea of the sign and tool intersection, where the key aspect is the link between thought and speech, memory and thought as well as memory and speech (Vygotsky, 1976, in Soukupová, 2012, p. 67).

Vygotsky’s propositions were of great importance for psychology, especially at the time they were formulated. They were progressive because the idea of that time was that “mental functions are always determined and invariable (sensation, perception, memory, attention).”

## ***2.2 Construct of the Zone of Proximal Development***

When we observe children, we usually see the capabilities that were developed as part of the interaction between hereditary dispositions and the environment, but we are essentially interested in what children are able to do and what their potential would be without the limiting environmental conditions as these are never ideal. Vygotsky analysed cognitive abilities in terms development and interaction but also in terms of their measurement.

He was one of the advocates of the psychosocial learning model, where learning should not be “at the tail of development” and just adapt to maturation (Helus, 2009, p. 62). Should learning be beneficial, it needs to precede development because mental development is dependent on external stimuli. Cultural influences include teachers, parents, books—information mediated and transmitted through interactions.

Vygotsky’s idea is based on the assumption that an individual goes through a continuous development in unseparated stages. The transition period between two stages represents the potential for higher performance and is called the zone of proximal development (Sternberg, 2009, p. 482).

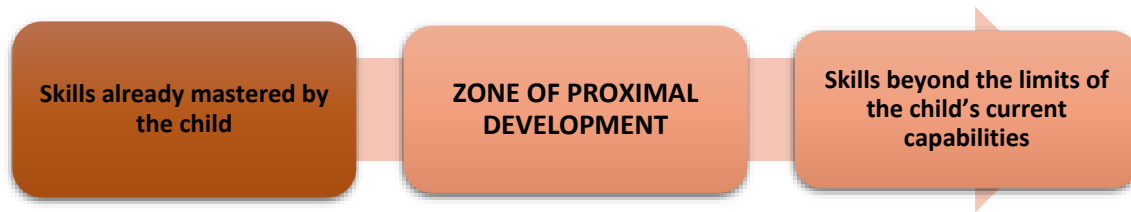


Figure 1. Zone of proximal development

The following levels (zones) of child development are distinguished:

1. Actual
2. Proximal development
3. Future

The actual zone represents the level where the child is right now. At this level, the child solves problems independently without external help. The level indicates the existing mature and complete functions. This level is not indicative of ongoing development or other development prospects.

The zone of proximal development represents the range between the child's observable level of capability (performance) and the child's latent capability, which is not entirely obvious.

The future level indicates where the child can move with the help of another person. From a developmental perspective, this stage is indicative of the child's maturing functions and state of readiness. At the same time, it covers the dynamics of the child's development and other perspectives (Šmelová, 2019, p. 60). These two levels should inform the teacher about the child's development and education.

As suggested by Blížkovský (1992, p. 92–95), uncovering the potentialities of the development and education of another person or oneself is not easy. A significant role is played by the environment in which the individual lives. The environment can have both positive and negative effects. An important aspect is the stimulating nature of the environment and a sufficient amount of material, social and cultural stimuli under which both the inherent and acquired potential transforms into the real traits and capabilities. In the case of an unfavourable environment, developmental possibilities remain unrealized.

In terms of self-assessment of one's capabilities, some people tend to underestimate or overestimate themselves, which may be related to the fact that they set high standards for themselves. An immature person tends to have vague ideas. Not even adult persons are always aware of their real potential.

The zone of proximal development provides a space for development—for the better or for the worse. It represents the stage of the child's development which can be reached only with the help of another person in the context of social cooperation. According to Vygotsky, effective learning influences the functions that are still maturing, not those that are already mature.

The zone of proximal development is mostly linked to the period of childhood. However, it can also be considered from a general perspective as a potential of the human psyche which is undergoing constant changes in the context of social interactions and available cultural tools (Berk, 2013, p. 225–226).



### **3. Vygotsky's Thoughts in the Context of Contemporary Preschool Education**

The purpose of this section is to reflect on selected Vygotsky's ideas in the context of the contemporary preschool education with an emphasis on the development of children's potentialities. Special focus is on social interaction, assessment of children's development and children's play.

#### ***3.1 Social Interactions as a Significant Factor of Child Development***

As an advocate of the sociocultural theory, Vygotsky emphasised the development of mental functions and the factors that support their development. He believed that the most important aspect was support and guidance provided by adults, especially parents, while in the context of educational institution this role is taken by teachers. The quality of these interactions is decisive for the development of the child and the child's ideas about the world and the self. In this sense, the child is not treated as a mere object. According to Vygotsky, the child is a social being who lives in a specific environment, in a community of adults and children who influence the child's attitude to the surrounding world and mediate the child's knowledge. The child learns about the world not only through others, but also through one's observation, discovery, experimentation, etc. The knowledge presented to the child must be appropriate to their understanding. As far as the development of higher functions is concerned, it is important to instil new ways of thinking and problem solving which can be adopted by the child if guided properly on the basis of appropriate contexts as well as general principles. Individual cognitive competences appear only as a result of the interaction with other people from whom they learn (Vágnerová, 2012, p. 50).

According to Vygotsky, the environment has to be considered not objectively and statically but relatively and dynamically. According to the author, the crucial aspect in both development and education is the child's own activity, for which appropriate conditions must be provided.

Although teachers have the key role in the process of education, the dialogue in the interaction between the educator and the educated must not be neglected. In this context, the educational process supports conscious activity and self-actualization. The teacher monitors the child's progress and responds in an adequate way, knowing that the newly created qualities are accompanied by the disappearance of the previous stages.

The discrepancies described above can be overcome in the educational process. More systematic and goal-directed encouragement of children's education in the context of the zone of proximal development as well as responding to children's needs according to their objectives, interests, wishes, aspirations, self-actualization tendencies, etc. increases the effectiveness of the educational process. To put it simply, only what is in the zone of proximal development today can be realized in the actual zone tomorrow (Blížkovský, 1992, p. 97).

#### **Social Interactions in the Context of the Preschool Curriculum**

As has already been mentioned, the quality of the environment is an important factor that has both positive and negative effects on children's development. This leads to interactions that can be of various nature. These may be social (interpersonal) interactions but also contact with inanimate objects or symbols. This leads to a process in which the development of the child is both stimulated and modified, under the influence of all environmental elements of varying degrees and quality. The role of the environment is to



develop these interactions and communications, which embed and develop all of the higher functions. The current preschool curriculum emphasizes the quality of the environment, not only in terms of material and psychosocial conditions but emphasis is on social interactions within a controlled educational process as well as daily interpersonal communication between children and adults. The pre-school is considered a very important environment for the realization of social situations. Preschool children are often exposed to social formation and communicative demands in everyday interactions with adults, which cause confusion and uncertainty. This can be inappropriately reflected in children's activities in the form of routine. Therefore, involvement of an adult in children's life worlds is important. The adult-child interaction is a feature of a friendly culture (Provázková Stolinská, Rašková, Šmelová, 2017). This is evidenced by the preschool curriculum.

For example, teachers are responsible for ensuring the following:

- The kindergarten disposes of sufficient area (floor space, air volume etc. in compliance with relevant regulation) and such spatial arrangement that suits various group and individual child activities;
- All the activities are organised in such a way that encourages the children to their own activity and experiments, to participate in activities organisation, to work at their own pace, etc.;
- Conditions for individual, group and frontal activities are created, the children can participate in collective activities in small, medium as well as large groups;
- Activities scheduling is based on the needs and interests of the children, and accommodates individual educational needs and limits of the children (FEP PE, p. 33).

The objectives of the preschool curriculum are defined in a way to develop the whole personality of the child in the physical, mental as well as social areas. Emphasis is also on the process in which the educated gradually becomes "self-educator and educator of others."

In terms of their general nature, the objectives of the curriculum are formulated at various levels. One of the categories includes the key competences that the child should achieve at the end of preschool education. For example, in the social and interpersonal areas, the child should achieve the following before starting compulsory education:

- Independently decides on his/her activities; can establish his/her own opinion and express it;
- Realizes that s/he is accountable for his/her actions and can be held responsible;
- In everyday situations applies basic social habits and rules of social intercourse; is able to respect others, negotiate, accept and enter into compromises;
- Imitates models of pro-social behaviour and interpersonal relationships observed among others;

Another area relates to the problem-solving competence. The child at the end of preschool education:

- Notices events and issues in the immediate vicinity; positive response to active interests naturally motivates him/her to continue facing new challenges;
- Solves problems through immediate experience; advances through trial and error, tests, experiments;

spontaneously invents new solutions to problems and situations; searches for different options and variations (has his/her own original ideas); makes use of experience and imagination; uses a logical, mathematical and empiric approach to challenge theoretical and practical problems; understands basic algorithms in solving various problems and situations and uses them in new situations;

- Begins to comprehend numerical concepts, uses numbers and mathematical concepts, identifies elementary mathematical relations (FEP PE 2018, p. 12).

In preschool education, the teacher performs deliberate and systematic activities in order to teach the child to live in a usual social environment, comprehend the environment and resolve problems, not as a passive object but as an active subject on the principles of reciprocity.

An active attitude of the child to the external world and to the self is reflected in the child's personality as a tension between the zones. This tension between the actual state and future state represents the dynamic force for the child's activities. In the context of the educational process, this relationship includes the existing level, set objectives (competences) and activities.

The most important persons in children's education are adults (teachers, parents, grandparents, etc.) According to Vygotsky, the quality of early relationships between the child and the adult is decisive for the emergence of higher functions. A significant role is played by close cooperation between parents and teachers because the teacher-child relationship is strengthened (Bruceová, 1996, p. 59).

The preschool curriculum places special attention on the family and the school. For example, the curriculum defines the following teachers' responsibilities:

- The parents have the possibility to participate in the kindergarten's events and various programmes, and to join their children's games if they wish. They are regularly and sufficiently informed about everything that happens in the kindergarten. If they show interest, they can participate in designing the kindergarten's programme, in problem-solving, etc.;
- The teachers inform the parents of their child's results as well as their individual progress in development and learning;
- They consult the parents about the joint efforts in their child's upbringing and education. (FEP PE, 2018 p. 33).

The examples above are a clear reflection of Vygotsky's ideas and his sociocultural theory. The curriculum reflects the significant influence of the environment and all factors relevant to the development of the child. In this context, the teacher should be aware of the environment from which the child comes to the kindergarten, whether the environment is stimulating or not and whether the kindergarten should make an intervention.

An important role of each kindergarten is child socialization. Children learn appropriate behaviour, adopt new knowledge and skills, learn to understand what is right and what is wrong. Children's opinions are created and changed under the influence of the sociocultural environment; they are socially constructed (Mareš, 2013, p. 40).

The preschool curriculum reflects Vygotsky's psychological theory on the development of the human psyche, which is based on the influence of culture on higher mental functions, where this culture is produced by people's social activities, both in terms of human history and mental development of an individual. The adult-child relationship is an important precondition for the child's mental development, where the social and later psychological competence of an individual is generated. This explains one of the fundamental Vygotsky's ideas that learning precedes child's development (Pupala in Kolláriková, Pupala 2001, p. 203).

### ***3.2 Zone of Proximal Development in the Context of Dynamic Diagnostics***

The principle of the educational process is systematic and targeted educational work consistent with the objectives defined in the curriculum. The teacher's educational activity is directly related to continuous evaluation of operational objectives. The child's progress is continuously evaluated, higher objectives are set and educational activities planned and implemented under specific conditions (external and internal). The preparation of the activities must correspond with and at the same time respect the child's level, interests and needs. Naturally, these must be known to the teacher.

The teacher plans further activities according to the assessment of the child's knowledge, skills and abilities. Educational diagnostics is usually performed in a static assessment environment, where the teacher talks to the child, asks questions and examines what the child is able to resolve. This provides an idea about the child's level. However, this is insufficient. According to Vygotsky, the static assessment environment must be changed into a dynamic assessment environment. In this case, the teacher is interested not only in the child's responses and in what the child can do correctly or incorrectly but in the case of an incorrect answer or incorrect solution can provide the child with a series of advice to help resolve the problem. The ability of the child to follow step-by-step advice informs about the child's development potential in the "examination—testing" period, i.e., how the child can develop beyond one's observable abilities. In this way, the teacher can go beyond the observed child's performance (Sternberg, 2009, p. 483).

Presently, this approach is referred to as the dynamic diagnostics, which takes place within the teacher-child interaction and includes both an educational dimension and especially an intervention dimension. This is consistent with Pupala, who claims that the dynamic diagnostics is a "prototype or model of an effective educational situation which is of a developmental and creative nature" (Kolláriková, Pupala, 2001, p. 201) The model can also be used when the teacher prepares tasks that require adult assistance.

The principles of assessment of the child's development in preschool education are set out in the curriculum.

- Regarding the evaluation of educational results, in preschool education this is not a question of the assessment of the child and their performance in relation to a given norm or a question of comparing individual children and their performance;
- As a result of individualization of education, it is necessary to monitor the development and personal educational progress of each individual child and to document them. The teacher should perform daily, long-term and systematic monitoring. No less important purpose of the continuous evaluation is to detect the child's potential problems and weaknesses in time and draw expert-based conclusions for their elimination and the child's further development. If required, timely intervention with necessary professional assistance should be provided (FEP PE, 2018, p. 33).

According to the text above, perfect knowledge of the child is one of the basic responsibilities of kindergarten teachers. This responsibility is directly imposed by the preschool curriculum. The question is to what extent this is accomplished. A stimulating approach is the already mentioned “effective didactic situation model” where the teacher not only examines the level of the child in the zone of proximal development and the child’s further development including prognoses but at the same time encourages, intervenes and supports the child’s development and thus moves the border of the zone of proximal development.

Educators should not accelerate the child’s development but use the child’s potentialities as much as possible.

### ***3.3 Play as the Most Natural Activity of Preschool Child***

Play is the most natural activity in the preschool period. This is also confirmed by Vygotsky. He considers play an activity that allows the child go beyond one’s current capabilities. He believes that this is related to the emergence of new needs and motives based on the currently unattainable possibilities and desires of a permanent nature.

At this age, an important aspect is imaginative play, which relieves the child of the pressure of reality and develops and practices the child’s self-control. Bruce (1996, p. 133) considers the zone of proximal development in the context imaginative play: “If Vygotsky’s concept of the zones of proximal development is true, collective imaginative play of children from three to seven years of age in a meaningful, embedded and specific context is a good opportunity for them to keep in their minds several facts—thoughts at once.”

Everybody can imagine children playing “shopping” in the school garden. They do not have the goods, money or other requisites but can do without them. Leaves from trees are used as money, bigger leaves are folded and used as a wallet, while little pieces of wood and stones are used as goods.

In this way, an object is assigned a different meaning compared with reality. Clearly, children are capable of operations at the highest level of thought provided that things or events are in a meaningful context. According to Vygotsky, in a meaningful context, in which children’s play usually takes place, children can show a considerable degree of self-control not to spoil the play. When children get involved in play, they set aside what they personally desire and are able to comply with the rules and accept different roles.

Vygotsky believes in the importance of imaginative creativity because at the age of five to eleven years this ability can be greatly developed in the musical, dramatic, visual or other areas.

He also believes that play is crucial to children’s representation because of the importance of self-control and the difference between the real and potential child development. He considers play in preschool age to be an ideal stimulation of the child’s personality structures, which develop and will become future personality structures.

According to Vygotsky, another important aspect is group play, which is involved in the development of the ability of decentration (empathizing). This is one of the essential competences that the teacher needs to focus on in the process of education, see below:

- The child expresses sensitivity and respect for others in a children’s way, helps the weaker, is able to express him/herself and submit to the others in a group, in joint activities tries to reach an

agreement (FEP PE, 2018, p. 15).

Decentration is one of the key abilities for life in society. These areas are defined in the following educational areas of the curriculum (2018): A child and the other person, A child and society. For example, the child should be able to give up one's wishes for the benefit of others in order to obtain greater satisfaction from the reward.

In order to achieve this, adults must be able to provide children with love, safety, background, mediation of experiences but also the awareness that one must not only "take" but must also be able to "give".

The preschool curriculum sets out the following teachers' responsibilities:

- Different qualities and opportunities for development require the application of appropriate methods and forms of work in preschool education;
- Learning through experience and cooperative learning through games and activities is a suitable teaching method based on direct experience of each child, encouraging his/her curiosity and need to discover. It also encourages the child to enjoy learning, enhances his interest in learning new things, gaining experience and other skills;
- Education needs to use children's natural flow of ideas and spontaneous ideas, and give them enough space for spontaneous activities and their own plans. Teaching activities should therefore have a form of a fun children game children like and enjoy playing without being forced (FEP PE, 2018 p. 8).

Children's skills need to be considered as unstable and variable. For teachers this means that it is not only important what the child can do but they need to think about the child's capabilities in the context of the key competences which represent a specific objective of preschool education. This is also related to the assessment of the child's future development. In this context, an inspiring approach is the "dynamic diagnostics" model. The knowledge about the zone of proximal development can be used in preschool education in the context of daily activities where the most important place is occupied by children's play. The preschool curriculum places great emphasis on individualization in education, which requires the teacher to address the needs of each child, think about their interests, needs as well as capabilities. The teacher should also focus on the intellectual processes used by the child to achieve success. The teacher must think about the procedures that the child uses, any mistakes made by the child, the child's ability to concentrate, etc. The teacher should use tasks to support the development of children's thinking, enrich their intellectual and working strategies and use feedback in error handling, which represents a source of further development of the child.

## **Discussion**

The work of Vygotsky is broadly applicable in the area of education and upbringing. He did not define any educational strategy but his work provided a background for their designing. A number of methods have been developed, focusing particularly on the social context of teaching. These include for example

reciprocal learning, which is a cooperative system of learning reading in a small group with a changing role of the teacher focused on text comprehension, or the Fifth Dimension Project, an extracurricular education project focused on cooperation, play, imagination and motivation for learning (Daniels, 2007, in Soukupová 2012, p. 119).

The Framework Education Programme for Preschool Education (2018) is a modern curriculum based on the knowledge of contemporary science. As a result, preschool education is affected by the ideas of many significant professionals from the area of education and psychology. Worth mentioning are the proponents of the cognitive psychological theory (notably Piaget) and socio-cognitive theory (especially Bandura, Bruner) including Vygotsky. In the case of the social cognitive theory, this applies especially to social and cultural interactions that affect contemporary education and didactics (Bertrand, 1998, p. 18). Vygotsky's legacy is timeless and evokes positive as well as critical reactions.

## **Conclusion**

Even today, Lev Semyonovich Vygotsky is considered a significant author who influenced developmental, social as well as cultural psychology and education throughout the world. Logically, his ideas are reflected in the current system of preschool education. In this paper, Vygotsky's ideas are presented not as a dogma but rather as a source of inspiration. At the same time, the paper touched upon the areas where Vygotsky's ideas are present.

## **4. Acknowledgement**

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# **Antifungal activity of some alternative control against mango anthracnose in Senegal**

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## **Abstract**

*Mango production in the South of Senegal is exposed to intensive rainfall from late May to October, with high temperature and moisture levels. These conditions are conducive for the development of anthracnose caused by *Colletotrichum gloeosporioides* (sensu lato) and leading to an absolute necessity for adequate control measures for good quality mango production. Anthracnose disease causes both pre- and postharvest fruit spots and fruit rot as well as premature fruit drop. The purpose of this study was to test the efficacy of several fungicide alternatives (fertilizers and biological control agents) against mango anthracnose in Senegal comparatively to standard fungicides. Field trials were set up in contrasting climates conditions and involved three orchards in the Northern part of the country with a short rainy season and dry climate over 9 to 10 months a year and three other orchards in the Southern part of Senegal with in a humid tropic environment. No anthracnose was recorded in the orchards in northern Senegal. In the south, in contrast, the disease was actual. Among the treatments tested for the control of anthracnose, Sodium molybdate were found effective after fungicides (azoxystrobin and thiophanate methyl). All the alternative treatments to fungicides provided a statistically significant control to the disease as compared to the control.*

**Keywords:** *Mangifera indica*; anthracnose control; *Colletotrichum gloeosporioides*; fungicides; Sodium molybdate; biocontrol products;

## **1. Introduction**

In Senegal, the main mango producing areas are located in the regions of Dakar, Thies, Kaolack, Saint-Louis, Fatick, Kolda, Sedhiou and Ziguinchor. The Niayes area (the coastal area between Dakar, Thies, and Saint-Louis) in the north is the main provider of export mango (Mbaye *et al*, 2006) and accounts for 80% of export volume. International mango trade is operated in an increasingly competitive environment governed by high-level standards. In order to meet consumer's expectations targeting flawless, healthy and beautiful fruits without pesticide residues, growers must resolve conflicting issues to produce the desired quality, in accordance with regulations and specifications. The yield issue is still one of the top priorities to guarantee profitability. Attacks by pathogens in the field and/or after harvest interfere negatively with

the ambition of substantially increasing the production and export volume more despite high delivery potential.

Fungi cause most of fruit diseases of mango with early infection stages occurring in the field, before harvest. They cause many types of fruit rotting during storage and and/or upon onset of ripening resulting in significant financial losses. In Senegal, fungal diseases play an important role after harvest in the mango business (Mbaye *et al.*, 2006; Diedhiou *et al.*, 2007). Among the fungal diseases causing fruit rots, anthracnose is the most important mango disease. The importance of losses due to this disease depends on the agro-climatic zone, with a 100% fruit rot in rainfall rich ecologies like the one in the southern part of Senegal (Diedhiou *et al.*, 2014b). The consequences are a shortening of the export window, and high risks of destruction of export mangoes in foreign markets. This often results in huge financial losses aggregating both direct losses due to expected sale price and penalties for the destruction as well as longer lasting difficulties linked with the loss of the market. Efficient systemic fungicides for with a protective effect as well as curative action have become available (Kumar *et al.*, 2007). Pre-harvest sprays of these fungicides are used to prevent the establishment of quiescent infections before harvest and reduce disease pressure, thereby improving considerably the effectiveness of postharvest fungicide treatments. There are many reports on the efficacy of azoxystrobin and thiophanate methyl against anthracnose on mangoes (Diedhiou *et al.*, 2007; Diedhiou *et al.* 2014a; Sundravadana, 2006). However, for environmental safety, some alternative approaches (resistant cultivars, cultural practices, and biofungicides) have been developed to control diseases (Conway *et al.*, 1991; Sugar *et al.*, 1997; Wilson *et al.*, 1997; Janisiewicz *et al.*, 2002; Hewajulige *et al.*, 2010; Diallo *et al.*, 2017; Jenny *et al.*, 2019). However, reports on efficacy in the field have been limited until Govender *et al.* (2006) demonstrated the ability of *Bacillus licheniformis* to control anthracnose of mango. Senghor *et al.* (2007) showed that *B. subtilis* significantly reduces anthracnose incidence on ripening fruits. Moreover, Peralta (2004) showed that a biological control product named Virtuoso 10 AS (*B. subtilis* QST 713 strain) had excellent activity in suppressing or reducing the severity of anthracnose on mango.

This study was carried out to examine the efficacy of several fungicide alternatives (fertilizers and biological control agents) against mango anthracnose in contrasting climatic conditions in Senegal comparatively to standard fungicides.

## 2. Materials and Methods

### 2.1. Field experiment in 2015 and 2016

The field studies were conducted in two regions of Senegal. In the North (region of Thies), the experiments were set up in three orchards. Each orchard harbored commercial mango varieties (Kent and Keitt) on over more than 100 ha. The mango trees were planted at high density (10 cm x 10 cm) and trees kept small through grafting and intensive pruning. All three orchards were engaged in organic farming and consequently only biofungicides and fertilizers were allowed for testing. The first treatments were applied before onset of the rainy season, generally in June. A treatment calendar with a 16-days interval, applied

twice was adopted. The first treatment was carried out on June 9, 2015 and on June 8, 2016. The second application was on June 25, 2015 and on June 27, 2016.

In the South (region of Ziguinchor), the experiment was also set up in three orchards. All three orchards were conventional and allowed synthetic chemicals. In that region, two fungicides - azoxystrobin and thiophanate methyl-, were used beside the two biofungicides (Sonata and Serenade), and sodium molybdate (fertilizer) as a reference. The three orchards are operated traditionally, with mango varieties, citrus and papaya trees grown mixed in the same field. The treatments started here also before the first rains of the season. The test products were applied twice at a 16-day interval. The first treatment was applied on June 16, 2015 and on June 14, 2016. The second on July 2, 2015 and on July 12, 2016.

## 2.2. Experimental design

Within each orchard, a completely randomized experimental design was used. Trees to be treated, representing the experimental unit, were selected in a way they were surrounded by untreated trees. Each experimental unit was repeated three times. The concentration of the products was calculated based on the assumption of 121 trees/ha, (Table 1). The products were Ortiva® (azoxystrobin), Fongsin® (thiophanate methyl), Sonata® and Serenade®. Sodium molybdate was purchased from Alfa Aesar (USA).

Table 1: Field treatments and rates applied in the north and the south

Treatment	Formulation	a i/hectare	a i in 10 L water for 3 trees
Azoxystrobin	Ortiva 250 SC	425 ml	11ml
Thiophanate methyl	Fongsin 450 SC	1,134 ml	30 ml
<i>Bacillus pumilus</i> QST 2808	Sonata	4,732ml	117 ml
<i>Bacillus subtilis</i> QST 713	Serenade Optimum	992 g	25 g
Sodium molybdate		90 g	2 g

## 2.3. Sampling

Mango fruits were collected at maturity, on July 22<sup>nd</sup> in the north and July 29<sup>th</sup> in the south. In each orchard, five fruits per experimental unit were randomly picked, in a total of 15 fruits per treatment summing the contributions of the three replicates. The fruits were placed in a plastic bag each, and transported to the laboratory.

## 2.4. Ripening fruit and disease assessment

The fruits were maintained in a clean and ventilated area at room temperature (26-29° C) in the laboratory. Every 2 days, each fruit was assessed for anthracnose lesions over a 8 days period.

## 2.5. Disease assessment and statistical analysis

The collected data was used for statistical analysis. When the data fails the normal distribution test, it went under the GLIMMIX procedure of SAS version 9.4. GLIMMIX is a generalized linear mixed model

assuming a Poisson distribution. The means were separated using a 95% confidence interval and the t-test pair comparison.

### 3. Results

#### 3.1. Field experiment in Senegal in 2015

In all orchards located in the north of the country, zero fruit was infected by anthracnose. For mango orchards in the south in contrast, anthracnose lesions were recorded on fruits. Namely, in Badjo's orchard, all the treatments provided significant disease control compared to mangoes from non-treated trees. Serenade, sodium molybdate, thiophanate methyl, and azoxystrobin performed significantly better than Sonata, although the latest reduced significantly diseases severity as compared to the control (Table 4). In Jean's orchard, sodium molybdate, thiophanate methyl, and azoxystrobin were more effective than Serenade and Sonata. However, all the treatments reduced significantly disease severity as compared to the control.

In Toure's orchard, despite differences in extent of performance, all the treatments provided significant disease control compared to mangoes from non-treated trees.

There was a homogeneity between the tree orchards in the south since the analysis of variance showed significative difference ( $P=0.4979$ ).

With respect to market value, the number of disease-free mangoes was assessed. It showed that in Badjo's orchard, treatment with azoxystrobin and thiophanate methyl allowed to obtain six disease-free mangoes out of 15 (40%) and 5 disease-free mangoes out of 15 for Serenade (30%).

In Jean's orchard, all the treatments had many disease-free mangoes (9 to 11 fruits, e.g. 60% to 73%) except for Sonata that gave only 40% of disease-free mangoes.

In Toure's orchard, the treatments protected effectively between 8 and 12 fruits meaning that from 53% up to 80 % of fruits could have a market value.

Table 2: Influence of field treatments with biological control products and two fungicides as well as sodium molybdate (fertilizer) on fruits anthracnose 8 days after harvest and incubation at room temperature in the laboratory. Treatments with the same letter are not significantly different ( $n = 15$   $p \leq 0.05$ ).

Treatment	Number of lesions per fruit					Disease-free mangoes			
	Badjo	Jean	Toure	Mean		Badjo	Jean	Toure	Mean
Control	143 A	123A	132 A	133 A		0	0	0	0.0
Sonata	54 B	63 B	31 DC	49 B		2	6	9	5.7
Serenade	34 D	46 C	53 B	44 C		5	9	8	7.3
Sodium molybdate	38 C	26 D	33 C	32 C		2	8	10	6.7
Thiophanate methyl	37 DC	30 D	27 D	31 D		6	11	12	9.7
Azoxystrobin	34 D	30 D	22 E	29 D		6	11	11	9.3

### 3.2. Field experiment in Senegal in 2016

Like for 2015, zero fruit was infected by anthracnose in orchards from the northern part of the country in 2016. During that same period, fruits from orchards in the south displayed some lesions of anthracnose.

In Badjo's orchard, all the treatments provided significant disease control compared to mangoes from non-treated trees. Azoxystrobin, serenade, thiophanate methyl, and sodium molybdate performed significantly better than Sonata (table 3).

In Jean's orchard, sodium molybdate, thiophanate methyl, and azoxystrobin were more effective than Serenade and Sonata as in 2015. However, all the treatments reduced significantly disease severity as compared to the control.

In Toure's orchard, azoxystrobin and thiophanate methyl were effective than sodium molybdate, serenade and sonata. Sodium molybdate came in the second position of effective compared to serenade and Sonata. Despite differences in extent of performance, all the treatments provided significant disease control compared to mangoes from non-treated trees.

There was a homogeneity between the tree orchards in the south since the analysis of variance showed significative difference ( $P=0.4979$ ) as in 2015.

With respect to market value, the number of disease-free mangoes was assessed. It showed that in Badjo's orchard, the number of disease-free mangoes is low for all the treatments.

In Jean's orchard, the treatment with sodium molybdate, thiophanate methyl and azoxystrobin had many disease-free mangoes (10 to 13 fruits, e.g. 67% to 87%) except for Sonata and Serenade that gave respectively 27% to 13% of disease-free mangoes.

In Toure's orchard, the treatment with sodium molybdate, thiophanate methyl and azoxystrobin had many disease-free mangoes (10 to 14 fruits, e.g. 67% to 93%) except for Serenade and Sonata that gave respectively 13% to 20% of disease-free mangoes.

Table 3: Influence of field treatments with biological control products and two fungicides as well as sodium molybdate (fertilizer) on fruits anthracnose 8 days after harvest and incubation at room temperature in the laboratory. Treatments with the same letter are not significantly different ( $n = 15$   $p \leq 0.05$ ).

Treatment	Number of lesions per fruit				Disease-free mangoes			
	Badjo	Jean	Toure	Mean	Badjo	Jean	Toure	Mean
Control	150 A	132 A	130 A	137 A	0	0	0	0.0
Sonata	50 B	75 B	58 B	61 B	2	4	3	3.0
Serenade	35 C	54 C	53 B	47 C	3	2	2	2.3
Sodium molybdate	38 BC	30 D	30 C	33 D	4	10	10	8.0
Thiophanate methyl	37 BC	27 D	24 D	29 D	4	11	13	9.3
Azoxystrobin	35 C	25 D	20 D	27 D	3	13	14	10.0

#### 4. Discussion

This study provides the first data on biological control and other alternatives control of anthracnose on mangoes in Senegal.

During the field trials in 2015 and 2016, the orchards in the north registered no anthracnose during the experiments. This should be in relation with the climatic conditions because the pathogen requires warm and humid conditions to infect and mango fruit. In that part of Senegal however, the rainy season starts often in August allowing mangoes to ripen before the moisture level becomes too high. Anthracnose disease developed already at the same period in the orchards in Ziguinchor (south) where rainfall starts in May confirming the requirements for anthracnose to develop.

The systemic fungicides azoxystrobin and thiophanate methyl were good for the control of mango anthracnose in southern Senegal. These results are consistent with those obtained in several studies like those of Diedhiou *et al.* (2014a) who reported excellent control of mango anthracnose in Senegal through treatments with azoxystrobin and thiophanate-methyl (benzimidazoles). This shows that systemic fungicides were more effective than non-systemic ones in controlling mango anthracnose as already reported by McMillan, (1984). Sundravadana *et al.*, (2007) reported that azoxystrobin inhibits 100 % of mycelial growth of *C. gloeosporioides* the causal agent of mango anthracnose. Diallo *et al.*, (2021) reported that in Senegal the causal agent of mango anthracnose is *Colletotrichum siamense* and not *C. gloeosporioides*.

Systemic fungicides are of great importance in the local conditions of Casamance (Ziguinchor area) where rainfall can be very frequent (700-1250 mm) between late May and October and the mango trees can be very tall, reaching more than 15m height. Optimal conditions for infection and dispersal of spores of *Colletotrichum* are met during the humid period with an average temperature of about 28 °C (Dodd *et al.*, 1997), prevailing in the Ziguinchor region during the rainy season.

The height of the trees and their huge canopy make it difficult to achieve a complete coverage of the mango trees when applying a contact fungicide. Systemicity of the product is therefore a great importance in these conditions as shown by the level of protection achieved in the 2 years experiments.

Several reports have shown that controlling anthracnose on mango relies heavily on the use of fungicides. However, the use of a specific group (benzimidazoles or strobilurin) of fungicides has declined drastically due to development of resistance by *Colletotrichum* species. According to Kumar *et al.* (2007), *Colletotrichum gloeosporioides* was moderately resistant to thiophanate-methyl in Andhra Pradesh, India. In addition, Meng-Jun Hu *et al.* (2015) showed that resistance to azoxystrobin and thiophanate methyl existed in *Colletotrichum siamense* from peach and blueberry in South Carolina.

The treatments with biofungicides *Bacillus pumilus* QST 2808 (Sonata) and *Bacillus subtilis* QST 713 (Serenade Optimum) were statistically significantly less effective than the two fungicides. It is however to point out that all the biofungicides were also very effective and provided significant protection for mangoes against anthracnose far better than the “do nothing option” represented by the control. Diallo *et al.*, (2017) reported that the protective treatments with the biofungicides allowed reducing significantly



the incidence of the disease as well as its severity. The good efficacy of the tested alternatives to fungicides is very encouraging for a sustainable control of mango anthracnose.

The field experiment in Senegal showed the efficacy of sodium molybdate which just behind the fungicides (azoxystrobin and thiophanate methyl). This product performed well, with performances just a bit below azoxystrobin and thiophanate methyl. It performed a bit better than the biocontrol products Sonata and Serenade. The efficacy of molybdate in reducing the intensity of diseases of bean and tomato have been reported (Dutta *et al*, 1981; Miller *et al*, 1983 and Júnior *et al*, 2004). In addition, Polanco *et al* (2014) speculated on a direct effect of molybdate (NaMo) on *C. lindemuthianum*, and thereby and increase of yield as interpretation of the decrease of the area under the disease progress curve through application of that product. Sodium molybdate should be considered a promising product to control mango anthracnose.

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## **Pregnant teenagers treated at the obstetric center of a university hospital**

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## Abstract

*According to the definition of the World Health Organization, adolescence is the phase of life between 10 and 19 years of age, a period marked by physiological and biopsychosocial changes, in which pregnancy is considered a risk factor for both mother and fetus from the biomedical point of view. Several factors have been associated with teenage pregnancy with negative maternal and neonatal impacts, such as: social vulnerability, low levels of education, income, and sexual education. This is a descriptive cross-sectional study with a quantitative approach, which aimed to identify obstetric factors and neonatal outcomes of greater frequency among pregnant adolescents treated at the obstetric center of a university hospital. Data collection was performed through a logbook of daily procedures at the obstetric center, so that all parturients under 19 years of age treated in 2018 were included in the study. The variables studied were age, parity, type of delivery, gestational age, diagnosis of syphilis and HIV, number of prenatal consultations, and insertion of an intrauterine device (IUD). As for the newborn, the following were analyzed: weight and hospital destination after birth. The data were processed using the SOFA.5.2 software (Statistics Open for All) and the significance level established was 95%, with a value of ( $P \leq 0.05$ ). Three thousand four hundred and thirty pregnant women were evaluated. There was a birth rate of 19.3% among adolescents, with a correlation between the low weight of the newborn with the longest hospital stay and the number of prenatal visits, and also the identification of low insertion of contraceptive methods immediately after delivery. Adolescent pregnancy was correlated with low-birth-weight newborns and a longer stay in neonatal units, consequences often associated with the insufficient number of prenatal consultations. Public health policies for the inclusion of qualified nursing professionals in the management of insertion of the intrauterine device for the prevention of subsequent pregnancies deserve special attention.*

**Keywords:** Adolescent; Childbirth; Pregnancy

## 1. Introduction

According to the Child and Adolescent Statute (ECA), a person below the age of 12 years is considered a child, and a teenager between the ages of 12 and 18 years (BRASIL, 1990), which is also defined by the world health organization (WHO) as a corresponding age period between 10 and 19 years of age. This stage is responsible for triggering physiological and bodily changes of the maturation of physiological development, a period in which pregnancy is considered a risk factor from a biomedical point of view for both mother and fetus (WORLD HEALTH ORGANIZATION, 1986; DIAS, TEIXEIRA, 2010).

Over the years, there has been a decrease in total fertility, however, recent studies have shown a worldwide rise in teenage pregnancies, estimated at 46 births per 1,000 girls aged between 15 and 19 years, mainly in Latin America and the Caribbean. In Brazil, the rate is 68.4% per 1,000 girls, which is higher than the rates in the Caribbean, being surpassed only by Sub-Saharan Africa (ORGANIZATION OF THE UNITED NATIONS, 2018).

Most countries with high adolescent fertility rates are located in Latin America and the Caribbean; in Central America, Guatemala, Nicaragua and Panama lead the ranking. In the Caribbean, the Dominican Republic and Guyana have the highest rates. In South America, the top leaders are Bolivia and Venezuela (ORGANIZATION OF THE UNITED NATIONS, 2018).

In contrast, developed countries such as the United States (USA) and Canada are below the world average of fertility. In the USA, for instance, there was a decrease in all ethnic groups, with a decrease of 8% between the years of 2014 and 2015 and, more recently, reaching a minimum of 22.3% of births per 1,000 thousand adolescents aged between 15 and 19 years (ORGANIZATION OF THE UNITED NATIONS, 2018).

In Brazil, the incidence of teenage pregnancy is present in groups of greater social vulnerability, being more concentrated among black and/or indigenous adolescents with low schooling, mainly in the north and northeast regions (BRASIL, 2013).

The low level of education among adolescents is shown to be negatively influenced in this process, where teaching has an important role in the dissemination of knowledge about sexual education, among others. A studied showed that 94.0% of adolescent mothers did not attend school (FALOPA *et al.*, 1994).

In view of these data, teenage pregnancy is considered a public health issue both for Brazil and for other developing and underdeveloped countries (ORGANIZATION OF THE UNITED NATIONS, 2018), becoming a risk for physiological and other aspects involved in adolescents' lives, such as: socioeconomic conditions, education, risk behaviors, seeking health services, understanding the gestational process and, especially, psychological issues (SANTOS *et al.*, 2014).

From the perspective of a successful pregnancy follow-up, it is important to monitor prenatal care as a tool for health interventions and reproductive control, ensuring maternal and fetal well-being (OLIVEIRA *et al.*, 2010).

From prevention actions and follow-up in prenatal consultations, the gestational outcome is determined. Worldwide studies have demonstrated a high incidence of premature births and low birth weight in this population when compared to other age groups (MARTINEZ *et al.*, 2011). This is a health index that determines maternal and, especially, neonatal risk, since prematurity and low birth weight are related to high rates of hospitalization for clinical complications, which will have an impact on the entire process of child development (BARBAS *et al.*, 2009).

With regard to the type of delivery among adolescents, based on studies carried out in the years 1993 and 1994, it was possible to observe high rates of caesarean sections, presumably due to the physiological conditions of pregnancy during this period, with a higher prevalence of cephalopelvic disproportion resulting from gynecological immaturity and also due to the medicalization process of childbirth, very present in the biomedical process (CUNHA *et al.*, 2002). Disagreeing with this scenario, recent data have shown higher rates of caesarean sections among older women, mainly being correlated to previous caesarean sections (FREITAS; SAVE, 2011).

The landmark for public policies aimed at adolescent health is recent in Brazil, having as its main reference the creation of the Child and Adolescent Statute (ECA) in the mid-90s (BRASIL, 1990). Public health policies for this public have important deficiencies in scope and quality regarding direct care in adolescence, with a small focus on birth control, family planning and sexuality education (FALEIROS,

2013). A manual for adolescents in primary care was recently published by the Ministry of Health, with chapters on teenage pregnancy (BRASIL, 2017).

Even though it is of fundamental relevance since guidelines/preventions must begin from the stage of primary care, there is a lack of actions that work with the intersectionality of services, sensitization of professionals and mainly with changes in the paradigms of being and existing in this age group.

This descriptive study aimed to identify obstetric factors and neonatal outcomes of greater frequency in pregnant adolescents treated at the obstetric center of a university hospital, as well as to make correlations with the literature, to contribute to the body of knowledge of the particularities of this public, adding data and information which can contribute to the promotion of public health policies on the topic of teenage pregnancy.

## **2. Material and Methods**

### **2.1 Type of study**

This is a quantitative, descriptive, cross-sectional study, which uses secondary data.

### **2.2 Population characteristics**

The city of Dourados is located in the south of Mato Grosso do Sul, with an estimated population of 220,965 people in 2018, an average of 17,682 thousand female adolescents aged between 10 and 19 years (INSTITUTO BRASILEIRO DE GEOGRAFIA E ESTATÍSTICA, 2018).

### **2.3 Sample**

The study sample was established using secondary data from a procedure log book of the obstetric center, which contains daily information of the parturients treated at the center. The sample was matched for age and exclusion criteria, resulting in a final sample of 491 adolescents.

### **2.4 Variables, inclusion and exclusion criteria**

The study included pregnant women under 19 years old, admitted to the hospital's obstetric center in 2018, with records of all variables surveyed. For the study, the following variables were selected: age, parity, type of delivery, gestational age, diagnoses of syphilis and HIV, number of prenatal consultations, insertion of an intrauterine device (IUD); as for the newborn: weight and hospital destination of the newborn after birth.

Pregnant women below 19 years of age who did not have all the variables surveyed in their records and all participants of indigenous ethnicity were excluded from the survey.

### **2.5 Data analysis**

The information obtained was inserted into tables using Microsoft Office Excel 2013, and the analyzes were performed using the SOFA.5.2 software (Statistics Open for All). Depending on the variability of the cases, continuous variables were presented as mean and standard deviation (SD) or median and interquartile range, whereas categorical variables were presented as frequency and percentage. To

verify the association between quantitative variables, we used Pearson's linear correlation association tests ( $r$ ) and for non-quantitative variables, Spearman's correlation test ( $\rho$ ). The level of significance was set at 95% ( $P \leq 0.05$ ).

## **2.6 Ethical considerations**

All procedures in this study were approved by the Ethics and Research Committee (CEP) of the Federal University of Grande Dourados (UFGD), under CAAE number: 13444519.1.0000. 5160.

## **3. Results**

The results are presented in tables with absolute and relative values, and for continuous variables they were presented as mean and standard deviation (SD) or median and interquartile range.

In 2018, a total of 3,430 parturients were attended at the obstetric center, 19.3% were adolescents ( $N = 652$ ). Among the adolescents, ( $N = 161$ ) were of indigenous ethnicity, who were excluded from the study, totaling a final sample of ( $N = 491$ ) adolescents.

In this study, the sample was made up of 491 parturients, included by the age group recommended by the World Health Organization (WHO), which is between 10 and 19 years old. The interval found between the ages was a minimum of 13 and a maximum of 19, with an average of 17 years, with a value of ( $p = 0.3$ ), with no correlation between the mother's age and the newborn's weight classification.

Regarding the participants' pregnancy history, the gestational age in weeks ranged between a minimum of 24 weeks and a maximum of 43 weeks, with an average of 38 weeks and 2 days. As for the number of pregnancies, there was a minimum 0 and a maximum of 5 pregnancies, with an average of 1.3 pregnancies per adolescent; for the history of abortion, the interval found was between a minimum of 0 and a maximum of 2 abortions, with an average of 0.1 for each teenager.

Regarding the newborn's weight in grams, a minimum of 666 grams and a maximum of 4,198 kg was identified, with an average of 2,955 kg. The relationship between the weight of the newborn and their destination in the hospital demonstrated a value of ( $p < 0.001$ ), demonstrating a significance between weight proportions and destination, which is described in (table 1).

The newborn's destination in the hospital units was 84% for joint accommodation ( $N = 415$ ), 4.7% for the intermediate neonatal care unit ( $N = 23$ ), 6.3% for the neonatal intensive care unit (ICU) ( $N = 31$ ), 0.2% neonatal death ( $N = 1$ ), and 4.3% referred to a different sector of the hospital ( $N = 21$ ) (Table 2).

As for the number of prenatal consultations, a minimum of zero and a maximum of 19 consultations was identified, with an average of 7.4 consultations, and a value of ( $p < 0.001$ ), with a significance in the correlation between the lowest number of prenatal care consultations and unfavorable neonatal outcome.

Considering the type of delivery, vaginal delivery appeared with a slight predominance of 60.3%, totaling ( $N = 296$ ), when compared to the caesarean surgical procedure of 39.3% ( $N = 193$ ), followed by 0.4% of deliveries which occurred at home ( $N = 2$ ).

After the rapid testing for infectious diseases at the obstetric center, 5.9% of the adolescents ( $N = 29$ ) had a reagent for syphilis, and 0.4% a reagent for HIV ( $N = 2$ ).

Among the contraceptive methods that were inserted immediately after delivery, 4.1% had the



intrauterine device (IUD) inserted, totaling a sample of (N = 20); 0.2% of the sample got an Implanon, corresponding to (N = 1), as described in (Table 2).

#### **4. Discussion**

The phenomenon of teenage pregnancy has a global relevance and in many countries is considered a public health issue (ORGANIZATION OF THE UNITED NATIONS, 2018). The percentage of adolescent births verified in this research was of 19.3%, which is lower than the Brazilian percentage of 68.4% for every 1,000 girls (ORGANIZATION OF UNITED NATIONS, 2018).

Over time, the fertility rate has exponentially reduced from 6.3 children per woman in the early 1960s to 1.8 per woman between 2002-2006 (BRAZIL, 2006), however, among adolescents this phenomenon has been slower.

In Brazil, pregnancies among adolescents aged between 15 and 19 years are above the Latin American average (WORLD HEALTH ORGANIZATION, 2018). When compared to world-class indexes, which are 46 births per every 1,000 girls, and in developed countries such as the United States of America (USA), the rates are even lower than 22.3 per thousand adolescents (WORLD HEALTH ORGANIZATION, 2018).

Adolescent pregnancy is emphasized by changes that go far beyond structural and physical development, a milestone that influences psychic, social, cultural and economic issues (SANTOS, 2009).

According to a WHO report, the main causes of death among adolescents between 15 and 24 years of age are associated with pregnancy. Some complications, even if not specifically connected to early pregnancy, are more frequently observed in the literature. Among the main complications are Hypertensive Disorders of Pregnancy, which are considered the main cause of maternal and neonatal death (HENDERSON *et al.*, 2017). In Brazil, the incidence is of 10% among all pregnancies, in developed countries this frequency varies from 2 to 8%, in a context where a first pregnancy under the age of 17 years stands out among the main risk factors for the development of the disease (HENDERSON *et al.*, 2017; BRASIL, 2012; NASCIMENTO *et al.*, 2015). The main characteristics, which define the predisposition in adolescents when compared to adult pregnant women, are the immaturity of essential organs for a healthy pregnancy, lack of information due to low levels of education and difficulty in accessing SUS - Unified Health System (SILVA *et al.*, 2010).

In addition to the increased risks for maternal mortality, getting pregnant during adolescence represents a risk for neonatal mortality, that is, death rates in the first 28 days of life, resulting in a 75% greater risk of having a premature birth than women in the age group considered as adults (BRASIL, 2018). In Brazil, the rates of premature birth and low birth weight among pregnant teenagers are an important epidemiological marker, characterized by consequences of neonatal morbidity and mortality, with prematurity being responsible for 70% of perinatal mortality in the country (LANSKY, 2002; BRASIL, 2018).

In our study, it was not possible to correlate the age of the mother with the birth weight of the newborn, but it is known that teenage pregnancy - in addition to being a public health issue as previously mentioned – concomitantly refers to another issue of great relevance which is prematurity and,



consequently, low-birth-weight newborns who present high mortality rates when compared to neonates weighing 2,500 kg or more and a gestational age considered at term with 37 weeks or more (BORDIN, 2000; ARAÚJO, 2007).

There are several conditions that predispose to prematurity and low birth weight among adolescents, such as nutritional, socioeconomic, and cultural aspects that directly influence fetal development, and consequently low birth weight (MONTEIRO, 2003; CONDE-AGUDELO, 2005). In our research, it was possible to associate the response of low weight and the destination of the newborn within the hospital domain.

In addition to the immediate impacts on birth weight for the newborn, other late consequential impacts can be cited, such as: increased risk for infections, respiratory and thermal instability, with sequels of cognitive and motor development in childhood, causing an impact on the child and their family, in addition to echoes on SUS, resulting in prolonged hospitalizations, mainly in intensive care units and neonatal intermediate care units (BORDIN *et al.*, 2000; MEIO, LOPES, MORSCH, 2003).

Another factor that contributes to prolonged hospitalization of newborns is congenital infections, with a higher prevalence of infections of sexual origin of the mother (BRASIL, 2011). Among adolescents, sexual activity has become an increasingly precocious practice, as it is a period of sexual vulnerability often related to unprotected sexual exposure and risky behaviors, resulting in a higher incidence of teenage pregnancy and infection by sexually transmitted infections (SOCIEDADE BRASILEIRA DE PEDIATRIA, 2018). Among the most frequent infections, syphilis has had a high incidence and when not treated or treated inappropriately, it can cause serious consequences to the fetus such as: malformation, abortions, and fetal death (BRASIL, 2011).

The State of Mato Grosso do Sul (MS) is among the four states with the highest incidence of syphilis in pregnant women. In 2016, MS had the highest rate of cases in the country with 23.7 cases per 1,000 live births, representing rates above the national average (BRASIL, 2017).

The incidence of congenital syphilis in Brazil is of 12.4 cases per 1,000 live births. The State of MS was also one of those with the highest incidence of congenital syphilis, with 8.3 cases per 1,000 live births. In the city of Dourados, the headquarters of the hospital where the research was carried out, in 2017 there was an incidence of 34.4 cases per 1,000 live births (BRASIL, 2017).

The identification of the Human Immunodeficiency Virus (HIV) during pregnancy was also found in our study. Even with a low incidence, it is worth mentioning that the exposure to HIV by congenital route or during labor, delivery, postpartum or breastfeeding requires special attention to reduce transmission. It is possible to associate the infection with premature labor, very low birth weight, intrauterine growth restriction (IUGR), small for gestational age (ABEYÁ *et al.*, 2004).

The high rate of caesarean sections is a topic that has been the subject of studies in recent years. The high frequency of this procedure considers a change in obstetric practice in Brazil (DECLERCQ *et al.*, 2006). Studies even point to the existence of the creation of a caesarean section culture, with high numbers of procedures not for clinical/obstetric indication, but for "favoring" and/or for the "privilege" of an economic class and type of payment (GAMA, 2014). As with any surgical procedure, caesarean sections cause immediate and long-term damage to puerperal women and newborns, so that there is not enough evidence to demonstrate the benefits of performing the procedure in women who do not need it (WORLD

HEALTH ORGANIZATION, 2018).

Caesarean sections in adolescents, especially in primiparous women, draw attention for its exposure, since in many hospitals in the country previous caesarean sections have been predictive for an upcoming birth delivery (FREITAS, 2006; GOODALL, 2009). A decade ago, it was pronounced: *“once a previous caesarean, always a caesarean”* (CRAIGIN, 1916). The new literature and recommendations of the National Childbirth Assistance Guidelines oversee vaginal delivery after caesarean sections, even after a woman has had two previous caesarean sections (BRASIL, 2017). The main risks that generate medical interventions are linked to uterine rupture, very similar risks when the woman has had one or two previous caesarean sections; hence, it is important to individualize the recommendations according to the clinical and current history of the parturient, with interventions based on the early recognition of any adversity (LEAL, 2018).

In 2016, the World Health Organization (WHO) launched 56 recommendations to try to reduce caesarean rates, especially in Brazil, where the rates overlap those considered ideal (ORGANIZACION MUNDIAL DE SAÚDE, 2016). Since the mid-1985s, statements about the percentage of caesarean sections have been discussed, with the percentage recommended by the international community in the last 30 years ranging between 10 and 15% (LANCET, 1985). High rates have brought negative consequences to obstetric, neonatal outcome and health costs (ORGANIZAÇÃO MUNDIAL DE SAÚDE, 2016).

In our study, vaginal delivery was more prevalent among adolescents, however the caesarean rates found were 39.3%, above what is recommended in the current literature. Based on the assumption that most adolescents are primiparous, the risk factors associated with maternal and neonatal outcomes become more worrisome, especially over the long term of this woman's reproductive life. Scientific evidence is still under construction on the real effects of high rates of caesarean sections. It is already known of the direct effects on maternal and neonatal morbidity and mortality when comparing the caesarean and vaginal delivery route, however studies on a larger scale remain to be carried out for the real impact on pediatric outcomes, social and/or psychological well-being to be assessed (MASCARELLO, 2017).

In relation to prenatal care, the average number of adolescents in the study attended the minimum expected number of consultations recommended by the Ministry of Health; on the other hand, some did not perform any or at most nineteen consultations. In our study it was not possible to establish in which period of pregnancy the adolescents began prenatal care. Health institutions establish that patients must attend at least six prenatal consultations for the objectives of prenatal care to be fulfilled, guided by strategies for the prevention and/or detection of maternal fetal diseases, enabling a healthy development for the fetus with a reduction of harm to pregnant women (BRASIL, 2012).

Early appointment, which consists of the beginning of prenatal care before the sixth month of pregnancy, and non-adherence to prenatal consultations is a challenge for pregnant adolescents, commonly motivated by the fact that it is an unplanned pregnancy, adding up to the lack of information about the benefits of prenatal care, as well as the shame of looking for a health unit, which is a scenario of greater frequency among poorer adolescents (CESAR, 2011).

In our study, we observed a statistical relevance between the smaller number of consultations and the worst neonatal outcome: low weight and destination in the hospital unit.

The attachment of the pregnant adolescent to the family health strategy in prenatal consultations is one of the main pillars for a safe pregnancy, allowing reduction of gestational risks, exchange of information, experiences, and promotion of a better understanding of the pregnancy, since this period carries with it many fears, being subject to greater vulnerability of coping (MIRANDA, 2013). The commitment of professionals involved in prenatal care should guide the quality of care provided to adolescents in a longitudinal way during prenatal, delivery and postpartum period (MIRANDA, 2013). With assistance focused on health education with information about sexuality, delivery, and contraceptive methods, in addition to clearing the fears of adolescents in a clear and high-quality way, it allows them to have autonomy of choice based on knowledge.

As a strategy for the reproductive control of the population, public health policies over time have fostered inter-sectorial and multi-professional projects and actions for the population's reproductive planning, with the insertion of incentive programs in health care networks (BRASIL, 2002; BRASIL, 2012). The definition of family planning can be found in article 2 of Law no. 9,263, dated January 12, 1996, as follows: family planning is understood as the set of fertility regulation actions that guarantees equal rights of constitution, limitation or increase in the number of offspring by women, men, or couples (BRASIL, 1996).

Among the health actions aimed at adolescents' sexual and reproductive health, trained professionals with qualified listening are needed, who seek to understand the demands of the population and the fulfillment of their expectations.

In view of the abovementioned scenario, it is possible to observe the paramount importance of adolescent reproductive planning, with the provision of contraceptive methods throughout the assistance network, which should be discussed in the family health strategy in partnership with sexual education programs in schools, as a way of expanding their offer (MONTEIRO, 1998; VIEIRA, 2006). Among the most recommended and routinely offered methods are non-hormonal and hormonal methods, and public policies in recent years have encouraged the use of methods in the immediate postpartum period, being used as a practice to prevent a future pregnancy (FILHO *et al.*, 2018).

In 2017, the Ministry of Health launched a decree to expand the use of the Tcu-380 model copper intrauterine device (IUD), which consists of an intrauterine device, with contraception duration of 10 years and effectiveness greater than 99%, with a little failure rate when inserted correctly, with a percentage of 1 pregnancy error per 100 women (BRASIL, 2017; FILHO *et al.*, 2018).

In addition to being a safe method where the mechanism of action consists of an inflammatory, cytotoxic reaction, causing the sperm action not to be viable, the IUD has the possibility of reversion any time there is a desire to plan a new pregnancy. Despite being a method not greatly used in Brazil, studies show that it is a good alternative for adolescents when compared to other contraceptive methods. Furthermore, when compared to oral contraceptives, the IUD represents 22 times less risk of unplanned pregnancy (FILHO *et al.*, 2018). It can be inserted in the normal postpartum or immediate caesarean section, post-abortion, or curettage or in the puerperal period on an outpatient basis, targeting women of reproductive age and adolescents (FILHO *et al.*, 2018).

The hospital where we carried out the study has been working since 2017 with the offer of post-procedure contraceptive methods already described, including the copper IUD, model TCu 380A. In view

of the number of consultations performed and the birth rates among adolescents and women who are the target audience of this planning method, there is a low adherence to insertion.

Researches have shown a higher percentage of the expulsion rate of postpartum IUD or other procedures when compared to the insertion of an elective outpatient, especially when it is inserted after 48 (forty-eight) hours. The later the insertion, the greater the risks, which is a fact commonly reported by professionals as a disadvantage of the method for the low adherence to this practice.

In some countries, the practice of inserting an IUD has become increasingly positive. States in Brazil, such as the Federal District (DF) and hospitals like Sofia Feldman, have performed the practice of insertion by a professional nurse in normal postpartum, abortion or on an outpatient basis as family health strategies (CONSELHO FEDERAL DE ENFERMAGEM, 2010). The nurse is allowed to insert an IUD as long as they are trained, as provided in Resolution COFEN n. 358/2009: they are able to perform clinical consultation, prescribe and insert an IUD (CONSELHO FEDERAL DE ENFERMAGEM, 2010).

The worldwide campaign “Nursing Now” launched in 2019 has been motivating the Ministry of Health to strengthen the role of nurses in recent years. Among the themes addressed, teenage pregnancy shows itself as a reemerging panorama, which requires innovative initiatives, both for access to information on pregnancy and regarding the focus on the prevention of a subsequent pregnancy (CONSELHO FEDERAL DE ENFERMAGEM, 2010). The campaign recommends training nurses, obstetric nurses, and midwives to insert and remove contraceptive implants. In addition to reducing unwanted pregnancies, the nurse professional - being ahead of primary care – facilitates a greater health education, reducing inequality and expanding the health care of adolescents (CONSELHO FEDERAL DE ENFERMAGEM, 2010; CONSELHO FEDERAL DE ENFERMAGEM, 2009).

As in any study with data collection design from secondary sources, there is a possibility of bias due to insufficient or incomplete data, which is a limitation of the present study. Another limitation for the characterization of pregnant adolescents was the impossibility of data on ethnicity/color, education, and income.

## **5. Conclusion**

Therefore, in this research it is concluded that a low birth weight and a lower number of prenatal consultations are among the main factors related to a longer hospital stay of the newborn. The complex nature of intensive care of low-weight or premature children demands a high cost from health services units, which leads to a reflection on the promotion of public health policies in favor of the adoption of incentive practices in the service network, with a primary focus on the prevention of subsequent pregnancies in adolescence, and with strategies for training professional nurses in the handling and insertion of the IUD.

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## Appendix

**Appendix 1**– Mean and standard deviation (SD) or median and interquartile range of the continuous variables of adolescents and newborns treated at the University Hospital of the Federal University of Grande Dourados - HU / UFGD, in 2018.

Variable	Mean (SD)	Median (IIQ)	Minimum	Maximum	P
Age (years)	17.3 ( $\pm$ 1.5)	18 (19 - 16)	13	19	
Gestational age (weeks)	38.2 ( $\pm$ 2.7)	39 (40 – 37)	24	43	
Newborn weight (grams)	2955 ( $\pm$ 602.8)	3045 (3370- 2630)	666	4198	P<0.001
Number of prenatal consultations	7.4 ( $\pm$ 3.2)	8 (9 -5)	0	19	P<0.001
Number of pregnancies	1.3 ( $\pm$ 0.6)	1 (2 -2)	0	5	
Number of abortions	0.1 ( $\pm$ 0.3)	0 (0 – 0)	0	2	

**Appendix 2**– Frequency and proportions of characteristics of adolescents and newborns treated at the University Hospital of the Federal University of Grande Dourados - HU / UFGD, in 2018.

<b>Variable</b>	<b>(N=491)</b>	<b>(%)</b>
<b>Type of Delivery</b>		
Normal birth	296	60.3%
Caesarean delivery	193	39.3%
Home birth	2	0.4%
<b>Positivity of the Rapid Test</b>		
HIV	2	0.4%
Syphilis	29	5.9%
<b>Postpartum Contraceptives</b>		
IUD	20	4.1%
IMPLANON	1	0.2%
<b>Destination of the newborn</b>		
Joint accommodation	415	84.5%
Intermediate unit	23	4.7%
Neonatal ICU	31	6.3%
Death	1	0.2%
Others	21	4.3%

Abbreviations: HIV - Human Immunodeficiency Virus; IUD - Intrauterine Device; ICU - Intensive Care Unit.

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# **The Effect of Earnings Management on Firm Value with Corporate Governance as a Moderating Variable**

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## **ABSTRACT**

*This study aims to provide a conceptual study of the effect of earnings management on firm value by including corporate governance as a moderating variable. This paper is a conceptual paper that discusses issues related to earnings management on firm value and the role of corporate governance in minimizing earnings management practices so as to increase firm value. Previous theoretical studies have shown that earnings management is effectively controlled by the corporate governance system and performance. In addition, the results of previous studies found empirical evidence that there is a positive relationship between earnings management and firm value. From the theoretical discussion and previous research, it is concluded that earnings management practices have a positive effect on firm value as moderated by corporate governance.*

**Keywords:** Earnings management; firm value; corporate governance; independent commissioner; managerial ownership; institutional ownership

## **INTRODUCTION**

Earnings management is a management intervention to influence earnings, usually for opportunistic reasons (Subramanyam and Wild, 2009). Gill *et al.* (2013) define earnings management as the practice of managerial actions reflected in the company's financial statements to either give the impression of periodic or annual smooth earnings, this is to show high profits in a certain year. The phenomenon of earnings management has occurred a lot in Indonesia in recent years, especially in companies listed on the Indonesia Stock Exchange (IDX), where the company's financial statements must be published to the public.

The issue of earnings management is often associated with *corporate governance* because according to the viewpoint of agency theory, the problem of earnings management can be reduced by implementing a monitoring mechanism for *good corporate governance* (Subanidja *et al.*, 2016). In Indonesia, *corporate governance* has become important after the 1998 crisis. Many people say that the long process of improvement in Indonesia is due to the weak implementation of *corporate governance* in companies. Since then, both the government and investors began to pay significant attention to practices of *corporate*

*governance*. Several previous studies have discussed earnings management and firm value. However, this study tries to include the corporate governance variable as a moderating variable and examines the non-financial state-owned companies listed on the IDX. Where BUMN companies should not be allowed to commit such violations because most of the shares of BUMN companies are owned by the state, which of course the losses incurred are also stated losses.

## **RESEARCH ISSUE**

Several cases of earnings management have occurred in Indonesia, such as PT Indofarma (Persero) Tbk, PT Kimia Farma (Persero) Tbk PT Timah (Persero) Tbk, PT Sekawan Intipratama Tbk, PT Cakra Mineral Tbk, and PT Bank Bukopin Tbk. It can be seen that state-owned companies can also carry out earnings management which should not be done by companies that are mostly owned by the state. Furthermore, the case that recently occurred was PT Garuda Indonesia, Tbk, wherein the 2018 financial statements, Garuda recorded a net profit of US \$ 809.85 thousand or the equivalent of Rp. 11.33 billion (exchange rate of Rp. 14,000). Among other things, this profit was supported by the cooperation between Garuda and PT Mahata Aero Teknologi. The cooperation is valued at US \$ 239.94 million or around Rp 2.98 trillion, of which the US \$ 28 million is part of the profit-sharing obtained from PT Sriwijaya Air. The funds are still receivable but have been recognized as income. So that it made the previous company lose money then made a profit. These cases show that earnings management occurs in many companies in Indonesia, especially public companies where they have a responsibility to the public for the performance of their companies. This is also associated with weak corporate governance oversight, where corporate governance mechanisms are very important in a company. Kang and Kim (2011) prove that real activity-based earnings management is effectively controlled by the corporate governance system and has a relationship between corporate governance and performance. However, Darwis (2012) states that earnings management has no effect on firm value. This is not in line with the research of Gill *et al.* (2013) who found a negative influence between earnings management and firm value. Thus, this research contributes to filling the theoretical gap.

## **LITERATURE REVIEW**

### **Agency Theory**

Based on the agency theory that agency relations can create a conflict of interest between the owner (investor) and the manager (agent). The contract is made with the hope of minimizing the conflict of interest. The earnings management actions taken will not give a favorable reaction which will have an impact on increasing company value. This agency theory perspective is the basis for understanding the issue of corporate governance and earnings management. The separation of ownership by the principal and control by agents in an organization tends to cause agency conflicts between the principal and the agent. Jensen and Meckling (1976), Watts & Zimmerman (1986), and Gunarianto *et al.* (2012) stated that financial statements made with accounting figures are expected to minimize conflicts between interested parties. With the financial statements reported by the agent as the responsibility for its performance, the principal can assess, measure, and monitor the extent to which the agent works to improve his welfare and as a basis for providing compensation to the agent.

### Earnings Management

Scott (2009) defines earnings management as an act of management to select accounting policies from a certain standard, for example by changing the declining balance method, straight-line, and other methods than which one has a higher cost to reduce corporate profits so that the company can reduce expenses. tax. Earnings management is also a manager's action to increase (reduce) the currently reported profit of a business unit for which the manager is responsible, without causing an increase (decrease) in the long-term economic profitability of the business unit (Hwihanus & Qurba, 2009). Several previous researchers have created models as a measure of earnings management, such as the Healy (1985), DeAngelo (1986), Jones (1991) model, the Industry Model (Dechow and Sloan, 1991), the Modified Jones (Dechow *et al.*, 1995), Dechow-Dichev (2002), Kothari (2005), Stubben (2010) and New Approach Models (Dechow *et al.*, 2011). The earnings management variable in this study is measured by identifying or measuring *discretionary accruals* using the Modified Jones Model because this model is considered the best model for detecting earnings management compared to other models and provides the strongest results (Dechow *et al.* 1995).

### Corporate Governance

According to the Forum for Corporate Governance in Indonesia (FCGI, 2001), corporate governance is a set of regulations governing the relationship between shareholders, company management, creditors, government, employees, and other internal and external stakeholders. with their rights and obligations, or in other words, a system that regulates and controls the company. Meanwhile, according to the OECD (Organization for Economic Cooperation and Development), Good Corporate Governance is a system to direct and control companies.

### Independent Commissioner

According to Agoes and Ardana (2014), Independent commissioners and directors are those who are appointed to represent independent shareholders (minority shareholders) and the appointed party is not in the capacity to represent any party and is solely appointed based on background knowledge. experience, and professional expertise they have to fully carry out their duties for the benefit of the company.

### Managerial Ownership Managerial

ownership is the number of shares owned by management, namely the board of directors and commissioners of the company. Jensen and Meckling (1976) stated that in order to reduce the conflict of interest between the principal and agent, it can be done by increasing managerial ownership in a company. By increasing share ownership by managers, it is expected that managers will act in accordance with the wishes of the principals because managers will be motivated to improve performance (Siallagan and Machfoedz, 2006).

### Institutional Ownership Institutional

ownership is the percentage of total shares at the end of the accounting period that is owned by external parties, such as institutions, companies, insurance, banks, or other institutions (Beiner *et al.*, 2004). The existence of ownership by institutions will encourage an increase in more optimal supervision of

management performance because share ownership represents a source of power that can be used to support or vice versa to the existence of management.

#### Company Value Firm

value is a description of certain conditions that the company wants to achieve as a form of public trust in the company for all activities carried out by the company which is used by investors as a perception in carrying out investment activities related to stock prices because increasing company value shows that the company has performance good for the welfare of company stakeholders (Darmawan *et al.*, 2019).

#### Effect of Earnings Management on Firm Value

The asymmetry between management and owners provides an opportunity for managers to carry out earnings management in order to increase firm value at a certain time. At first, the company value did increase in a certain period, but in fact earnings management could decrease the company value in the future. Tang and Chang (2015) also explain that *discretionary accruals* (DAs) and *discretionary current accruals* (DCA) have a significant negative effect on asset returns and Tobin's Q for companies with weak governance. This implies that managers in companies that are governed by weaker firms are more likely to violate accounting policies than in strongly regulated firms, leading to decreased firm performance.

H1: Earnings management has a positive effect on firm value.

#### Corporate Governance Moderating the influence of Earnings Management on Firm Value

Corporate governance is a system that regulates and controls the company which is expected to provide and increase company value to shareholders. Thus, the implementation of good corporate governance is believed to increase company value. Lei and Song (2012) revealed that companies can increase their value by increasing their corporate governance standards and that board reorganization can be an effective way to increase corporate and corporate value.

H2: Independent Commissioners moderate the effect of earnings management on firm value

H3: Managerial ownership moderates the effect of earnings management on firm value

H4: Institutional ownership moderates the effect of earnings management on firm value

## DISCUSSION

Kang and Kim (2011) prove that real activity-based earnings management is controlled effectively by the corporate governance system and has a link between corporate governance and performance. Gill *et al.* (2013) found a negative influence between earnings management and firm value. In the Indian context, investors tend to impose sanctions on companies whose management carries out intensive earnings management. Lin (2011) states that earnings management can increase firm value. Suffian *et al.* (2015) also found that there is a relationship between each Real Earnings Management (REM) activity and firm value. Susanto and Christiawan's research (2016) found a positive and significant influence between earnings management and firm value. Yorke *et al.* (2016) show that earnings management has a negative relationship with firm value. Yung and Root (2019) show a relationship between policy uncertainty and

earnings management, where companies increase/decrease earnings management when policy uncertainty is high/low.

The findings of Bae *et al.* (2012) corporate governance has a positive relationship with East Asian and Latin American companies during the post-crisis recovery period. Then, Black *et al.* (2015) suggest that better governance moderates negative effects on value and increases the sensitivity of firm profitability to industry profitability (consistent with less tunneling). Subanidja *et al.* (2016) found that the GCG mechanism which is proxied by institutional ownership, managerial ownership, independent commissioners, and audit quality has a positive and significant effect on firm value. Men's Research (2014); Siagian *et al.* (2013); Arora and Sharma (2016); and Siddiqui (2015) also found that GCG is positively related to firm value. The findings of Latif *et al.* (2017) show that corporate governance effectively improves the quality and value of corporate earnings.

## CONCLUSION

Previous research discusses how earnings management affects firm value described in agency theory (Kang and Kim, 2011; Gill *et al.*, 2013; Lin, 2011; Suffian *et al.*, 2015; Susanto and Christiawan, 2016; Yorke *et al.*, 2016; Yung and Root; 2019). Based on the results of previous research, it is concluded that earnings management can increase firm value because management tends to make the company look good to investors. However, when including the corporate governance variable as a moderating variable, it will weaken the relationship between earnings management and firm value. Because corporate governance is a system that regulates and controls the company so that it can reduce managers' actions in manipulating earnings (Lei and Song, 2012; Bae *et al.*, 2012; Black *et al.*, 2015, Suriawinata and Correia, 2019; Darwis, 2009; Lee and Chen, 2011).

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## **Systematic Review on the Theme of Sustainability in Industry 4.0**

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### **Abstract**

*On the recent process of reflection on the values of a based-on consumption society, the analyst put in check the global capacity to attend the demand for capital goods and consumption combined with the simultaneous quality of life. Sustainability, in turn, as a field of disputes, seeks to extend practices in the industrial environment as a carrier of dimensions beyond the environmental, and also seeks to present new paradigms of production and consumption for the creation of new industrial value, seeking to mitigate impacts and externalities of the production process, through sustainable development. This article proposes to understand that interactions can be established between the fourth industrial revolution and the dimensions of sustainability, presenting their characteristics and their interconnections in the literature search. Through a systematic review of the literature, using the PRISMA method, the leading publications on the levels of integrated technologies of the so-called Industry 4.0 that are related to the dimensions of sustainability and its main trends in the academic field were analyzed.*

**Keywords:** Industry 4.0; Sustainable development; Systematic literature review; PRISMA method.

## 1. Introduction

It is consensual that the current economic model today is in check. The global competitiveness in the productive sector needs constant changes since the environment is already showing signs of exhaustion. Within the actual production process in situ, companies are confronted by a variety of external factors, such as product range, shorter delivery times and product life cycles or high-quality requirements, leading to a complexity increased of the production process. An approach emerges and provides perspectives for establishing communication by sectors/machines in the production, through the internet, the so-called industry 4.0 (MAGDALENA; ERNST, 2016).

On the other hand, the capacity for constant renewal of the environment is already showing significant wear and tear, caused mainly by the commodification of ecosystems as providers of industrial inputs. Awareness is given in large part by the excessive search for advantages in the competitive market, and it is in this context that the so-called third and fourth industrial revolution appears as a milestone in the inexorable use of natural resources for their development (VEIGA, 2013). Since this awareness of the degradation of the environment and the decrease in the quality of life of the population measures are created to make the industrial process less aggressive.

In parallel with the discussion of industrial productive eco-efficiency, we have the organization of political-scientific reports that recommend, on a worldwide level, the internalization of residues inherent to the lifestyle based on consumption. Highlighting the “Limits to Growth” and the “Brundtland Report” (FILHO, 1993), which now consider intergenerational impacts and use terms such as Ecodevelopment and Sustainable Development, as alternatives to the so-called civilizational future. Also, the World Summits on Sustainable Development Rio 92, Rio +10, in Johannesburg and Rio +20, in Rio de Janeiro, which started to consider agendas with development objectives, also incorporating the intra-generational vision, with proposals aligned with the proposition of building paths for sustainability development considering dimensions that go beyond the environmental, economic and social tripod, starting to consider the political, cultural and territorial dimensions, in a context of interdependence (SACHS, 2008).

This discussion leads to new paradigms in the industry when it begins to adapt to the proposed models. In addition to environmental contributions, it represents a great opportunity to carry out sustainable industrial activities and create value in all dimensions of sustainability (STOCK; SELIGER, 2016). Among these opportunities, sustainable manufacturing presents the integration of processes and systems, making it possible to produce high-quality products and services using more sustainable resources, making it safer for employees, customers and surrounding communities (MACHADO; WINROTH; SILVA, 2019). The sustainable manufacturing using Industry 4.0 technologies is the principal choice left to manufacturers to help in the transition to a circular economy, in addition to positively influencing sustainable manufacturing resources (BAG; PRETORIUS, 2020).

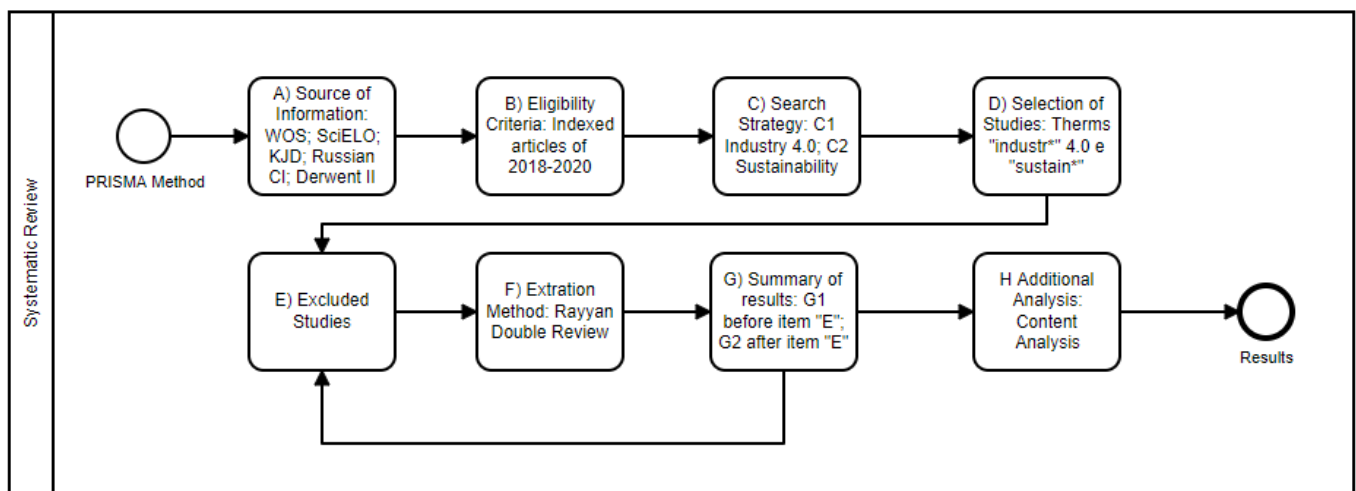
Given the need to change the paradigm of production and consumption, the technological advance proposed by the fourth industrial revolution and the need for sustainable actions, the problem posed is to highlight the trends in the debate that integrates sustainability with industry 4.0. In this context, the objective of this

article was to update, through a systematic literature review, the sustainability debate in industry 4.0, pointing out the trends, macro and micro categories that surround the theme.

## 2. Methodology

The systematic review of the literature from the categories industry 4.0 and sustainability, were adapted by the PRISMA Method (Preferred Reporting Items for Systematic reviews and Meta-Analyze) for studies of a socioeconomic nature. The PRISMA guidelines guide the objective of improving the quality of reporting of systematic review and meta-analysis data (BRASIL, 2012; MOHER et al., 2009) and its adaptation consisted of the following methodological path (FIGURE 1):

**Figure 1- Adaptation of the PRISMA Method as a methodological pathway of bibliographic review**



### A. Source of Information:

- a. Databases searched were Web of Science (WOS), SciELO Citation Index, KDJ, Russian Science Citation Index and Derwent Innovation Index;

### B. Eligibility Criteria:

- a. Articles Published in journals indexed between the years 2018 to 2020, including all countries with the publication of articles with title, abstract and keywords in English;

### C. Search strategies:

- c.1) Industry 4.0 category and
- c.2) Sustainability category;

### D. Selection of Studies:

- a. search terms:
  - i. "industry 4.0"
  - ii. "sustainability";

### E. Excluded studies:

- e.1) duplicate articles,
- e.2) that do not deal with the two themes in the same article;
- e.3) that do not treat Industry 4.0 and Sustainability as the main theme;
- e.4) conference articles and books;

e.5) articles before 20xx.

**F. Data Collection Protocols Extraction method:**

a. Double Review using Rayyan application (OUZZANI et al., 2016);

**G. Summary of Results:**

g.1) bibliometry before item “E”,

g.2) bibliometry after item “F”;

**H. Additional Analysis:**

h.1) content analysis after item “F” (BARDIN, 1977),

h.2) definition of macro-categories, micro categories and trends of studies on Industry 4.0 and Sustainability.

The choice of the period 2018-2020 was made based on two recent studies that carry out articles until 2018, with an average of more than 30 citations per year. The first article portrays sustainability in industry 4.0 as a trend, with the study of 85 articles from 2012-2017, with a focus on the macro category technology, with main articles on the interaction between machine-human and human-machine (KAMBLE; GUNASEKARAN; GAWANKAR, 2018). The second, with 35 articles from 2008-2018, considers that the field of sustainability in industry 4.0 is not consolidated and guides trends in sustainability in industry 4.0 in micro categories such as business models, circular economy, value chains and policy agenda for sustainable development goals (MACHADO; WINROTH; SILVA, 2019). In this article, in turn, it sought to observe the emergence of new and / or maintenance of trends in the recent bibliography between 2018 and 2020.

### **3. Results**

To reach the objective of updating the discussion on sustainability and industry 4.0, the results will be presented in 3 parts. The first consists of the multiple dimensions of sustainability and bring fundamental questions and historical references for understanding the emergence of sustainability as a new paradigm of production and consumption. The second part presents the industrial revolutions and the introduction of sustainability in the production process, with the priority for a reference until 2018. In the third part, finally, the trends of the intersection of these two categories are presented, focusing on the academic production of the last biennium.

#### ***3.1 The multiple dimensions of Sustainability***

Since the mid-twentieth century, as a reflection of social dissatisfaction about the impacts of the contemporary way of life, they have appeared with exponential works on ethics, with emphasis on “A Sand County Almanac” (LEOPOLD, 1949) and public health issues, with emphasis on “Silent Spring” (CARSON; DARLING; DARLING, 1962). In 1968, after scientific discussions with researchers from different fields of knowledge, a political debate began at the global level, intending to unite the pro-environment discourse, which was consolidated at the Stockholm World Conference in 1972 (FILHO, 1993 ), which produces an important report called “Limits to Growth”. In this report, Filho (1993) highlights that Ecodevelopment, as a development model, presupposed an intergenerational balance,



concerned with meeting its needs, the population and the economy of natural resources from an ecological perspective and also mentioned as the synchronic and diachronic solidarities.

Ahead, the concept of development model is improved to the idea of Sustainable Development (DS), which now comprises three dimensions, established in the midst of a debate that, according to Nascimento (2012), consists of the social, environmental and economic dimensions, known as the sustainability tripod. It should be noted that the method of only three dimensions did not cover all components in the civilization project; thus Filho (1993) includes two more dimensions, encompassing the concept of the dimensions of sustainability for also social, economic, ecological, spatial and cultural sustainability dimensions. Under the perspective that implies the scope of the dialogue on the limitation between socioeconomic and ecological, it is necessary to expand the dimensions both in perspective and in the future in social and pedagogical spheres. Therefore, only the three dimensions addressed are not able to measure eco-development. Nascimento (2012) states that the main problem of this is to focus only on these three, and not to address issues in the dimension of power, since political decisions influence and are connected to changes in production and consumption patterns. Thus, in addition to the five dimensions discussed above, the political factor will also be addressed, given the relevance of the theme.

To discuss Sustainable Development in a paradigm that enables dialogue with the State and its Public Policies, Sachs (2008) points out that sustainability is composed of eight dimensions, which, if worked integrally and synergistically, provide a significant step to think articulation of these agents and agencies. These dimensions are: economic, environmental, ecological, social, cultural, territorial, internal policy (so that projects are implemented) and foreign policy (based on equality of nations).

Since 2015, in this analysis of sustainability as multifactorial constraints, the UN has instituted 17 Sustainable Development Goals (SDGs) and 169 goals, integrating the 2030 agenda that presents proposals for improvement in public and private policies, for a higher quality of life in a sustainable manner for current and future generations. However, the Industrial sectors are more prone to negative sustainability (Kannan, Shankan and Kannan; 2020), so it is necessary to address strategies to promote and implement the practice of SD objectives in the industrial sector since two of the objectives (industry, innovation and infrastructure, and responsible consumption and production) are directly linked to Industry.

### ***3.2 Industrial Revolutions and the introduction of Sustainability in the Productive Process***

The concept of technical bases in carrying out human activities is also expanded, where this new process has revolutionized economic, social activities and human interaction with the environment. The Industrial Revolutions constituted this process, and it has been impacting (positively and negatively) all layers of sustainability, going from the first revolution, with the use of the first mechanizations, until the current one, bringing the Cyber-Physical system and enabling its interaction, with automation already installed at the factory, (MAGDALENA; ERNST, 2016).

After the three industrial revolutions, the fourth revolution, also known as Industry 4.0 or Advanced Manufacturing, presents itself as a new stage of development of industrial production in the world (VERMULM, 2018). The great advantage of Industry 4.0 on automation is the integration of technologies and artificial intelligence (VERMULM, 2018). In addition to the methods and technologies already used since the third revolution, more opportunities are still needed to ensure that information is being processed

and shared effectively and still simplifying by industry 4.0 on five levels, namely: level of intelligent connection, level of data conversion, cyber level, learning level, configuration level (MATOS; SCHEIDT, 2018). The same author also mentions the need to use tools to obtain the desired results, such as Big Data, Internet of Things (IoT), Cyber-Physical System, Cloud Computing and Security, helping in decision making, making it faster and more effective. These tools become pillars in technology and will transform the industrial process, making it more efficient (Silva et al. 2018), increasingly using renewable energies, as part of a supply, in addition to the power provided by the conventional electrical network (STOCK; SELIGER, 2016), and reducing carbon dioxide emissions (MAGDALENA; ERNST 2016).

In Germany, in addition to the good results obtained in the private sector, for being the pioneer in use, Industry 4.0 has prevailed, as one of the main sources of the economy in the country. The activities of the industrial sector represented in the economy a total of 20 to 24% of its Gross Written Value (VAB), and among the sectors that export, in Germany, the industry is the one that stands out the most, showing its high international superiority (SILVA et al. 2018). In Brazil, technology is still lagging in comparison with high powers, such as the United States and Germany. Ichi et al. (2018) state that industries in the national territory are still in the process of transition between Industry 2.0 and Industry 3.0, and that it is only through government investments that the implementation process may actually be accelerated. However, this investment should include, in addition to the market, education, to insert professionals in this new work scenario.

Leal et al. (2008) make explicit the environmental impacts that all industrial revolutions caused, since the concentration of pollution in places that had the growth in the population, and how these impacts stopped being local, to be planetary. However, Industry 4.0 brings with it the so-called integrated technology (MAGDALENA; ERNST, 2016), and the detailed information on the production process through it, improves not only the production chain but also improves energy use and energy efficiency (STOCK; SELIGER, 2016).

In a social projection, one of the key issues is the possibility of interaction between the fourth industrial revolution and society, so that the associated technologies help to repair the damage to society that the last three have caused (MORRAR, 2017), and in the ways creating values for people and the society of technologies that form the pillars of industry 4.0. This integration evolves ideas analyzed as opportunities to contribute to the so-called Super Intelligent Societies. Japan begins to integrate these technologies in the creation of Society 5.0 (FREITAS, 2018).

On a geographic scale, one of the benefits of Industry 4.0 is decentralization, avoiding overcrowding, one of the possibilities being the creation of new business models in less crowded places, since Industry 4.0 allows these models, prioritizing the development of small companies to supply their products and/or services (BEZERRA et al. 2018). Through these new business and investment models, decentralized industrialization and non-agricultural jobs in rural areas are possible. The Community Based Company (EBC) Bauana (Amazonas Community) is an example of the new business combined with artificial intelligence. Taking into account that both are linked to Industry 4.0, it is already present in remote places in the Amazon (through the encouragement of NGOs and private initiatives), in which actions such as the production of natural oils, entrepreneurship, higher education via the Internet favored by IoT and renewable energy (TRINDADE, 2019) are already a reality for residents of the region (Fundação Amazonas

Sustentável, 2020). This geographical impact caused by technologies originating from the fourth industrial revolution, in addition to being geographic, is still present in social, economic and environmental proportions.

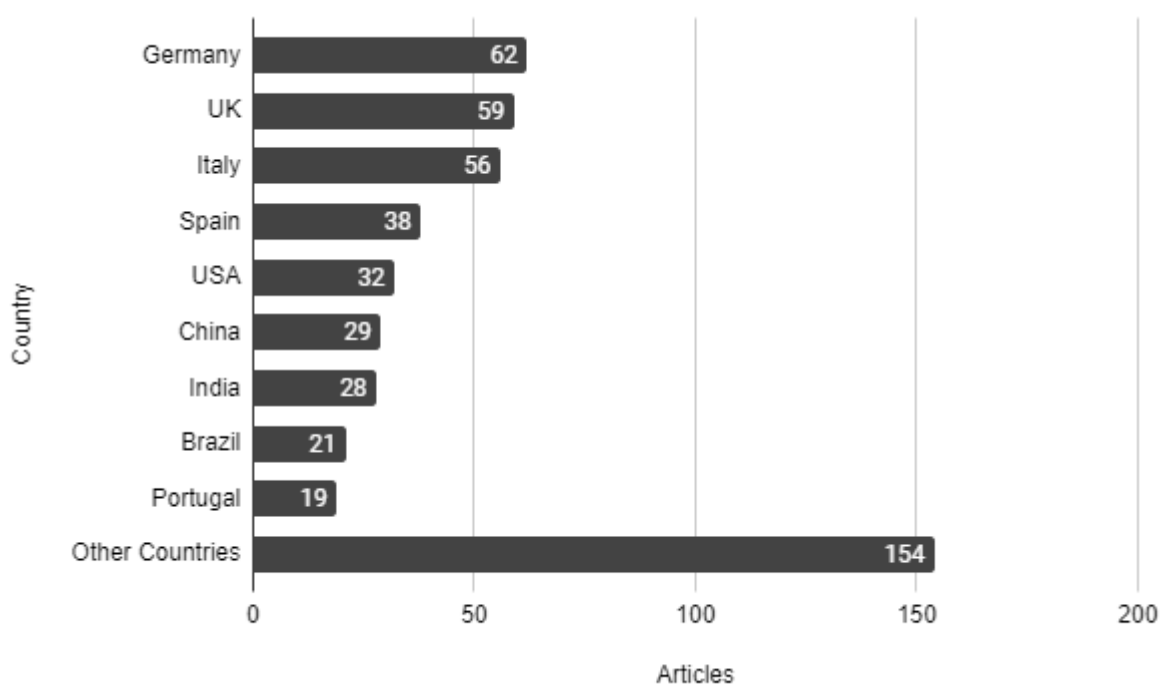
Integration is essential for the better quality of life of the population, and it is necessary, in addition to raising awareness of the correlation between these themes, the interest of public and private institutions in the implementation of Industry 4.0 in social, economic, political, cultural, geographical and in the reduction of environmental impacts.

Today we are already experiencing the Fourth Industrial Revolution and its massive economic potential. However, the question of the sustainability of this industrial development model is worrying, and it is necessary to adapt to this new industrial scenario, adjusting sustainability and its dimensions.

### 3.3 Sustainability Trends in Industry 4.0

In order to update the trends of the academic discussion about the theme of sustainability in industry 4.0, it was avoided categorizing previously as areas surrounding the two themes, in order to avoid pre-notions, and for the possibility of the emergence of new trends could arise. In this sense, a systematic review adopts the PRISMA method adapted with Content Analysis so that the categorization occurs after the application of the method, based on the pillars of Industry 4.0 and sustainability, analyzing its dimensions and interactions. The first bibliometric result is the concentration of articles produced by countries. In the first attempt, in part A, B, C and D of the methodology, a total of 498 articles were found between 2018 and 2020 (July 31), of which approximately 70% were concentrated in 9 countries (Figure 2), with a strong concentration thematic in European countries.

**Figure 2- Concentration by countries responsible for 70% of article production (n = 498)**

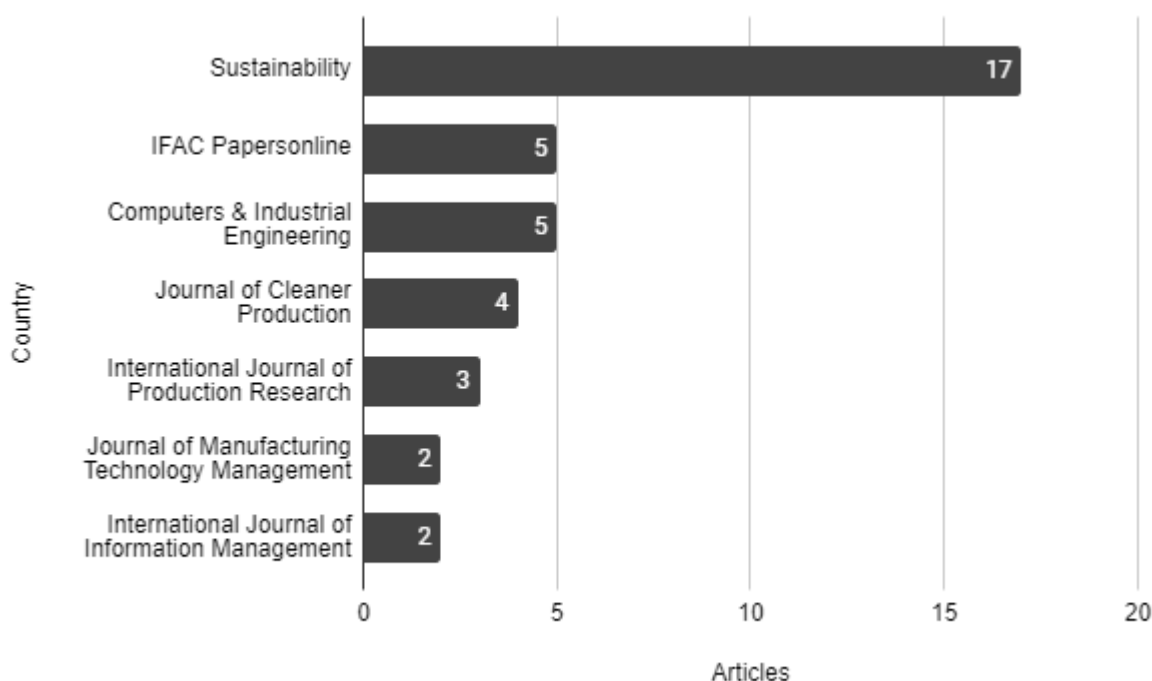


After reading the title, abstract and keywords of the 498 articles, applying the eligibility criteria indicated

in part E of the methodology, 258 articles were excluded in a double review, two of which were duplicates and 188, which dealt with only one of the two thematic, 47 articles of literature review on the themes and, finally, 69 articles excluded for not addressing these as the main theme. Of the remaining 192, 46 published in conference papers and 22 papers published in books and book chapters were still excluded. It was verified that of the rest, there were still 44 indexed articles dated before 2018.

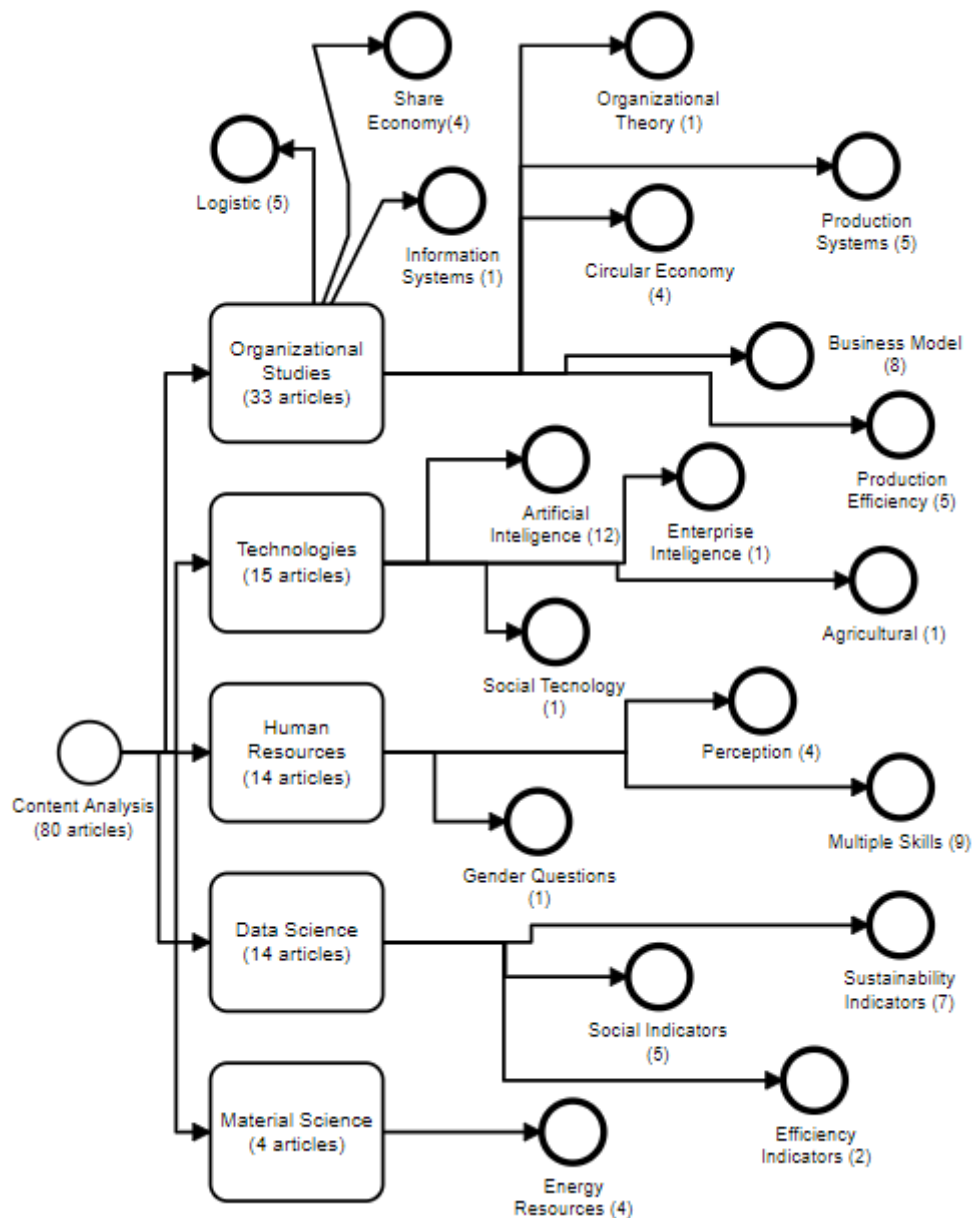
In the end, after the procedures from A to F, there are 80 articles in indexed journals, which deal with the two themes as the main focus, updated between the years 2018-2020. Of these, seven (7) journals stand out, corresponding to 47.5% of all articles (Figure 3), with the rest of the articles being distributed in 42 other journals.

**Figure 3- Concentration by journals (more than 2 articles) of article production (n = 38)**



In all, in the period of 18 months, 575 citations were obtained, granting an average of 4.79 citations of articles per year.

The content analysis of these 80 articles consisted of three parts: 1) full reading and file; 2) categorization into macro-categories identifying the area of knowledge about each article; 3) distribution in micro categories with the main result of each of these areas. Regarding the macro-categories, five (5) major areas of knowledge were identified that produced recent articles with the debate on sustainability in industry 4.0: organizational studies, technology, human resources, data science and materials science (Figure 4) and 19 respective micro categories.

**Figure 4- Flowchart of analysis of the macro and micro categories**

In all, nine (9) articles concentrate approximately 45% of the total citations and point to the trend of scientific production on sustainability in industry 4.0, these concentrated in seven (7) micro categories and with representation in the five (5) macro categories.

### 3.3.1 Main trends in Organizational Studies

In Organizational Studies, two articles stand out, the first addressing the micro-business model category and the second on the circular economy. In a business model, the article talks about new business systems integrated with industry 4.0 and analyzes, considering the sustainable use of resources and supplies (Panetto et al., 2019). As for the circular economy, it analyzes cause and effect beyond the artificial intelligence of Industry 4.0 applied to the supply chain, showing results in a manufacturing, recycling, maintenance, useful life and sustainable supply chain ecosystem (Rajput and PrakashSingh, 2020).

### 3.3.2 Main Human Resources Trends

Two other articles point to trends in the volume of citations, the first highlighting multiple skills demonstrating how the sharing of knowledge and knowledge of employees (external and internal), human resource development can, through educational resources, help companies to adapt to Industry 4.0 (STACHOVÁ et al., 2019). Following, the second micro category on perception, addresses a sustainable city and the interaction with companies, obtaining results and the influence of the smart city in the qualification of employees for SMEs, sustainability (economy, environment, social) and recruitment of elderly and foreigners (Matt et al., 2019).

### 3.3.3 Main trends in Technology

In technology trends, both articles are related to artificial intelligence. The first presents ways and software to digitize the manufacturing of SMEs, through IT with management philosophies, in order to help in the transition to Industry 4.0 (Ghobakhloo and Fathi, 2019). The second, with a proposal to develop virtual education systems for students at universities (Salah et al., 2019).

### 3.3.4 Main trends in Data Science

In this category, both main articles studied deal with Social Indicators. The first proposes an analysis of environmental and social performance in consumer electronics companies in which there is a cooperation between R&D and eco-innovations, and their implication in economic performance (Tumelero, Sbragia, Evans, 2019), and the other analyzes the sustainable supply chain in health 4.0, proposing the glass structure as a channel that offers lighting resources, solar energy with photovoltaic panels and water management (Daú et al., 2019).

### 3.3.5 Main trends in Materials Science

The article studied on Materials Science deals in the micro category on energy resources, and studies the use of piezoelectric fibers and components, for generating electricity from natural and sustainable resources such as rain and wind (Chen et al., 2019).

## 4. Conclusion

There is a need for constant discussion based on Sustainability. As it is affected in its dimensions by Industry 4.0, from the analyzed bibliographies, it is possible to analyze the impacts suffered by previous revolutions, and the ways that the fourth revolution through its technology affects the environment, society, economy, politics, culture and geography.

To update the main trends arising from the integration between sustainability and industry 4.0, it was evidenced through analysis of the PRISMA method, 5 macro-categories of the 80 filtered forged articles from 498 surveyed initially. These macro-categories consist of organizational studies; technologies; human resources; data science; materials science. Of these macros, 19 micro categories are branched, of which, selected as having received the highest number of citations, and address sustainability and industry 4.0: business model; circular economy; multiple skills; perception; artificial intelligence; social indicators;



energy resources.

The debate integrated with the research shows the main trends in the academic world in the junction of the subject. This partial convergence is not new in academic publications, which allows for a greater explanation of the subject, and shows that people are attentive to the integration of concepts. The issues are connected, but there is still a strong misalignment between sustainable development and industrial development; however, their intrinsic alignment is vital for the smooth running of both Industry 4.0 and the dimensions of sustainability.

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# **Learning Analytics for Whom? A Reflexion On the Retrieval of Learning Information by The Student**

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## **Abstract**

*The present work aims at addressing how the use of Learning Analytics (LA) has enabled the retrieval of learning information by the student oneself, by analyzing data availability, self-management and student autonomy in learning processes inside and outside virtual environments. The bibliographic research conducted had a qualitative nature and consisted of a narrative literature review anchored in the theoretical foundations of information (information retrieval and representation) and Learning Analytics. Two relevant user case studies that dealt with LA were selected from the researched articles - the first analyzed the user approach in an adapted learning context with LA whereas the second analyzed the user approach in a personalized learning context with LA. One concluded that the student, as an information user, still has little access to an effective retrieval of what was consolidated throughout one's own learning process. Besides, in relation to the effectiveness of LA, in the context of adapted and personalized learning, there was a perceived increase in student performance with regard to the use of activities and tasks.*

**Keywords:** Learning Analytics, Information Retrieval, User Study, Personalized Learning, Adapted Learning.

## **1. Introduction**

Learning technologies have moved from simple learning systems institutionally managed to learning environments mediated by personal and social tools (Chatti & Muslim, 2019). The growing number of digital tools used in daily learning activities generates data on an unprecedented scale, offering challenges for information and education scientists.

In the educational context, a large amount of data produced by students can be collected, making it possible to carry out various analyzes related to students' behavior in order to support teaching and learning processes. In spite of being a relatively new research field, in which data produced by students are analyzed inside and outside Virtual Learning Environments (VLE), Learning Analytics (LA) has gained prominence in educational literature as an auxiliary process in adapted learning or as a process of pedagogical alternation, in which traditional teaching is hybridized with virtual platforms. Computational methods are increasingly used to analyze student data and learning dynamics, as well as to create predictive models and test theories (Buckingham Shum & Ferguson, 2012). The drive for LA in all education sectors requires

academic research that clearly demonstrates the value proposition implicit in this field for parents, students, teachers and managers (Teasley, 2019).

This study aims at answering the following questions: How has Learning Analytics been applied in order to enable the student to retrieve information? Students are the main providers of the data used by LA, but are they exercising the use of this information? Is the data also available to students? Can students self-manage their learning process?

Thus, the general objective of the present study was to describe how the application of Learning Analytics has enabled the retrieval of information by students. The specific objectives were to (i) identify what LA data is available to students; (ii) explain students' interaction with these data and (iii) report evidence of the effectiveness of LA to the student.

## **2. Information Retrieval and Users Study**

The approach of information retrieval by the user is associated with studies on Information Representation. When characterizing information, Setzer (1999) states that it is an informal abstraction, in the sense that it cannot be formalized through the principles and foundations of Mathematics or Logic (Philosophy). Based on this characterization, the author considers that information representation can occasionally be achieved by means of data, thus enabling its computer storage. In this case, the author reinforces that the representation can be transformed, but the meaning remains. This representation cannot consist of attempts to create an information context in view of information retrieval programs, since Cornelius (2003) highlights the disadvantages of limiting such representations in the light of what the context comprises.

Data representation in information systems aims at supporting certain human activities, such as those associated with the retrieval of information by the user. In this sense, information should be considered as a reflection of the social function of the information system (Capurro & Hjørland, 2007).

Regarding information as a reflection of the social function, Capurro (2010) questions for whom information is intended in this global society. Apparently, there is communication of everything with everyone, since Information Science seems to be situated "between the utopia of a universal language and the madness of a private language" (Capurro, 2010, p. 259).

Knowing who will use certain information implies understanding a scenario of changes, uncertainties and challenges. Therefore, with the growing advances in technologies, Alvarenga (2003) reiterates that the present century will undergo countless innovations that will directly interfere in the processes of recognition, codification, transmission and retrieval of knowledge. Due to these changes, user studies have consolidated a model that privileges the study of certain subjects in certain contexts of use, such as platform users in virtual learning environments and the increased performance in their learning (Araújo, 2008).

The key concept for user studies is interaction, because according to Araújo (2012), it highlights the evidence that an action or influence exerted by something can also be affected by that something. In this interactionist perspective, Araújo (2012) asserts that the user is not totally determined by the context in which one is inserted, nor completely isolated, nor even alien to it. One infers the need to consider

information and its social function within the information system, as approached by Capurro & Hjørland (2007). Likewise, the user is social, which means, according to Araújo (2012), that one is not completely determined by the collectivity nor isolated from it, since one contributes to the construction of this collectivity (built by the concrete subjects inserted in it) and receives contributions through collective constructions. In this scope, Araújo (2012) states that accessing and using information are simultaneously cognitive, emotional, cultural and contextual actions.

In view of the technological advances that influence the information area, new techniques of representation and recovery by the end user have emerged (Bräscher, 2002). Therefore, there is a tendency for the development of intelligent systems that contribute to information retrieval based on natural language processing, considering the availability of full texts on the machines and the availability of more favorable interfaces for the end user. Bräscher (2002) highlights the need for systems that recover models of knowledge representation that allow the contextualization of the meanings described in the stored texts.

Bearing in mind the development of intelligent systems, Learning Analytics (LA) appears as a possibility to address the question of the interface designed for the end user. According to Biagiotti & Baldessar (2017), properly developed smart LA systems are able to promote the presentation of a friendly interface, as well as data mining and data crossing as a result of an interdisciplinary data analysis technique that allows the convergence of knowledge areas such as Education, Psychology and Computer Science.

### **3. Learning Analytics**

As discussed at the 1st International Conference on Learning Analytics and Knowledge, which took place in 2011 in Canada, there has been a growing demand for technological transformation in education at a global level. The following indicators justify the creation of a specific forum for researching Learning Analytics: the inability of organizations to understand data on knowledge, teaching and learning at the same pace as they arise; the inefficiency of learning institutions and corporations with regard to the use of data that students “discard” in the process of accessing learning materials, interacting with educators and colleagues and creating new content; and the growing pressure on educational institutions to reduce costs and increase efficiency (Long & Siemens, 2011; Teasley, 2018).

In this context, Learning Analytics presents itself as an alternative that helps “measuring, collecting, analyzing and reporting data about students and their contexts, for the purpose of understanding and optimizing learning and the environments where it occurs” (Long & Siemens, 2011). According to Andrade and Ferreira (2016), LA focuses on issues related to learning and, for Long & Siemens (2011), LA promises to be important lens through which one can visualize and plan changes in the levels of courses and institutions.

According to Teasley (2018), the data analyzed by LA systems can represent both the learning process - records of student activity, use of the library, accessed resources, etc. - and the learning products - evidence of learning found in discussion posts, blogs, tweets, hashtags, etc. - , thus providing a very rich image of the student's behavior. According to Teasley (2018) when advanced data repositories are formed by integrating data from various student information systems with data from other online educational systems, it is possible to extract valuable information for the identification of trends, patterns and anomalies.



The complexity of educational systems, which encompasses very different data and users, requires a careful analysis and assessment of the real effects of LA on the learning of users involved in the processes where this technology is used. Therefore, during the development of a LA-based system, it is necessary to understand what data will be collected, who will have access to this data, why and for what purpose this data will be needed and how it will be captured and made available. The “What? Who? Why? How?” proposed by Chatti, Dyckhoff, Schroeder & Thus (2012) aims at assisting and systematizing the identification of opportunities and possibilities for data collection and analysis in a LA system according to the following dimensions:

- "What?" - Definition of what data will be used for analysis;
- “Who?” - Identification of the targets or stakeholders of the analysis;
- “Why?” - Evaluation of the objectives of each analysis type;
- "How?" - Identification and definition of the techniques that will be part of data analysis.

The model presented aims to assist users in the evaluation of intelligent systems supported by LA, attempting to achieve the effectiveness and the advantages of the system as presented by Andrade and Ferreira (2016): (i) early detection of students at risk (students who do not comply with delivery times, have negative results or do not manifest themselves in activities); (ii) personalization and adaptation of the learning processes; (iii) the positive effects on student motivation, confidence and achievement; (iv) maximizing the use of teachers' time and effort; (v) improving curriculum development processes; and (vi) interactive visualizations of complex information.

The first academic works in the field of LA focused on the identification of key variables to predict student results, such as retention and time to obtain degrees. Over time, in addition to predicting performance results, LA researchers began to create systems that visually presented performance metrics, making it possible to monitor student progress and identify students who indicated the need for academic intervention. In recent years, however, there has been an increasing number of systems developed to provide "actionable intelligence" for instructors, academic advisors and, more recently, directly for students themselves (Teasley, 2018). With the maturation of research in LA, there has been a change in the perception of student's role in the learning process; the student is no longer a mere supplier user, but also a user who actively uses one's own information.

The systems aimed at students, which are the focus of analysis in this study, are divided into two models: the adapted and the personalized models. The learning adaptation model is guided by the system; the system decides what to do. The learning personalization model is oriented to the student; the system helps the student to decide what to do (Chatti & Muslim, 2019). The following is the theoretical framework on systems that use Learning Analytics applied to both an adapted learning model and a personalized learning model.

#### **4. Systems in the context of adapted and personalized learning**

Faced with contemporary education challenges, Chiappe & Rodriguez (2017) emphasize that the “industrial education” model needs to be overcome and transformed into a model that aims at the formation of individual and unique apprentices. The current context demands individuals whose education, according

to Chiappe & Rodriguez (2017), is sustained by global awareness and social and ecological responsibility, since it is necessary to educate workers capable of navigating in a world flooded with information without the risk of sinking.

Adapted Education does not focus solely on students with learning difficulties or special educational needs, since all students must advance in their learning and recreate themselves through that learning. In this context, the teaching staff, the educational administration and the society must guarantee working conditions (use of adequate spaces, sufficient time, good infrastructure, recognition), in addition to specific resources (teacher education and training, specialized services, materials) that favor the adaptation of teaching methods to a diversity of students (Coll, 2012).

Learning Analytics (LA) can provide data that contribute to possible adaptations in teaching, since they are generated by students and consist of different types of data, such as user navigation, AVA data, demographic data, amongst others (Moissa, Gasparini & Kenczinski, 2014). In this sense, the authors point out that several analysis techniques, such as data mining, statistics, information visualization, can be used in order to reach the most diverse objectives, such as prediction, tutoring, adaptation and personalization of learning. LA also allows identifying what problems occur during the learning process even if they are not explicit, thus enabling accurate decision-making on necessary interventions (Nunes, Silva, Laisa, Ugulino & Lucena, 2016; Scheffel et al., 2014).

In Adapted Education, in order to provide indications, corrections and readjustments in the learning objectives, Nogueira et al. (2018) expect students to have access to data that contribute to their self-learning and self-assessment, assisting them in the design of their study plan and allowing them to fill in gaps that are possibly associated with conventional education. Chatti & Muslim (2019) reiterate that there is a crucial need to develop intelligent learning environments that put students at the center and give them more autonomy and control over their own learning experience.

Research on personalized learning environments has gained ground in recent years, allowing the emergence of new technological solutions that put students in control of their own development and learning, such as Personal Learning Environments (PLEs), Massive Open Online Courses (MOOCs) and Open Educational Resources (OER) (Chatti & Muslim, 2019). For Kurilovas (2019), the future of education is the personalization of learning, which means creating and implementing personalized learning units, suitable for specific students according to their personal needs.

According to Chatti & Muslim (2019), personalization is crucial to achieving intelligent learning environments in different contexts of lifelong learning. Dawson, Gasevic, Siemens & Joksimovic (2014) state that the next generation of personalized learning environments should provide resources adapted to the needs of the student, thus integrating interactions, skills and competences in the mapping of academic disciplines knowledge.

In this context, Learning Analytics presents itself as an important resource in the development of personalized learning experiences. LA systems use predictive models that provide users (students, instructors and educational institutions) with actionable information based on a multidisciplinary approach to data processing, thus enhancing technology learning, educational data mining and visualization (Scheffel et al., 2014). Pardo, Jovanovic, Dawson, Gasevic & Mirriahi (2019) state that Learning Analytics systems use machine learning techniques and predictive modeling to analyze students' digital tracking in order to

understand and optimize the learning process. LA systems with a focus on personalized learning provide real-time feedback to students (Avella, Kebritchi, Nunn & Kanai, 2016); which, according to Chatti & Muslim (2019), helps them to decide and continuously shape their activities to achieve their individual goals more efficiently and autonomously.

The Learning Analytics field emerged with the objective of using data to increase the perception of learning experience and to improve student support (Dawson et al., 2014), thus expanding the understanding of individual learning and creating interventions aimed at teaching and learning practices (Wise, 2014). Chatti & Muslim (2019) and Avella et al. (2016) agree and add that LA has opened new opportunities to promote personalization and adaptation, providing insights into the comprehension of how students learn and supporting personalized learning experiences that meet students' goals and needs. Finally, Scheffel et al. (2014) point out that LA increases students' awareness by helping them to make constructive decisions and to perform their tasks more effectively.

## **5. Methodology**

In order to achieve the objective of describing how the application of Learning Analytics allowed students to retrieve information, one opted for a qualitative bibliographic research, more specifically a narrative review of literature focused on case studies that addressed the theme. For Mendes-da-Silva (2019), the narrative review usually addresses one or more questions and, unlike systematic reviews, their selection criteria for inclusion of articles may or may not be explicitly specified by the researchers.

The narrative review consists of identifying the corpus of knowledge related to the objective and analyzing it to obtain answers. Wendler (2012) highlights that the clarity regarding the path adopted allows to generate an information framework that will help further researches, enabling them to identify the methods, contents and trends of the publications used. In the present research, one mapped not only classic literature, but also articles published in journals indexed at Scopus database by means of structured search procedures. The search consisted of looking for the key word "Learning Analytics" in the titles. One excluded dissertations, theses, duplicate texts, videos, images or articles whose abstracts proved them to be inappropriate for the theme of this investigation.

The time limit used was 5 (five) years, with a range from 2015 to 2019. One opted to select only articles in Portuguese, English and Spanish, as well as those whose full texts were available and consisted of case studies. After the search, 243 articles were retrieved and one analyzed their abstracts to identify case studies. Out of the 243, 36 case studies were selected and one analyzed which ones dealt with adapted and / or personalized learning. None of the studies presented a simultaneous analysis of the two learning approaches. Considering the selected articles, one opted for the analysis of two case studies. They were selected because their abstract directly referred to the adaptation or customization of learning by means of Learning Analytics and because they were recently published (2018 and 2019). The results are presented in the following topics.

## **6. User study in the context of adapted learning with LA**

In the article entitled *What Learning Analytics tell us: group behavior analysis and individual*

*learning diagnosis based on long-term and large-scale data*, Zhang, Zhang, Zou & Huang (2018) analyze the characteristics of student group behavior when performing certain tasks and the factors that influence learning and individual outcomes. The analysis considered data obtained from online learning records of 1088 students from 22 classes and they analyzed aspects associated with login behaviors, the resources used on Moodle platform, quizzes, interactive behaviors and also academic performance. The analysis period was five months, between September 2015 and January 2016. All students involved in the study attended a blended course, with traditional activities on-site and online activities on Moodle.

The research carried out by Zhang et al. (2018) was quantitative and used the following methods in order to interpret data obtained in the process and in the results of online learning: statistical analysis, analysis of visualization of social networks and correlation analysis. The results obtained by Zhang et al. (2018) are described below.

The statistical analysis initially considered the analysis of the access behavior (login). The first fourteen weeks showed a stable frequency in the number of hits, and from the fifteenth week on, the number of hits increased, having a sharp peak in the last week (nineteenth). This result showed that the teacher's intervention led some students with low attendance to increase their accesses in the final stretch. Accesses decreased with the approach of the weekend, presenting a new increase in each beginning of the week.

Then, the use of resources was analyzed, namely: questionnaire, thematic discussion, submission, expanded resource, daily communication, didactic material download and course notification. The results showed that teachers who used around 60% of the available resources presented better results in online learning in their classes. The questionnaires with tests at the end of each chapter presented a markedly higher completion rate than the other resources as they are strongly linked to the final exam.

The analysis of visualization of social networks aimed at studying interactive behavior. The peaks of interaction between students, between groups and between students and teachers occurred in the last month. Leading students presented more interactions with a larger number of people and formed small groups around their "atmosphere of influence".

Finally, a correlation analysis was used to obtain results on academic performance. The students showed greater concern with modules and resources directly linked to the final grades. The results showed that the number of students who paid attention to different activities was deeply associated with the requirements for learning and assessment tasks.

The interaction between the teacher and the students in the four classes reinforced that online attendance could be affected by many factors, especially the adaptation of activities, methods and resources in order to arouse students' enthusiasm and initiative. This implied a rate of resource use 13.09% higher than the average use rate, with an achievement rate higher than 85% in regular, optional and final activities. Finally, the correlation between the global scores and the completion of the questionnaires was obvious.

In the diagnosis of collective behavior, Zhang et al. (2018) indicated that teachers who actively participated in the platform exercised a leadership and mediation role in most of the thematic forums. The participation of one of the teachers stood out and by means of the interactions with the students, this teacher promoted an environment that was favorable for student individual participation. According to the data presented and analyzed, the adaptations in the educational practice provided indications, corrections and readjustments in the learning objectives, contributing to self-learning and self-assessment. Therefore,

according to Nogueira et al. (2018), adaptations in educational practice allowed to fill in the gaps of conventional education, which was evidenced in the performance of 85% in activities.

## 7. User study in the context of personalized learning with LA

In the article entitled *The PERLA Framework: Blending Personalization and Learning Analytics*, Chatti & Muslim (2019) presented the *Personalization and Learning Analytics (PERLA) Framework* (Figure 1). It is a conceptual framework to effectively support customization in different lifelong learning configurations. The main objective of the PERLA framework is to provide LA researchers and developers with a systematic way to design and develop indicators to support personalized learning.

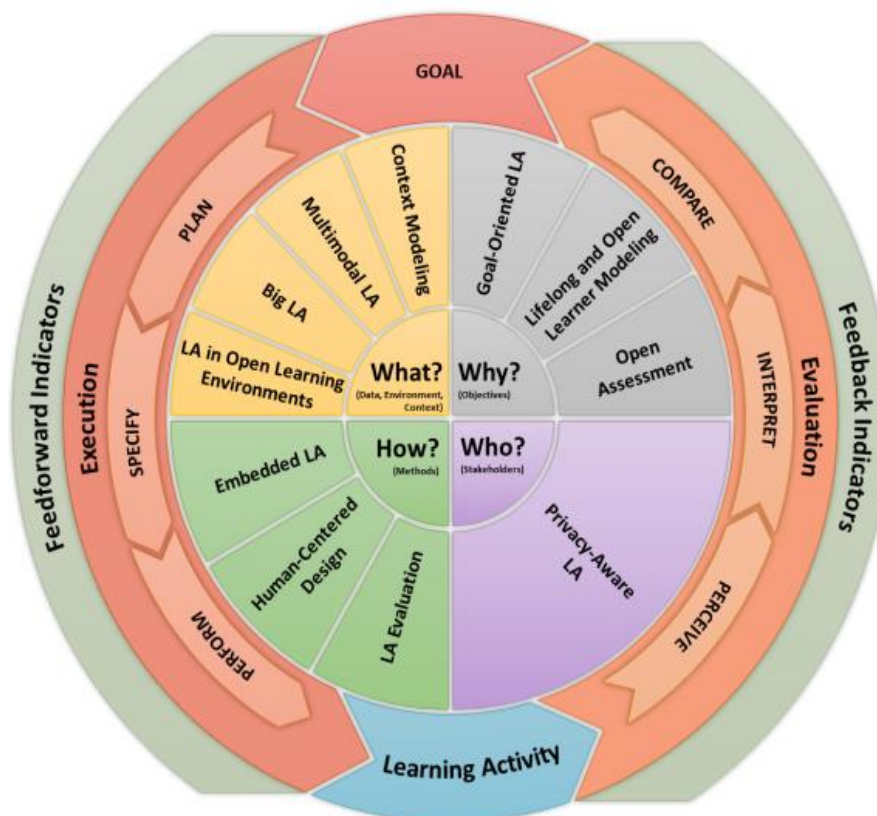


Figure 1. Personalization and Learning Analytics (PERLA) Framework

Source: Chatti & Muslim (2019)

When developing PERLA, Chatti & Muslim (2019) aimed to provide a structure that could assist in measuring the efficiency and effectiveness of LA, since, according to them, although several studies revealed the importance of using and analyzing data, few highlighted how data analysis would be changed to optimize learning. In order to highlight the positive effect of LA on the personalized learning experience, one highlights the results published by Pardo et al. (2019) in the article *Using learning analytics to scale the provision of personalized feedback*. In this article, the authors conducted a case study to analyze the impact of personalized feedback on the student's academic performance and evaluate the student's perception of the quality of the feedback received.

In the PERLA structure, feedback is one of the most important mechanisms for the development of intelligent learning environments to help students achieve their goals. In the structure, this mechanism is



addressed within the scope of the requirements for open assessment and assessment indicators. According to Chatti & Muslim (2019), open assessment is a generic term for different assessment methods, such as easy assessment, self-assessment, peer review and feedback. LA had the potential to support open assessment, with timely and personalized feedback, providing an explanation of how and why feedback was given, validating the peer review and making learning achievements explicit to support awareness, trigger self-reflection and promote self-assessment (Chatti & Muslim, 2019).

Hattie (2008 apud Pardo et al., 2019) also identified student-directed feedback as one of the most important factors that influence academic performance. In the article, Pardo et al. (2019) presented a new approach to providing personalized feedback based on a set of engagement indicators derived from students' activities in the learning environment. For each activity defined in the course design, instructors prepared in advance a set of feedback messages for each level of student interaction with the learning resources. For example: "if an activity contains a video, instructors will provide feedback to students who barely took a look at the video, for those who watched a significant part of the video, for those who watched the entire video and for those who watched the video several times "(Pardo et al., 2019, p. 131). The assumption behind this approach was that instructors can use the level of involvement with the activity to modulate the feedback sent to students, so that it was much more personal and connected to their behavior. After these comments were created, an algorithm was executed at the end of each instruction cycle in order to select the appropriate comment for each student based on the student's level of participation in the activity. The comments selected for each activity were grouped in a detailed feedback message that was sent to the student through the virtual learning environment or by a personalized email. The goal was for the students to take advantage of the feedback received at the end of a cycle to improve their performance in activities in the next cycle (Pardo et al., 2019).

In order to analyze student satisfaction with the feedback received and to evaluate the effect of this feedback on students' academic performance, Pardo et al. (2019) conducted a research with students enrolled in the 2013, 2014 and 2015 editions of a 13-week first year Computer Engineering course at a university in Australia. According to Pardo et al. (2019), the interviewees were: 291 students who enrolled in 2013 (46 women, 245 men, 97.3% engineering students), 315 students who enrolled in 2014 (57 women, 257 men, 1 individual without gender identification, 93.6% engineering students) and 414 students who enrolled in 2015 (75 women, 339 men, 94.2% engineering students).

The intervention promoted by Pardo et al. (2019) was implemented in weeks 2 to 5 of the 2015 edition of the course and consisted of sending each student a personalized email (Figure 2) at the end of the week with detailed feedback on their involvement with the proposed activities. To this end, the instructor created four feedback comments for the 37 activities in the four cycles that preceded the intermediate exam (weeks 2 to 5); a total of 138 short texts (with one or two sentences). The activities were available through the institutional Learning Management System (LMS) that captured all student interactions with the activities and learning resources (Pardo et al., 2019).



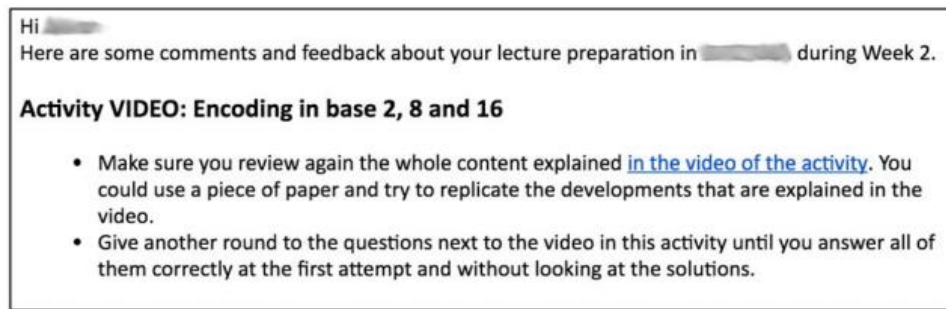


Figure 2. Example of a personalized message

Source: Pardo et al. (2019)

The research hypotheses explored in the study carried out by Pardo et al. (2019) were:

- RH1: providing feedback through personalized messages based on student engagement with learning tasks increases student satisfaction on a blended learning course.
- RH2: providing feedback through personalized messages based on students' involvement in learning tasks increases academic performance.

For the first research hypothesis (RH1), the authors, Pardo et al. (2019) performed a unidirectional ANOVA test between subjects to compare the effects on the level of student satisfaction with the feedback reported in the years 2013, 2014 and 2015. The results suggested that in the 2015 edition, in which personalized feedback was included, there was a significant positive effect on how students perceived feedback. For the second research hypothesis (RH2), the authors performed a t-test of independent samples to compare the intermediate scores of students in the two editions of the course. The result suggested that providing personalized feedback messages in the 2015 edition had a small positive effect on students' intermediate scores. Pardo et al. (2019) concluded that, although the effect of the intervention was not as high on the intermediate score as on the perception of the quality of the feedback, the combination of these two results showed that the proposed approach had a significant and positive impact on the students' learning experience.

## 8. Final Considerations

In this study on the use of Learning Analytics it was possible to evaluate how the student, user of the system, has recovered the information by means of data on the computer. It was noticed, however, that this recovery was less intense and less representative when compared to the recovery of data by other users of educational systems, such as teachers and managers, for example. In both analyzes, it was observed that the student, as a user, still had little access to an effective recovery of what was consolidated throughout the learning process. Concerning the effectiveness of the LA, there was an increased performance in both analyzes with regard to the use of activities and tasks when the student received feedback on one's performance in the general and social learning contexts.

In the analysis carried out with the perspective of adapted learning, the interaction between teacher and student was observed by means of small adaptations made by the teacher in the activities and tasks that already existed on the platform. But the adaptations in the system seemed only to point out which way to

go, within the existing options. It was also noticed that this approach was more focused on the teacher's performance, either when they demanded tasks from students or insisted on students to use the platform due to the approaching assessment period, according to the school calendar. However, the students (as users) received information related to their performance and, thus, could compare their performance with the other performance data provided, such as average class rates and performance per activity.

Regarding the analysis that focused on personalized learning, there was a greater flow of information available to the student, by means of personalized feedbacks. In spite of not being measured, these feedbacks unveiled opportunities for information retrieval, what suggests that there is room to expand in this area and to improve the effectiveness of students' access. Based on these feedbacks, students could take decisions on the most appropriate procedures to continue their study.

This study was limited to the analysis of the impact LA had on the interaction between student and teacher in an adapted learning context and on feedback in a personalized learning context. However, there are still several other impacts and contexts to be analyzed by future research on LA, such as: interaction between students, data security, student-centered platform design, amongst others.

The question in the title of this work reinforces the importance of specifying the “what”, the “why”, the “how”, but above all the “for whom” in Learning Analytics. It is paramount that students not only generate information but also be regarded as users of the generated information; thus avoiding the commonplace of information being institutionally appropriated with no return for the student.

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# **The state of the art of government policy and program evaluation methodologies**

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## **Abstract**

*This research analyzes the conceptual aspects and the state of the art of evaluation methodologies within government policies and programs, based on theoretical and empirical evidence on the subject. This article aims to map the evaluation study and discuss evaluation practices in Brazil, the United States and Europe. It is, therefore, an exploratory and bibliographic research, with a qualitative approach, based on studies indicated in the selected literature. Although the evaluation practices in Brazil are recent and not fully established, the results point out a similarity in the evaluation activities, when compared with the American and European countries. On the other hand, these evaluation practices are still little used in Brazil, which still faces contextual and methodological challenges in the evaluation of public policies and programs, as well as the implementation of continued evaluation policies.*

**Keywords:** Evaluation; Public policies; Governmental programs; Evaluation practices

## **1. Introduction**

The public policy evaluation process is an instrument to verify the effectiveness of government programs. This process is related to issues of effectiveness and performance of public management (RAMOS; SCHABBACH, 2012).

In general, evaluation has become an increasingly common practice in all sectors of society and, consequently, discussed in literature in a very diverse way, considering an area still under conceptual and methodological construction (FARIA, 2005). It is evident the importance and necessity of the evaluation activity in the governmental environment, both as a tool to support management and as a tool to evaluate policies and programs, in order to justify the continuity or redirect public financing (JANNUZZI, 2005). In this sense, Bonifácio et al. (2018) complements that, along the years, the evaluation of public policies and programs started to be considered as an essential activity for the rationalization and optimization of actions and financial resources, in the scope of public management.

In general, the process of evaluation of public policies and governmental programs refers to the planning and structuring of the evaluation activity aimed at understanding the process of execution, results and impacts of a public action, in order to propose improvements and changes needed to improve these actions. (RAUEN et al., 2013)

In Brazil, over the years, the interest in evaluation practices has gained dimension in both governmental

and academic environments. However, there is still some resistance to the dissemination of this practice by the public sector, which for Sá (2020) one of the reasons is the presentation of the results, when questioned about the capacity of the State in the application and management of public resources. On the other hand, the presentation of good results can legitimize the actions and behavior of management (SÁ, 2020).

This article deals with the main conceptual aspects and the state of the art of evaluation methodologies in public policies and government programs, based on theoretical and empirical evidence pointed out in the selected literature on the subject. It also seeks to present a discussion about the relevance of the evaluation of public policies in Brazil and other countries, and its main contextual and methodological challenges faced in the practice of evaluation activity. In this context, this article aims at mapping the study on evaluation and discussing the evaluation practices in Brazil, the United States and Europe, aiming at contributing to the enrichment of studies on the evaluation of public policies and programs.

To carry out the study, an exploratory and bibliographic research was used, with a qualitative approach, based on studies pointed out in national and international literature. And to achieve this objective, the research was divided into four sections, besides this introduction. The second section approaches a brief review of the literature, contemplating the historical context of the evaluation process, its main definitions, criteria and evaluation typologies addressed by scholars of the subject. The third section presents a contribution based on empirical evidence in mapping evaluation practices of government policies and programs, their trends of evaluation studies in Brazil, the United States and Europe. The fourth section presents and discusses the main results of the study on evaluation practices in the national and international scenario, pointing out the main methodologies used, their challenges and needs for improving the evaluation activity of public policies and programs. Finally, the last section brings the conclusion that closes this research.

## **2. Theoretical revision**

This section presents a brief review of the literature, contemplating the historical context of the evaluation process, its main definitions, criteria and evaluation typologies addressed by scholars of the subject.

### ***2.1 Brief historical contextualization***

In the field of public policies, evaluation began to play a relevant role in public administration in the twentieth century and, according to Santos et al. (2017), it began to be disseminated in Brazil and Latin America in the 1980s, in the face of a scenario of economic and fiscal crisis in the world. The authors start from the assumption that with the increase in public spending, the need to evaluate public expenditures arose, in face of budgetary limits and the great demand for government policies and public resources (SANTOS et al., 2017).

According to Faria (2005), the role attributed to evaluation evolved mainly in the 1960s, after the boom in public policy evaluation in the United States. In that decade, the emphasis on evaluation prevailed over the information function, where the main axis was program improvement and managers were interested in using evaluation as a feedback mechanism (TREVISAN; BELLEN, 2008). Until the 1970s evaluations were systematic and only in the areas of education and health, according to Fagundes e Moura (2009). This



type of evaluation was restricted to measuring only the achievement of established goals and to adapting the means to the objectives of public policies and programs. This scenario began to change in the 1980s, when the analysis of public policies experienced a boom due to the country's economic, political, and social situation.

In Brazil, studies on public policies are recent (TREVISAN; BELLEN, 2008) and its first efforts towards the evaluation process began in 1960, with the evolution of the role attributed to the evaluative research that, according to Faria (2005), was put at the service of the state reform and seen as a tool for planning and public management. From then on, the evaluative research provoked a growth of studies in public policies, increasing the number of academic production (articles, dissertations, theses and others), creating disciplines in undergraduate and graduate courses, incentive programs by research, development and innovation promotion agencies, specific lines of research in the area, special lines of funding for promotion and specific forums on public policies (ARRETCHE, 2003). At that time, the field of study of public policy evaluation began to use the scientific basis in a rigorous manner to analyze the solutions to social problems, establishing methodological designs that avoided failures in the evaluation process (SÁ, 2020).

The evaluation process began to gain prominence in 1970. For Bonifacio et al., (2018), at that time the predominant discussion was that of a Brazilian development model, following an agenda of research in the area of municipal public policies and decentralization of these policies. Sá (2020) adds that scholars began to link evaluation with research, generating new knowledge based on long-term causes and strategies on public policies, as well as improving government plans and programs in the short term. In the 1980s, evaluation research was driven by the democratic transition (BONIFÁCIO et al, 2018). In the period between 1980 and 1990, based on previous studies, a more complete theoretical model was sought that presents an integral view of policy, going from design and formulation to implementation, covering not only results but also the general context and actors involved (SÁ, 2020).

With the 1988 Constitution and the various initiatives of interest in public policies in the country, it is noticeable that interest in the subject has increased due to recent changes in Brazilian society (ARRETCHE, 2003) and the awareness of the need to use social science methods in implementation to assess the impact of public policies and programs (CRUMPTON et al., 2016).

In 2004, the Secretariat of Evaluation and Information Management (SAGI) of the Ministry of Social Development (MDS) was officially created, the first body specifically instituted to carry out evaluation activities in public policies, together with the Committee for Monitoring and Evaluation of Federal Public Policies (CMAP), (BONIFÁCIO et al., 2018).

## ***2.2 Main definitions and evaluation criteria***

The evaluation concept goes beyond the need to control, analyze and justify actions and processes for decision making. When related to public policies, the term evaluation brings the concept of measuring results against proposed objectives and goals. For Dagnino et al. (2002), evaluation constitutes an element capable of selecting problems that need to be considered, evaluating their political social importance.

In this context, Crumpton et al. (2016) emphasizes that the analysis of public policies in the evaluation process becomes a set of research tools that goes beyond identifying problems and proposing solutions. The evaluation of policies, programs and government plans is not the final destination, but an important

tool to improve the efficiency of public spending, the quality management and social control of government actions.

In Costa and Castanhar's (2003) view, evaluation is a way to measure the performance, implementation and results of an action, with the purpose of presenting its efficiency, effectiveness, sustainability, impact and the relevance of its objectives. For Cavalcanti (2006), evaluation is therefore considered an instrument to measure and judge actions through a quantification process that allows the demonstration of numerical indicators or scores on what is being evaluated.

In fact, evaluation is an instrument of great importance for decision makers, with the purpose of guiding them as to its continuity, the need for improvements, or even the interruption of an existing policy or program (RAMOS; SCHABBACH, 2012). It is important to highlight that evaluation plays an important role in public sector reforms, as it has been increasingly present in public policy analysis processes.

Moreover, the evaluation process can be understood as a set of techniques adopting different alternatives in order to interpret government actions and investments, especially when dealing with the process of public policy formulation (DAGNINO et al., 2002). In this sense, evaluation is now seen as a tool capable of promoting benefits that will subsidize decision making, beyond the control of public spending.

In the case of public policies, the concept of evaluation admits multiple definitions, some of which are considered contradictory. For Trevisan and Bellen (2008), evaluation is to determine a pertinent action and reach its objectives, its effectiveness, efficiency, impact and development sustainability. Howlett et al. (2013), on the other hand, define evaluation in simple terms: it is the "stage of the process in which it is determined how a policy is actually working in practice". That is, the evaluation process seeks to identify the impacts that policies have on society.

According to Costa and Castanhar (2003), evaluation definitions refer to the systematic and objective examination of a policy, program or project completed or in progress, related to its performance, implementation, results and impacts. Thus, evaluation should be seen as a mechanism for improving the decision-making process to ensure better information on which to base their decisions and better account for public policies (TREVISAN; BELLEN, 2008). These authors also reinforce that the purpose of evaluation is to guide their managers as to the continuity of public policies, the need for improvement or even their discontinuity. In other words, the evaluation process must establish essential criteria to determine the continuity or not of a government policy or program, and can be considered a "set of research tools that goes beyond identifying problems and proposing solutions" (CRUMPTON et al., 2016).

However, it is important to note that the practice of evaluation can contribute to improvements in the planning and formulation of public interventions, as well as in the social control of the efficiency and effectiveness of government actions (CRUMPTON et al., 2016). This practice involves judging the values of a program or policy implemented, with the purpose of providing information that can seek improvement in decision making in the public system. Still according to Crumpton et al. (2016), this process requires the definition of criteria to be adopted and the set of attributes and characteristics considering the extent of the policies or programs to be evaluated.

Table 1 presents the main criteria to be used in the process of evaluating programs and public policies.

Evaluation Criteria	Definitions
Efficiency	Relationship between the results and the costs involved in the execution of a project or program.
Efficiency	Measure of the degree to which the program achieves its objectives and goals.
Impact (or effectiveness)	It indicates if the project has (positive) effects on the external environment in which it intervened, in technical, economic, socio-cultural, institutional and environmental terms.
Sustainability	Measures the ability to continue the beneficial effects achieved through the social program after it has ended.
Cost-effectiveness analysis	Similar to the idea of opportunity cost and the concept of relevance; the comparison of alternative forms of social action to obtain certain impacts is made in order to select the activity/project that meets the objectives with the lowest cost.
Satisfaction of the beneficiary	It evaluates the user's attitude towards the quality of the service that the program is getting.
Equity	It tries to evaluate the degree to which the benefits of a program are being distributed in a fair and compatible way with the user's needs.

Source: adapted from Ramos and Schabbach (2012), Brotti and Lapa (2007), Costa and Castanhar (2005), Cotta (1998)

The evaluation process requires a way of measuring and judging the performance of programs and public policies, and it is essential to define criteria for evaluating the results obtained (COSTA; CASTANHAR, 2003). These authors highlight the importance of selecting appropriate evaluation criteria, which vary according to what is specified in the process.

In this sense, Costa and Castanhar (2003) reinforce that the application of these evaluation criteria depends on operationalization to identify and quantify the results obtained in the process, which can be done by means of evaluation indicators, allowing the measurement of the achievement of predetermined objectives. In this sense, Cotta (1998) highlights that the selection of criteria varies according to the type of evaluation and the phase of the evaluation process in focus.

### ***2.3 Types of evaluation of public policies and programs***

The evaluation should provide information that is possible and useful to enable the incorporation of the experience gained into the decision-making process. It is observed that, in the face of this statement, the process of evaluation demands to reflect, plan and reach proposed objectives, with the purpose of bringing the understanding that evaluation research is articulated to the educational, social and political process of a country.

In literature this subject is quite vast and a theme of such complexity. For Cavalcanti (2006) the types of evaluations seek to respond to the problems of formulation and implementation of public policies and government programs, offering effective subsidies for decision-making.

The evaluation typologies are found in different forms of classification in the literature, considering the position of the evaluator, the nature of the evaluation, the evaluation methodology, the time of its completion and the question to be answered (CUNHA, 2018; SANTOS; RAUPP, 2015; SIMÕES, 2015; RAMOS; SCHABBACH, 2012; PATTON, 2008; COTTA, 1998).

Using the evaluator's position criteria - who evaluates and who participates in the evaluation process - external, internal, mixed and participatory evaluations are classified. The external evaluation is carried out by specialists who do not belong to the institution executing the program being evaluated, usually professionals who have experience in this type of activity. Despite not having specific knowledge about the program, the external evaluator usually tends to maintain its neutrality, objectivity and impartiality during its evaluation (RAMOS; SCHABBACH, 2012; PATTON, 2008).

When the evaluation process is under the responsibility of the institution executing the program, it is called internal evaluation. This type of evaluation is performed by professionals belonging to the managing institution, with the collaboration of people who participate in the program. In this case, when the professionals are directly linked to the program management and execution, Cavalcanti (2006) calls this operation self-evaluation -considering a subtype of internal evaluation- where the evaluators examine their own activities and may not be entirely objective and impartial. The author reinforces that the internal evaluation must be "performed by professionals who are part of the institution responsible for the program, but who are not effectively involved in its execution" (CAVALCANTI, 2006).

In the case of mixed evaluation, as the name already says, it combines the two previous types, considering the participation of external and internal evaluators, working together or independently (CUNHA, 2018), in an attempt to balance the unfavorable conditions and reinforce the favorable ones of the evaluation process (CAVALCANTI, 2006). The participative evaluation, on the other hand, foresees the beneficiaries' performance in the planning, execution and evaluation of actions. For Simões (2015), this type of evaluation does not seek to provide specific information on the impact of a government policy or program, but rather on the perception of the participants.

In relation to the nature of the evaluation - as to its purpose - it can be classified as formative or summative. The formative evaluation is related to the formation of the policy or program and seeks the generation of knowledge to structure and identify improvements in its implementation process. The information generated helps those who are directly involved, providing elements to make corrections to procedures to support and improve the process (CUNHA, 2018; SIMÕES, 2015; TREVISAN and BELLEN, 2008). Summative evaluation refers to the analysis and production of information on both the implementation and previous steps. The information is generated during the execution of the policy or program with the purpose of ascertaining its results, assessing whether its objectives are being achieved and how much it is adding value to society (SIMÕES, 2015; RAMOS and SCHABBACH, 2012).

As far as methodology is concerned, evaluation is classified into qualitative and quantitative models and the difference is more in the type of data than in the design (WEISS, 1998). Qualitative evaluation refers to what cannot be measured. The qualitative research seeks to provide an evaluation of scientific research, with the most descriptive and exploratory character. For Simões (2015), this model acquires relevance by analyzing processes, cultures and behaviors in specific contexts and social perceptions about intervention to the detriment of measuring its results, focusing on the subjectivity of the objective to be analyzed. Ramos

and Schabbach (2012) consider an evaluation mechanism relevant to the analysis of policies and program management, as well as the institutions that execute them.

The quantitative evaluation refers to what can be quantified, presented through numbers and information. For Ramos and Schabbach (2012), this model is a scientific method that adopts the collection and processing of statistical and econometric data and methods in order to quantify information about a given program. The quantitative research seeks to analyze the problem situation, the evolution of indicators, the goals and results of the program and the evolution of the social, economic and environmental picture in the time space (SIMÕES, 2015).

When it comes to the time of its realization, the evaluation studies differ in *ex ante*, in *itinere* and *ex post*. The *ex ante* evaluation is performed before the program starts, in order to support the decision to implement it or not (CUNHA, 2018). The main information of this modality of evaluation is the diagnosis, helping the allocation of resources according to the objectives proposed by the program. In addition, Ramos and Schabbach (2012) emphasize that this evaluation model uses techniques of cost-benefit and cost-effectiveness analysis of the programs. The authors reinforce that these techniques can collaborate with the decisions of the programs even before their implementation.

The *in itinere* or *itinerary* evaluation is performed during the program execution process. Its objective is to verify if the governmental actions implemented through the programs are generating expected results and if it is necessary to make some adjustments or adaptations in the program being monitored (SOBRAL; SANTOS, 2018)

And finally, the *ex-post* evaluation that is carried out during the execution of a program or after its conclusion, when decisions are based on the final results achieved (RAMOS; SCHABBACH, 2012). In this type of evaluation, evidence is sought to support whether the program being executed has continuity or not, should be maintained in its original format or undergo modifications, based on the results obtained up to the time of evaluation. According to Cunha (2018), the *ex-post* evaluation is the most methodologically carried out and has the greatest application lately. In this case, if the evaluation is of a program already concluded, the relevance of reproducing the experience in the future is analyzed (SIMÕES, 2015).

Regarding the question to be answered - what is evaluated - the modalities of process evaluation, results and impacts are classified. The evaluation of processes is carried out during the implementation of a program and refers to the management dimension (CUNHA, 2018). According to the authors Ramos and Schabbach (2012) and Cunha (2018), this is a modality of periodic evaluation, which seeks to detect the obstacles that occur during its process, with the objective of making corrections and adjustments, serving as a support to improve the efficiency of the program's operationalization.

The evaluation of results aims to assess the intermediate results of the intervention and seeks to identify to what extent the program has achieved its objectives. In addition, it presents its effects and consequences and if there was any change in the problem situation that originated the preparation of the program, after its implementation (RAMOS; SCHABBACH, 2012).

In the evaluation of impacts, the focus is on the return on investment. This type of evaluation seeks to measure the effectiveness of the program or public policy, as well as verify whether the final results with society meet what was proposed, that is, whether it produced the effect it expected (CAVALCANTI, 2006).



For Cotta (1998), the difference between the evaluation of results and impact evaluation depends on the purpose of the analysis:

If the objective is to inquire about the effects of an intervention on the clientele served, then it is an evaluation of results; if the intention is to capture the reflexes of this same intervention in a broader context, then it is an evaluation of impact (COTTA, 1998, p. 113).

The evaluation of results refers to the analysis of effectiveness, that is, whether the program or policy has been implemented in accordance with the guidelines established for its execution and whether it has achieved the proposed goals. The evaluation of impacts refers to the effects of the program or policy on society as a whole (SILVA et al., 2016).

For Cunha (2018) the evaluation process is conducted from a specific point in the life cycle of a policy or program, and consists of in-depth research in order to verify whether what was originally planned was effectively met, especially regarding its effectiveness, efficiency and effectiveness. In the public policy cycle, evaluation is at the last stage, where results are presented and the entire process is reviewed in order to improve policies (BONIFÁCIO et al., 2018).

### **3. Empirical evidence**

This section presents a contribution based on empirical evidence in mapping evaluation practices of government policies and programs, their trends from evaluation studies in Brazil, the United States and Europe.

#### ***3.1 Policy and program evaluation practices in Brazil***

The practice of evaluation has become increasingly important at the governmental level, both to subsidize management support tools and to evaluate policies and programs in order to justify their continuity, the need for improvements and the redirection of financing, when appropriate.

In order to contribute to the strengthening of the evaluation agenda and to know how the evaluation practices of International Cooperation projects in Brazil<sup>1</sup> work, Costa (2018) presents a study that investigates how public agents see the evaluation process, how they carry out this activity, the types of evaluations and methods used, the use of their results and their perspectives. This research provides an overview of evaluation practices and seeks to contribute to the discussions in the field of evaluation (COSTA, 2018). Thus, the author brings a broad knowledge on the subject and emphasizes the maturation of evaluation activities, their new methods and the advancement of new practices in the country.

Involving the international scenario, Crumpton et al. (2016) point out a study that compares the practice of evaluation of public policies carried out in Brazil and in the USA, with the objective of presenting the degree of establishment of research in evaluation in these countries. The authors used methods of bibliometric analysis, comparing academic articles published in the last 10 years. Among the results of the study, they point out that the two countries have been acting in research and publication in the same areas of knowledge, especially in the field of health, education and social welfare, using the same methods of

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<sup>1</sup> Carried out by the Federal Government and some national institutions that are also part of the Brazilian cooperation



data analysis as well. In addition, the study highlights the consolidation of research in evaluation in the USA, both in the field of study and in practice. Unlike Brazil which, although there is evidence of advances in research and an effort by Brazilian researchers, the country is not yet with this practice fully established (CRUMPTON et al., 2016).

Considering the Brazilian government demand, Sobral and Santos (2018) present a study of three cases of evaluation of public policies in C,T&I, which served as a basis for developing a methodological proposal for ex ante evaluation, that is, before implementation, evaluation in itinere, which occurs during the execution process, and ex post evaluation, after implementation, from the perspective of subsidizing government actions and propose recommendations for improvement and continuity in public policies (SOBRAL; SANTOS, 2018).

In this context, Cunha (2018) brings a discussion about the evaluation practices in the scope of the Multiyear Plans of Brazil, adopted by the federal government and the state of Rio Grande do Sul and their contributions to decision making in the implementation of programs and public policies. In this study, the author characterized it as an intermediate evaluation practice, of a formative nature, mostly conducted internally, with the objective of assisting managers on the need for improvements in the operationalization of programs. In this way, the author emphasizes that in this evaluation model the focus ends up being only on the results of the programs and not on the impacts of government actions on society. Both levels of government have noted the need for advances in the evaluation system, especially in terms of integration between the evaluation and monitoring processes, and some stages of the public policy cycle (CUNHA, 2018).

Rossi et al. (2004), proposes a complete research study, based on the logical design of intervention in the practice of evaluation of public policies, called "life cycle of programs". This design contemplates a comprehensive evaluation plan, with emphases in the investigation of the program implementation process (Program Process Assessment), in the evaluation of its impacts and results (Impact Assessment) and finally, in the evaluation of efficiency or cost-effectiveness (Efficiency Assessment) (ROSSI et al., 2004). Based on this proposal, Jannuzzi (2011) presents a conceptual and methodological contribution of monitoring systems and evaluation studies of government actions, specifically in the management of social programs in Brazil. For this author, the monitoring and evaluation processes complement each other and should be carried out in accordance with the maturity stage of the program to be evaluated, regardless of the types of research. This research proposal is presented as a technical-scientific undertaking, using social research methods throughout the "life cycle" of public programs (JANNUZZI, 2011).

### ***3.2 Evaluation practices: international analysis***

The United States and Europe are highlights in public policy evaluation studies. In addition, these countries are considered benchmarks in evaluation practices, especially when it comes to policies to encourage innovation in companies, as is the case of economic subsidy programs also executed in these countries.

For Vedung (2010), historical advances in the evaluation process have reached countries at different times and with different intensities. In this context, the author points out that the development of the evaluation initially took place in the United States, where he began the study in the area of public policies.

In the USA, the analysis of public policies and programs occurs, at the same time, both in the governmental

and academic spheres (BONIFÁCIO et al., 2018). In the governmental sphere it is traditionally practiced at the three levels: federal, state and municipal. The evaluation activities are carried out on a large scale, in a systematic way and practiced by agencies that are in charge of the implemented programs (CUNHA, 2018).

The American evaluation practice is conducted by central agencies such as the Government Accountability Office (GAO), the government agency responsible for evaluation. Evaluations are conducted by external experts, called ad hoc, and/or program managers, in order to examine the performance of public policies, both in the achievement of their objectives and in the context in which this occurs (CUNHA, 2018). Aiming to support the evaluation process, Ramos and Schabbach (2012) emphasize that the U.S. government seeks to insert in the agencies the participation of university researchers and consulting firms. This joint effort aims to develop more in-depth studies and propose new policies.

The World Bank, the United Nations (UN) and the Organization for Economic Cooperation and Development (OECD) are international organizations that have a primary role in structuring and strengthening institutionalized evaluation practices (RAMOS; SCHABBACH, 2012) and have a tradition of evaluating programs to encourage innovation, such as Small Business Innovation Research (SBIR) and Technology Innovation Program (TIP), developed in the United States and considered one of the most important in the world (LEAL, 2018; VARELLA, 2013).

Europe has also developed a study identifying and using practices of innovative evaluation methodologies, with multi-sectoral coverage (OLIVEIRA; PASSADOR (2019). In European countries, the evaluation practice is similar to that of the United States, which has sought to develop metrics, based on contextual and econometric studies, to compare the relationship between investments in innovation programs and policies (spending on RD&I) and the impacts on economic development (increased productivity and wealth) of a given region (LEAL, 2013).

Edler et al. (2012) analyze evaluation practices in national innovation policy across Europe, drawing on the Repository<sup>2</sup> of 171 evaluation reports within the European Union, in an attempt to compare evaluation profiles from different perspectives. The study sought to understand the real needs and discuss the practices of the evaluation process in a comparative manner, following a distinct methodological approach, using meta-evaluation and meta-analysis techniques to evaluate the overall design, implementation and its functionalities in order to learn about the evaluation itself (EDLER et al., 2012, p. 4).

The international scenario brings relevant experiences and indicated the need to establish an institutionalized structure for the realization of evaluation practices and, in the conception of Bonifacio et al. (2018), these practices should involve specific concepts and techniques that should be part of the whole evaluation process. In this way, international experiences can provide input to the evaluation process for decision-making before, during and after the execution of programs and policies in Brazil.

## **4. Results and discussions**

This section presents and discusses the main results of the study on evaluation practices in the national and international scenario, pointing out the main methodologies used, their challenges and needs for improving

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<sup>2</sup> INNO-Appraisal database, developed by the University of Manchester, funded by the European Commission.

the evaluation activity of public policies and programs.

#### ***4.1 Main types of evaluation and analysis techniques used***

The main studies refer to a diversity of methodologies that evaluate the effectiveness of programs and public policies. According to the national and international experiences presented, it is noted that the main interests of the current evaluation practices are "results, rational budget allocation and reorganization of programs in order to achieve planning objectives" (CUNHA, 2018, p. 54).

In order to know how the evaluation practices of International Cooperation projects work in Brazil, Costa (2018) used the online survey methods and semi-structured interviews to analyze eight dimensions of the Brazilian international cooperation evaluation area, among them the use of evaluation as a regular practice, the types and methods of evaluation used and the use of the results. In relation to the frequency of the evaluations, the research has revealed that 39,1% of the institutions maintains the evaluation practice, 21,7% has an expressive evaluation activity and that only 8,6% realizes this activity in an intense way. For the author, this reveals a heterogeneous scenario in the evaluation process of the organizations.

About the type of evaluation used, it was noticed a predominance of internal evaluations (48%), followed by external evaluations (22%) and mixed evaluations (17%), which approximate internal and external evaluators at the same time. Although the study presents a predominance of internal evaluation, Costa (2018) corroborates the importance of external evaluation bringing to the institution a differentiated view of the program or policy and an analysis with more impartiality, without any institutional link and bureaucratic conflict (SOBRAL; SANTOS, 2018) Regarding the methods used, Costa (2018) presented a predominance in the use of mixed methods (quali-quant) (52%), only qualitative (22%) and quantitative (10%). It also reinforces that qualitative methods are those that provide more subsidies for improvements, as well as better explain the results presented.

Another highlight of the survey was the use of the results of the final evaluations, used in large part to subsidize new partnerships and the elaboration of future projects and, on the other hand, the low dissemination of the results to society (COSTA, 2018).

In view of the results presented in the Costa (2018) study, it is noted that there is no systematic evaluation of the products generated, in general, in the organizations, but there is an effort to improve evaluation practices, considering necessary to justify the contribution of resources and the continuity of actions. The author reinforces the existence of institutions that are maturing in the field of evaluation, with some experiences considered successful in the area of evaluation of Brazilian international cooperation, but emphasizes that there is no exchange of these specific experiences in evaluation (COSTA, 2018).

Still in the national scenario, Sobral and Santos (2018) conducted an experiment involving three procedures for evaluating public policies in the area of Science, Technology, Innovation and Education (C, T, I&E). In this study the authors proposed methodological models aimed at evaluating the types *ex ante*, *in itinere* or *itinerary* and *ex post*. The first procedure consists in the analysis of the Strategy for Expansion of Higher Education in Brazil, previously evaluating the public policy before its implementation, using the *ex ante* evaluation type. In the following procedure, the *in itinere* or *itinerary* type of evaluation was used, in order to verify the progress of the execution of the Professional Master's Program in National Network Mathematics, that is, if the expected results were being generated and if they needed to adopt improvements

during its execution. Finally, in the third model, an ex-post procedure was carried out in order to evaluate the results and impacts of the Brazilian Public Schools Mathematics Olympiad after its implementation (SOBRAL; SANTOS, 2018). The experience with the elaboration of the three methodological models allowed the authors to present recommendations and essential evidence for the cycle of government programs to promote C, T, I&E, as well as the evaluation of their public policies.

On the other hand, Santiago et al. (2015) present a methodology focused on the evaluation of a patent portfolio for licensing purposes. This methodology is divided into two macro-phases: classification and technology evaluation. In the first stage, potential markets for the technology are assessed, considering the eligibility for patent licensing (i.e. whether it can be licensed). The second phase is a logical sequence of the classification phase to define licensing fees in which company patents and patents licensed by other companies in the same industry are analyzed to use them as a benchmark. Although robust enough, the methodology of Santiago et al. (2015) is focused on the technology licensing process from an existing portfolio within the organization itself. This makes it difficult to apply to organizations without a patent portfolio that is consistent with the analysis one intends to undertake.

In the United States, innovation incentive programs are traditionally evaluated. In methodological terms, the evaluation practices of Small Business Innovation Research (SBIR) and Technology Innovation Program (TIP) can also be applied to other programs, considering the following elements: i. statistical analysis or econometric studies; ii. research based on beneficiary case studies; and iii. research based on social rate of return case studies (LEAL, 2018, p. 92). For the author, the evaluation seeks to understand the scope of innovations and commercialization, on the part of the beneficiaries, through data made available by the program's funding agency. It also seeks to evaluate the capacity to stimulate entrepreneurship and its economic and social impacts on American society.

Link and Scott (2009) evaluated the contributions of the SBIR program, in the short and long term, within the companies that received the incentive in the last ten years. In this study, specific contexts, databases and performance indicators of the program and the probability of commercialization of the product or process were explored, adopting the method of analysis of ordinary least squares (SILVA, 2013). Other studies present a diversity of methods for evaluating U.S. policies and programs, involving the evaluation of efficiency, ordinary least squares method, analysis of input and output variables, fixed and dynamic models and regression analysis (LINK; SCOTT, 2009; SILVA, 2013).

Cunha (2018) and Edler et al. (2012) highlight that the European Union recommends the practice of institutionalized evaluation, mainly in areas of P,D&I and in programs promoted by Structural Funds<sup>3</sup>. Thus, the evaluation activity becomes an integral part of innovation policy in European countries. The design and evaluation reflect the terms of the program formulators, where 90% of the evaluations are carried out by those responsible for the operationalization of the program (internal evaluation), and 10% are internal and external evaluations at the same time, designed in the annual evaluation plan of this particular program (EDLER et al., 2012).

In Europe, the analyses presented in the study by Edler et al. (2012) show a considerable degree of uniformity between evaluations. Regarding the moment of evaluation, the authors point out that 40% of

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<sup>3</sup> More than 20% of the assessments presented in the Repository are carried out in the context of the European Structural Funds.

the evaluations are intermediate (in itinere), 30% ex post and 30% in both moments. The ex ante evaluation does not appear in the analysis. Most of the evaluations combine formative and summative nature (50%), 30% are only formative and 20% summative, which are directly related to the characteristics and methods applied. For the authors, although the formative evaluation is the most recommended by specialists, because it brings more the context, the consistency and the process of the program, it is the summative evaluation that leads to a broader discussion and a more definitive adjustment for the program or policy studied (EDLER et al., 2012). In this case, the authors suggest that for a better quality evaluation, approaches and purposes of formative and summative nature should be combined.

On the other hand, Santiago et al. (2015) present a methodology focused on the evaluation of a patent portfolio for licensing purposes. This methodology is divided into two macro-phases: classification and technology evaluation. In the first stage, potential markets for the technology are assessed, considering the eligibility for patent licensing (i.e. whether it can be licensed). The second phase is a logical sequence of the classification phase to define licensing fees in which company patents and patents licensed by other companies in the same industry are analyzed to use them as a benchmark. Although robust enough, the methodology of Santiago et al. (2015) is focused on the technology licensing process from an existing portfolio within the organization itself. This makes it difficult to apply to organizations without a patent portfolio that is consistent with the analysis one intends to undertake.

In the United States, innovation incentive programs are traditionally evaluated. In methodological terms, the evaluation practices of Small Business Innovation Research (SBIR) and Technology Innovation Program (TIP) can also be applied to other programs, considering the following elements: *i.* statistical analysis or econometric studies; *ii.* research based on beneficiary case studies; and *iii.* research based on social rate of return case studies (LEAL, 2018, p. 92). For the author, the evaluation seeks to understand the scope of innovations and commercialization, on the part of the beneficiaries, through data made available by the program's funding agency. It also seeks to evaluate the capacity to stimulate entrepreneurship and its economic and social impacts on American society.

Link and Scott (2009) evaluated the contributions of the SBIR program, in the short and long term, within the companies that received the incentive in the last ten years. In this study, specific contexts, databases and performance indicators of the program and the probability of commercialization of the product or process were explored, adopting the method of analysis of ordinary least squares (SILVA, 2013). Other studies present a diversity of methods for evaluating U.S. policies and programs, involving the evaluation of efficiency, ordinary least squares method, analysis of input and output variables, fixed and dynamic models and regression analysis (LINK; SCOTT, 2009; SILVA, 2013).

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Regarding data analysis, the study refers to a variety of evaluation methods. Some evaluation practices of limited use, such as advanced quantitative approaches, such as: and input and output analysis (26%), econometric analysis (23%), cost-benefit (23%), counterfactual (22%) and control group (20%). On the other hand, studies involving more simplified qualitative approaches are observed, such as simple descriptive statistics (76%), context analysis (67%), document analysis (52%) and case study analysis, considering the most used method for data analysis (EDLER et al., 2012).

Regarding data collection methods, Edler et al. (2012) states that the evaluative analyses were performed through monitoring data (80%) and existing databases (70%). Other data collection methods were interviews and surveys with program participants. Bibliometric and techno metric surveys are little used methods (2%) in data collection. For the evaluation of results, whether short or long term, specialized knowledge in the area and analysis by peers, which are very relevant when it comes to the evaluation of innovation programs, are necessary.

It is also noticeable that in the empirical literature, both national and international, the proposals for evaluative analysis use methodologies involving several typologies, and foresee the evaluation of processes, results and their impacts (CUNHA, 2018).

#### ***4.2 Main challenges encountered***

Every evaluation process ends up having to face a series of challenges, whether conceptual, contextual or methodological (COSTA and CASTANHAR, 2003). In other words, in any kind of evaluation, the conduction of an evaluation process of policies or programs of innovation requires, in fact, the confrontation of specific challenges, which can be either in the methodological, conceptual or practical aspect (RAUEN, 2013).

In fact, the challenges and implications for the development of evaluation methodologies present some particularities and differentiated needs. In this context, Rua (2010) presents a series of challenges to be faced when applying an evaluation, among them: i) dealing with the limitations related to the main sources of information from administrative records; ii) another source of information are the beneficiaries, from which direct data is obtained; iii) it is essential to evaluate the contexts; iv) open the possibility of evaluating unanticipated results; v) evaluation be able to absorb changes over time, feeding back into policies, programs and projects; and vi) open the possibility of innovation-oriented evaluation (RUA, 2010, p. 2-3). For Rauen (2013), these challenges alter not only the coherence of the evaluation, but also the evaluation process itself. From the same point of view, Costa and Castanhar (2003) state that the practice of evaluation



in the public sector is considered a major challenge, especially with regard to defining practical ways to measure the performance of the program and provide this information for its management, as well as for other agents involved. This information is considered useful for evaluating the effects of public programs, their need for correction, or even the interruption of the program if it presents a negative effect (COSTA and CASTANHAR, 2003).

Santos and Raupp (2015) emphasize that, despite efforts to develop useful information that can be used to review and correct government policies, programs and plans, the monitoring and evaluation process remains a major challenge for public management.

It is worth pointing out that the evaluation process represents a strategy of mutation in the managerial model of public management. According to Rua (2010), this strategy causes policies and programs to be evaluated for compliance with their goals and objectives. The author also reinforces the importance of its managers to naturally encourage these strategies, in order to make use of the information himself, seeking a good monitoring of their performance as compared to their objectives.

It is relevant to note that the growing challenges in evaluation practices have led to the investigation of new perspectives for the evaluation process of its impacts, so that a new generation of methods, techniques and tools seems to be emerging from the need to make the challenges come from the complexity of the theme (SANTOS et al., 2004).

Another challenge presented by Santos and Raupp (2015) refers to the achievement of a direct link between the results achieved through policies or programs and government strategy and with the goods and services offered to society. Still according to the authors, the monitoring and evaluation proposal opens a path that makes it possible to follow the physical and financial goals proposed in the PPA in a format that does not require a high degree of detailing of the planning instruments, avoiding budget reallocations during financial years (SANTOS; RAUPP, 2015).

In this concept, Rauen (2013) identifies three major challenges for the evaluation of policies and programs to promote innovation in Brazil. These challenges are faced by both *ex ante* and *ex post* evaluations. Even if described separately, the challenges are not independent of each other. In fact, each challenge influences the others, feeding back into the evaluation difficulties.

For Rauen (2013), the first major challenge refers to the use of indicators, both of results and impact. For the author, in Brazil there is still a great deal of confusion regarding definitions and the dynamics of the innovative process itself. The second challenge is associated with understanding the cause and effect relationship between public intervention and the observed result or impact. And the third challenge is an object of research in the sociology of science and technology and concerns the aversion to the evaluation of research activities by individuals outside the academia (RAUEN, 2013).

When it comes to new indicators, the challenge is to think about how to obtain data to compose the baseline of indicators selected to express each result or performance (RUA, 2010). In this sense, Ramos and Schabbach (2012) state that one of the main challenges of the evaluation is to demonstrate that the results found are causally related to the products offered by the policy or program. In other words, the challenge is to define the scope of the evaluation, its objective, who should be involved and, finally, how to build an evaluation and decision process that leads to effective results (CUNHA, 2018).

For Jannuzzi (2011), better structuring the systems of monitoring and evaluation indicators, as well as

specifying more consistent evaluation surveys, are considered challenges that need to be quickly addressed at the three levels of government (federal, state and municipal). In addition, methodological difficulties eventually lead to the use of indicators that apply predominantly to aspects of policy or program production, in achieving the proposed goals or objectives (COSTA; CASTANHAR, 2003).

Another important challenge concerns internal capacity building and effective participation of managers in the debate on methodologies and results of the evaluation process. Managers who are at the forefront of implemented policies need to be clear about which questions they intend to answer in relation to the policies that will be evaluated, which are the best indicators and methodologies to answer these questions, and which information needs to be generated for this purpose (DE NEGRI, 2013). It is relevant to note in this regard the challenges and possibilities of operating an evaluation methodology that takes into account the nature of the program and the means available (COSTA; CASTANHAR, 2003).

For De Negri (2013), one of the main challenges for the implementation of a monitoring and evaluation policy in public institutions is to integrate these activities within a systematic and routine planning that makes it possible to continue the process of evaluation of C, T&I policies, as well as the exchange of experiences between the different evaluations carried out.

Finally, it is important to emphasize that the implementation of systematic evaluation in public policy processes involves great challenges. On one hand, the contextual and methodological challenges inherent to the evaluation of policies and programs. On the other hand, the institutional challenges in the implementation of a continuous evaluation policy (DE NEGRI, 2013).

## **5. Conclusion**

The search for greater effectiveness and economy of public policies and the greater capacity of the government to meet society's demands and needs has made the insertion of the evaluation process in the management cycle of government policies and programs increasingly important. When carried out in a systematic, integrated and institutionalized manner, the evaluation practice shows the efficiency of public resources. It identifies the possibility of improvements in the process and results, directly contributing to public management development and improvement.

Several studies refer to various experiences in evaluation, both national and international, to provide a critical reflection on the evaluation practices in the governmental scope and discuss the most used approaches, concepts, techniques, and evaluation methods, allowing a better standardization for public policy evaluation routines.

This article aimed to map the study on evaluating public policies and government programs and discussing evaluative practices in Brazil, the United States, and Europe. For this, the conceptual aspects, the typologies and techniques of analysis, and the state of the art of the methodologies for evaluating public policies and programs were analyzed based on theoretical and empirical evidence pointed out in the studied literature. When analyzing the evaluative practices pointed out in the national and international scenario, it is observed that the evaluation process goes beyond identifying problems and proposing solutions, requires an in-depth and specific study of the life cycle of the policy or program, where the results are presented, and the entire process must be reviewed before (*ex ante*), during (*in itinere*) and after (*ex post*) its implementation.

(SOBRAL; SANTOS, 2019; BONIFÁCIO et al., 2018; CUNHA, 2018, EDLER et al., 2012). The authors defend the importance of using appropriate and specific methods and techniques for carrying out the evaluative activity, aiming at a more accurate and intense investigation.

In Brazil, evaluation practices are recent and little used, besides facing contextual and methodological challenges in the evaluation of public policies and programs and the implementation of continued evaluation policies. Unlike the United States and Europe, the analysis and evaluation of public policies and programs are old practices in developing public policies and worked systematically and continuously.

There is a growing search for evaluative activities in the American and European experience and a degree of uniformity of evaluation designs. Generally, this process is developed in an institutional structure, involving specific concepts and techniques. What is no different here in Brazil, when the evaluation methods are compared, the results point to a similarity in these evaluative activities.

The study also demonstrates that, although there is a wealth of evaluative practices in the international environment, with successful experiences and maturation of specific institutions for this purpose, there is little exchange of experiences between countries (COSTA, 2018). In this sense, Bonifácio et al., 2018 reinforce the importance of stimulating exchanges between them to discuss recommendations and good evaluation practices. The authors defend the creation and structuring of research networks involving research institutions, universities, and the governmental sphere (CRUMPTON et al., 2016). Besides, they suggest developing strategies for the dissemination of collected data, the methodologies performed and the sharing of information obtained (COSTA, 2018; CRUMPTON et al., 2016).

Finally, the studies pointed out that Brazil's evaluative practices are recent and are not fully established, despite the results pointing to a similarity in the evaluative activities compared with the American and European countries. On the other hand, these evaluation practices are still little used in Brazil, which still faces contextual and methodological challenges in evaluating public policies and programs and the implementation of policies for continuous evaluation.

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# **ECOLOGIZING KNOWLEDGE, REVERBERING FOR TEACHING BEING-DOING IN (POST)PANDEMIC TIMES**

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## **Abstract**

*We present results of a study about the challenges of teaching practice in the context of the pandemic that we lived in 2020. We take complex thinking as the guiding thread to ecologize knowledge and establish relationships and reflections with the voices of female and male teachers in the basic education network that worked with this scenario. In this context, ecologize has the meaning of knowing oneself and the other, based on conceptual pluralities and valuing life. The methodological path was inspired in Bernard Charlot's methodological instrument (2009) for the generation and understanding of the voices of female and male teachers who lived the investigated daily life. The aforementioned instrument, called "balances of knowledge", allowed the analysis of the data generated, which is represented in a picture, a word cloud where the meanings of being and teaching in the path of the year of the pandemic lived are, the main voices being expressed: ecologize, emergency, digital technology, learning, feelings, meaningful,*

*innovation, learning, fabrics, possibilities and transformation. The interconnections between these voices and the theoretical concepts outlined in the study reverberate movements towards the knowledge of the self, giving meaning, with activation of complex thought networks, that the image of the figures that we present may signal new ways to face the challenges of the situations experienced.*

**Keywords:** Ecologies of knowledge. Balances of Knowledge. Emergencies. Self-knowledge. (Re)drawings of teaching practice;

## **1. Introduction**

This paper aims to reflect on education in times of (post)pandemic, considering the context arising from the social isolation triggered by COVID-19. This context, in the school reality, is characterized, among other aspects, by the physical distance between teachers and students. Thus, the teacher is challenged to deal with this scenario in order to carry out his teaching action, in which uncertainties and urgencies permeate her/his practice. Their students are at home and likewise live with uncertainties and fears. The demands that appear do not seem to be answered by the beliefs and activities in progress. What was being done seems not to be sufficient to account for what is presented; new challenges and perspectives in relation to current knowledge are presented. In this sense, we can think that the pandemic gives rise to a process of reorganization of the current practices.

Thus, we live in a moment of crisis, of a certain malaise in society, signaling the need for a redimensioning of beliefs. Morin (2005) argues that situations that emerge at the heart of society come from the subjects' ways of being and proposes a path, based on the understanding of the complexity of the human experience traced by self-analysis, self-criticism and self-responsibility.

We start from the assumption that, in order to understand and bring about alternatives for overcoming, we need an ecologization of knowledge, based on a system that can enable the emergence of transformations. According to Tardif, "(...) the relationship of teachers with knowledge is not reduced to a function of transmitting knowledge already constituted. Their practice integrates different knowledges, with which the faculty maintains different relationships. It is possible to define teaching knowledge as plural, formed by the amalgam, more or less coherent, of mastery from professional training and disciplinary, curricular and experiential knowledge". (TARDIF, 2012, p. 36).



Figure 1

OLIVEIRA, Lucila Guedes. *Redes construídas*, 2020.

That thought marks the place of understanding of their practice, reverberating the expertise and know-being. Given these considerations, the study we present, of a qualitative nature of the phenomenology of complexity, with the method of Bernard Charlot (2000), for the process of understanding the feelings of teachers in contemporary time, seeks to express ecologies of knowledge, in order to weave a network of concepts to rescale the concept of being a teacher, conceiving it from yourself.

Paulo Freire (1996) points out that the world is not. It is being on the path that is underway, considering the time and space in which the subject is inserted. Thus, we take Figure 1 as a mobilization, in order to trigger a more critical look, a reflexive attitude, understanding what it reveals and the feeling it brings us. Therefore, consider that an image has its meaning and expresses a message.

According to Carney and Levin (2002), the image in favor of reflexive learning in relation to teaching is an important complement to the interpretation and perception of the subject, facilitating the process of learning, since an abstract concept becomes associated with a graphic element. And, according to Blight (1998), the image can bring benefits, not only for the student, but also for the teacher, with visual perception of the studied concepts. What does the image in Figure 1 reveal to us? What does it instigate us? How does it touch us? Does it disturb? Like the pandemic, it can be understood as encouragement for resizing, so we propose that this image can be an inspiration to think about ways of transforming current practices.

Therefore, we call attention to the relationship with current knowledge and the image: that expectations and judgments concern over, at the same time, the meaning and the social function of knowledge and school, the discipline taught, the learning situation and ourselves (CHARLOT, 2000). The relationship with knowledge is the correlation with the world, it is the (organized) set of relationships that an individual maintains with everything related to 'learning' and knowing with the other and with

her/himself; it is, therefore, the relationship of a human being confronted with the need to learn (CHARLOT, 2000).

In other words, in the face of what we are experiencing, because of the current moment of the pandemic and of what the image presents us, inspires, unleashes, what emerges? What ecologies can we build between what we know and live and what the image inspires and instigates us?

The built networks are an image that invites us to dialogue about possible and persistent constructions in the complex fabric of education. The hands that open up to the new create scenarios of multiple experiences of knowledge for the (re)invention of education in the pedagogical plan. The lines are drawn and redrawn in the space created by the movement of the hands. Forms are self-organizing systems. Learning in this movement plays with the senses, generating inclusion and exclusion as solidary references.

We will take the concept of complexity as the guiding thread for building our reflections, understanding it as a regulating principle of thought and action, capable of articulating relationships, connections, interactions, in addition to helping us organize thinking to better understand reality, in order to see objects relationally, inserted in their respective contexts and dependent on them. As Morin supports, this thinking leads us to reconnect, in the domain of thought and action, what is already, directly or indirectly, linked in nature, in the organization of the material world. In this way, complexity does not lose sight of the reality of phenomena, does not separate subjectivity from objectivity and does not exclude the human spirit, the subject, culture and society (MORIN, 1996a).

## **2. The threads that weaves the pandemic scenery**

The context of COVID-19 affected the need to solve problems yesterday, today. The misunderstanding about reading the context has displaced us to walk and build other goals for educational and social reform. The reasons are built to constitute the hope of living in a better world, suggesting attitudes that benefit society as a whole, valuing the recognition of difference. Boaventura alerts us to possible alternatives, considering that "(...) societies adapt to new ways of living when this is necessary and felt as corresponding to the common good. This situation is conducive to think about alternatives to the way of living, producing, consuming and inhabiting in these first years of the 21st century". (BOAVENTURA, 2020, p. 29).

The questions raised in this study run through the idea that the pandemic causes us to perceive our place in the earth-house, in the sharing of affections and knowledge, putting thoughts into movements (events). This possible future stimulates the process of (re)invention of oneself and the world. This mutual relationship privileges the neighborhood, the communities and the home itself as territories for (re)meetings.

The 21st century virus motivated social isolation, and certain restrictive measures guided by public authorities and the World Health Organization (WHO) affected educational processes and other sectors of society. The feeling of fear of the flu virus that, after decades, has returned to the contemporary scene, places biological and social discourse as a phenomenon in the fight against the pandemic.

According to UNESCO data (2020), at the height of the pandemic, around 1.6 billion students in 190

countries left classrooms, representing more than 90% of students worldwide. A scenario is established that marks the greatest educational break in history. For educational institutions, a common recommendation was the possibility of not revoking activities, but making teachers and students work together, using digital resources for pedagogical communication. The United Nations Children's Fund (UNICEF) highlights that it is vital that pupils continue their learning from home, using all possible channels, radio, television, internet and cell phones (UNESCO, 2020). Circumstances that require adequate actions for each situation experienced in their daily lives, in order to avoid exclusion, even considering the fact that many of them do not have access to the internet or a device for their studies.

In fact, what happened is that the routine chores of life put aside the immediacy, making room for memory, affection, the desire for solidarity and acts in addition to the planetary care. In this perspective, the concept of creation and work took on a new dimension to understand life, the nature of power and the diversity of knowledge.

The scenario is favorable to the changes experienced in the narratives of humanity, woven into the devices of production of subjectivity that coexist with languages and learning experiences, expressing epistemological partnerships in this time of distance/presence along with articulating to politically emancipatory tasks. In this way, we have reached ethical-political crossroads, imposed by certain reflections, including what we intend to be, do and hope at this moment, besides living the pandemics that are yet to come.

### **3. Epistemological fabrics: education and complexity**

How can complex thinking mobilize creative and emancipatory acts in education in the (post)pandemic scenario? We know that each time imposes changes in the different fields of knowledge, causing dialogues and collective actions. The threads of this context outline a tangle of ideas and involve the recognition of the object of these changes and who can lead them. To this movement, we resort to the fabrics of systemic theory, which alert us to the relational character of education and life, of ruptures and continuities. In this direction, Assmann draws the following thesis: “(...) the living organism and its surroundings form, at each moment, a single system, and any distinction about the subsystems' autonomies of that system (for example, individual learners in a learning system) must emphasize the relative character of these autonomies; that is, subsystems only exist as long as they coexist within the system set”. (ASSMANN, 2007, p. 38).

From what has been said so far, the living organism is conceived as an active creator of living and open thinking, admitting new challenges and following the flow of social, political, economic and cultural transformations through forms of self-organization. It seems evident that the school is characterized as a living organism, because it has within it the subjectivity of the individualities and collectivities built in the space of interaction and language.

The COVID-19 Pandemic lived in the 21st century invites us to realize the vitality of our thinking about life processes, offering opportunities for new learning and experiences based on aesthetic and ethics. The constant crisis experienced by education has taken the pedagogical debate to understand the relationship between theory and practice. It is important to contemplate what the choices to (re)design the new paths

of education will be.

Listening to the signs of the new time implies a certain openness and flexibility to deal with uncertainties, discomforts and the unknown in relation to scientific knowledge, allowing the overcoming of beliefs, dimensioning their ethical and political character. Education is shown as a tangle of actions that, in a glance over time, left evidence and repetition.

From these deliberations, we understand that education needs to be in tune with the time lived and, in addition, permeated by a number of forms of dialogues and collective processes, concerned with the ecologies of knowledge, which provide experiences of creation and self-creation. Education, conceived as one of the fundamental processes in the subject's life, needs to construct creative formative paths, with insightful changes in its internal dynamics, generating new behaviors. It is from this understanding that pedagogical relationships are made up of layers to be known, overcoming the idea of transmitting truths and certainties. In this sense, "educating means providing and triggering processes of self-organization in people's neurons and languages". (MORIN, 2007, p. 71).

The aspect of complexity allows us to enter the internal movements of recursion, operating and providing subsidies to (re)build a new educational paradigm, which supports the understanding of oneself, the other and the world. The necessary reform of thought is responsible for generating a conception of the context and the complexity. For Morin, contextual thinking "always seeks the relationship of inseparability and inter-feedback between any phenomenon and its context, and this with the planetary context. The complex requires a thought that captures relationships, interrelationships, mutual implications, multidimensional phenomena, realities that are simultaneously regulating them), that respects diversity, at the same time as unity, an organizing thought that conceives the reciprocal relationship between all the parts". (2007, p. 22).

Contextualize pedagogical thinking is to ecologize, expressing the perspective of the teaching formative system in its entirety, which, in a way, also shows signs of crisis, raising the following problem: How to ecologize educational dialogues, overcoming the limits and facing current demands and everyday life? The epistemological turnaround outlines the critical struggle and lies in the possibility of breaking with paradigms based on certainties, without ignoring hope, interests, converted into the inclusion of the other. In this perspective, "(...) it is extremely subtle to sensitize human beings to solidary goals, because it is not a matter of 'creating awareness' in a rationalist sense, but of triggering self-organizing processes - cognitive and vital - towards a more solidary world, respecting and taking as initial conditions of self-organizing currently existing". (2007, p. 66).

From the epistemological point of view, the theory of complex thinking conceived by Morin enables inter and transdisciplinarity, opening up to questions about teaching practices in the sense of transforming forces for an emancipatory education built throughout life. Thus, the complex pedagogical action reverberates in human coexistence what, in turn, enables an education based on difference and alterity, developing mindful subjects for being and an ecologized knowledge.



#### **4. Aesthetic and ethic of network: the wholeness of being**

The quotidian reflections present the challenges in relation to the knowledge of oneself, to self-acceptance, because the times of life have been resized under a routine that did not allow the reflection of life itself, of human existence. The forced stop generated a rupture that caused profound and reflexive changes. We were driven to look at journey, our experiences, teaching practice, and ourselves. Finally, for ethical, spiritual questions - in fact, for the wholeness of being.

There are great possibilities for us to look in a network process, of encounter, which, according to Figure 1, invites us and encourages us to penetrate, review the tunings, the sounds that emerge from our energies, vibrations of life itself, to the educational processes, which permeate teaching. According to the authors, we do not have the key, but we have access to the world and, mainly, to the door that is open for our self-knowledge: "When I was ten, I took my house key to school, because I came back before my parents, who sometimes worked late. One winter night, when I arrived at the door, I looked for the key and could not find it. The house was isolated. Night was falling. I had no key. I was waiting in front of the house. One hour, two hours, three hours. My parents did not arrive. I thought they would never come back. I started to cry. I felt very alone, abandoned, exiled, unhappy. Finally, my parents arrived. "Why are you crying?" They asked. "As we saw that you had forgotten the key, we left the door open." I pushed the door. It was open. I had not even thought about trying to open it without a key. I wanted to tell this story before I started just to say that I know you do not have the key. Nobody has the key. No one has ever had it. We do not need a key. The door is open. Enter your home". (LÉVY, 2000, p. 24).

This invitation by Lévy, as well as by Lucila, are interesting triggering elements of self-knowledge that reaffirm the words of Sacramento (2018, p. 62): "I understand that self-observation and self-knowledge relate to a coupling with the inner being, in a state of human wholeness". This entire state is great, it is a life process, which for Larossa reflects on the fact that education, in turn, "always has to do with a life that is beyond our own life, with a time that is beyond our own time, with a world that is beyond our own world ... and as we do not like this life, nor this time, nor from this world, we wanted the new ones, those who come to life, time and the world, those who receive life, time and the world from us, who will live a life that will not be ours and in a time that will not be ours and in a world that will not be ours, but a life, a time and a world that, in some way, we give you ... we wish that the new ones could live a dignified life, a dignified time, a world in which it is not ashamed to live". (LAROSSA, 2015, pp. 36-37).

The outsets of Larossa dialogue with Sacramento (2018, p. 59) "(...) the conception of wholeness of being, in the sense of a state of consciousness that allows one to look at oneself with legitimacy and presence in order to be with the other, in coexistence and mutual transformation". This legitimacy in looking at oneself activates innumerable situations, as it generates suffering from not accepting oneself, from not welcoming the place we find ourselves. This is the great challenge, but, at the same time, a legacy for the teaching staff to realize that dialogue is the necessary movement to recognize themselves, at first. This process has been painful and teachers have sought treatments, such as psychological, psychiatric, and therapeutic, among other forms of support. These are elements that can be of great value and help; however, it is necessary to accept this welcome from yourself, from internal movements: "I emphasize the importance of the subject's internal movements, in the search to understand and identify his way of

being: what motivates, angers oneself; their anxieties, challenges, joys. Such movements are generated when the subject is affected by the desire to know his emotions and feelings, in a process of self-observation. When this is set in motion, it establishes a mutual and dynamic interaction with its sensations and with the environment in which it operates, resulting in coordinated coordinating actions, so that it operates recurrently, with the environment, in the environment and with itself. In this flow, his structure is always molded to the domain of action in which he develops his ontogeny, so that everything he does, in the domain of his interactions, is determined by his structure at every moment” (MATURANA, VARELA, 1997 *apud* SACRAMENTO, 2018, p. 61).

It is necessary, as historical and ethical subjects, we do the exercise to get to know each other and understand the reasons which affect us, be it in relation to the situations that upset and distress us, such as those that make us happy, so that in this process of self-observation let us find the meaning of life and teaching. This perception allows for sensitive listening, the knowledge of oneself, of possible answers and the raising of other questions, such as: What time is it now? How to manage it? What about now? Where are we going?

#### **4. What about now? Where are we going?**

What about now? Where are we going? These are questions related to life and teaching, especially of individuals who have lost people from their families, creating a great void and insecurity. A feeling of helplessness in the face of the challenges that arise in light of the pandemic and which exceeds linear understandings, with standardized labels, but, rather, a contrast that questions the curricular components and breaks the frontiers of knowledge. In a perspective of the ecology of knowledge - “First, the understanding of the world far exceeds the Western understanding of the world. Second, the understanding of the world and the way it creates and legitimizes social power has a lot to do with conceptions of time and temporality”. (SANTOS, *s.d.*, p. 3).

Regarding temporality, Santos also highlights that: “It is as if the light he projects blinds us. Suddenly, the pandemic breaks out, the light of the markets fades, and from the darkness with which they always threaten us if we do not give them a vassal, a new clarity emerges. Pandemic clarity and the apparitions in which it materializes. What it allows us to see and how it is interpreted and evaluated will determine the future of the civilization in which we live. These appearances, unlike others, are real and are here to stay”. (SANTOS, 2020, *s.p.*).

The forementioned questions materialize the mediation with other learning interfaces, but mainly, “(...) the teaching subject is constituted in the flow of his operations, (...) he experiences his teaching practices, 'in his teaching life', in a way recursive, in which its structure is constantly transformed, congruently with its interactions, with itself and with its surroundings”. (SACRAMENTO, 2018, p. 61).

This process ascends, according to the author, the presence in engagement with students, in learning spaces, especially when this coexistence is sought under the dimension of education for peace, and spirituality flows the empowerment of the subjects. Coupling (MATURANA; VARELA, 1997) in the sense of a process of being together in legitimacy with acceptance of the different ways of being. A process underlying the transformation of existence and, therefore, generating the processes of knowing.

Faced with these theoretical considerations, we propose to reflect on the following question: "How is it possible for the ecologies of knowledge mobilize the view of the educator as a whole, having as a guiding thread reflections on complex thinking in the face of the experiences of the teachers?"

#### **4. Methodological outline: possibilities for what is next**

To build a response to the questioning, we chose to generate data by listening to female and male teachers of basic education who experienced the scenario of social isolation and were challenged to carry out their practice using the digital resources offered by the schools, as well as the entire situation that presented itself.

To support this path, we used the instrument Balances of Knowledge, by Bernard Charlot (2009), to inspire the generation of data and its subsequent interpretation. The balance consisted of the elaboration of a text based on a statement that provides a reflection on the experience of each subject educator in contemporary times. The analysis focused on the assigned meaning, evoked on the feeling experienced.

The research subjects were female and male teachers of basic education in the municipalities of the States of Santa Catarina and Rio Grande do Sul, Brazil. They manifested themselves through remote access via Google® form, comprising the term of confidentiality and consent to participate in the generation of data. For the purposes of this study, the following statement was prepared for the Balances of Knowledge: "What is the feeling of being a teacher in times of the pandemic of COVID-19? Teachers expressed themselves freely, writing about what they lived, felt and perceived.

Based on this statement, 14 basic education teachers from state, municipal and private schools participated. The Balances of Knowledge were read as a single text, which brought speeches by the teachers about their experiences in the relationship with students, in their doing and being an educator. These female and male teachers are connecting with students through digital technologies in this pandemic period.

To understand the data generated, there were "comings and goings", trying to understand in the text what those teachers lived. From this attentive and sensitive reading, some words and expressions emerged, and they were the starting point to generate a cloud-based figure, which means the dimensions that emerged from ecologizing the being and making teachers in the year 2020, in the voices of female and male teachers who contributed to the data generation.

Thus, Figure 2 expresses the cloud-based image, which was created using the digital mentimeter environment in an interactive way, in which the size of each word expresses how much it was referred to in the voices expressed by the teachers participating in the study.



Figure 2. Cloud-based words.

Word cloud: Emergencies of being and teaching in the context of the pandemic.

Source: The authors (2021).

The word and its meaning are fundamental to think about how we inaugurate the process of change, of greening, about the paths of knowledge and learning. The most promising direction is the recognition of oneself and the other in the formative process, to create dialogues contained in the word cloud as a generator of meanings, for the continuity of an understanding of the echoes of the voices of the teachers – feminine and masculine –, as shown in Figure 2.

Thus considered, according to Munzner (2014), the image assists the subject in perception and expands the capacity of human cognition: by communicating over visual language, which allows realizing, interpreting information, as well as facilitating the process of knowledge discovery in large complex systems. In addition to designating something which, while not always referring to the visible, borrows some features from the visual and, in any case, depends on the production of a subject: imaginary or concrete, the image passes through someone, who produces or recognizes it (JOLY, 1996).

From the image that presents the words that reverberate in the displacement of the teaching being-knowledge in the learning processes, networks are activated with forces to emerge in their constitutions. The data that weaves the time lived with the uncertainties subtly imposes the identification of the place of the pedagogical weaknesses and fragilities, leading to a complex discerning to deal with the lived situations.

Words expressed in the cloud – such as *technologies*, *challenges*, *possibilities*, *alternatives*, *knowledge* – act as forces to find, in a self-organizing process, conditions for the (re)invention of educational practices, interweaving school period with the time lived by the subjects and their knowledge.

## 5. Discussion and analysis: the emergencies of Balances of Knowledge

After the analysis of the statements in the Balances of Knowledge, the dimensions of emergency relations

emerged the associations with the knowledge of uncertainty, of challenges and of change. Thus, in Figure 3, some of the statements of female and male teachers in relation to their emergencies, in which there was a transition in the approach of being and doing physically, in person, to be and do through digital technologies.

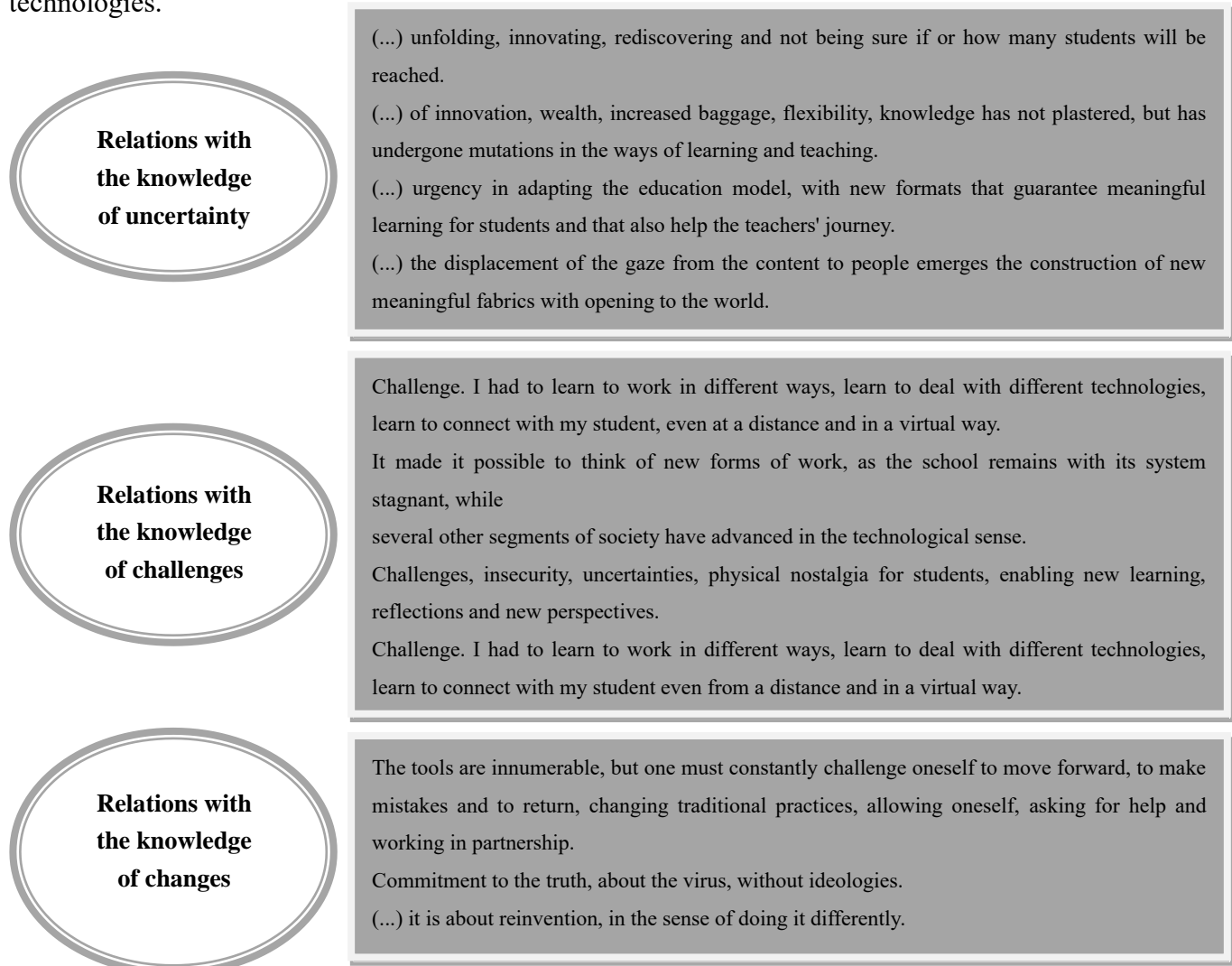


Figure 3. The Voices of Emergencies: Teachers' speeches regarding their emergencies.

Source: The authors (2021)

These relations of threads emergencies intertwine and stand out in a broader two-way perspective, so that, in the first, Charlot points out, based on the norm: “(...) there are ways of learning that do not consist of appropriating knowledge, understood as content of thought; second, while trying to acquire this type of knowledge, other relationships with the world are also maintained”. (CHARLOT, 2000, p. 59). The second, in its turn, is exposed by the premise that consists “in the fact that any attempt to define a pure subject of knowledge forces, *in fine*, to reintroduce other dimensions of the subject in the discussion. Symmetrically, any attempt to define ‘knowledge’ raises a subject who maintains a broader relationship with the world than the relationship of knowledge”.

Such connections emerge recursively, what means in each new cycle a new learning takes place and refers to the figures of learning, which are established by the need to learn in the face of the world that presents itself, in addition to the ruptures that arise. According to what Charlot (2000, p. 67) proposes,



there is “the most radical question: what kind of activity is learning? To analyze this point is to work on the relationship with knowledge as an epistemic relationship”. By "subject of knowledge" we mean, here, the subject who dedicates themselves (or intends to dedicate) to the search for understanding. To do so, learning “requires an intellectual activity and only one who engages in meaning is engaged in an activity” (CHARLOT, 2013, p. 146).

The sense of being engaged means dedicating attention with pleasure and being deeply involved in what you have proposed in the activity of learning, which thus generates empowerment. People can commit to undertaking many activities, such as sports, hobbies, jobs and studies; however, the better people feel about what they are doing, the more focused and willing they be to do it well.

The remote regime is, in turn, a temporary emergency measure organized to fulfill the need for social distance. In this type of management, pedagogical coordination and teachers interact with students over the internet. One of the alternatives found was the online class, in which teachers and students need to connect at the same time (synchronously), on the same days and times as the face-to-face classes. Although it seems simply a change of “location”, remote education creates the need for tools to assist in the teaching and learning process, as well as the promotion of technological appropriation for teachers and students.

Using the digital culture system is vital in times of social distance, given the different possibilities that are created by digital social networks. In order to be present in the rapprochement relationship between the subjects of the educational system, they promote and facilitate the meeting and communication concerning the subjects, such as, for example: groups on WhatsApp® and profiles for movements of directions, guidelines and information on Facebook® and on Instagram®, in addition to promoting video calls, using school management systems, from which it is possible to obtain monitoring of the school universe as a whole, with different computational languages, representative images, graphics, material production, records of perceptions of the teachers, families and students.

These aforementioned aspects mobilize collective intelligence, which, for Lévy, (2015, p. 29), consists of “an intelligence distributed everywhere, unceasingly valued, coordinated in real time, which results in an effective mobilization of competences”. Collective intelligence values and maximizes human diversity, so that the space of knowledge, in this perspective, is effective in human relations and dialogical guidelines. Thus, it constitutes a look at the daily life of Education with regard to involvement and participation that can expand interaction, teaching and learning between subjects.

Hence, such adherence instigates an important role in all dimensions of life, in which the protagonism of the individual arises from satisfaction with the action of and in the world of being with the innumerable relationships, in order to deal with the challenges prompted. It also provides opportunities for learning from the new, the different, represented by the demands ascending from the presence of social isolation, because of COVID-19. New ways of teaching and learning are pointed out, that is, of doing, seeing and creating, to be and stand, therefore to ecologize the educational processes based on recurrent and recursive interactions.



## **6. Conclusion, closing remarks**

What is expected from post-pandemic education? Although the ecology of knowledge has been addressed in the emergence of complex thinking, in a way the importance of recognizing a new educational paradigm has always been evident. Throughout the interaction between the researchers in this article, woven threads often created a tangle around uncertainty and fragility in relation to reading the context of the subjects involved in the educational processes.

The pandemic, by triggering movements to reorganize ways of being and standing, inspires several movements (events): self-knowledge, the complexity of life, enabling dialogue and collaboration, in addition to empowering individuals. Teaching, from this perspective, is a co-creation space for new processes of knowledge ecologies.

This legacy is shaped by art, dance, feelings, limits, dreams, self-knowledge and human subjectivity. Teaching, by recognizing these aspects, enables the greening of knowledge and co-creation.

The study points out some important results to build collectively ethical, caring and spiritual narratives strengthened in the social body. In this perspective, teacher education opens space for language, for protagonism, escaping the alienation generated by hegemonic relations. Thus, it must break (without denying) institutionalized models, ceasing to be configured in the service of the system. Therefore, it must be built in a shared way among peers and marked by epistemological and aestheticized partnerships. The identification of teacher training as an object of study in constant action/reflection/action, dimensioned by the understanding about pedagogical trends, needs to overcome the recurrence of empiricism, including learning, "with a view to building a world where everyone can fit". (ASSMAN, 2007, p. 113.) Then, there is an understanding about the different backgrounds and circumstances, so that it is possible to problematize about which displacements should direct our choices.

The world invites us to flexibilize and create. The question is how we are captured by the sound, by the collection of the world, the result of the different images that, in a way, we chose to compose our narratives. These narratives are legacies that we build and leave to the new generations.

Knowing how to read images is a requirement of contemporary society, given the amount of information that is conveyed to us through this language. Knowing the visual grammar makes us able to read and interpret pictures with awareness.

It is important to highlight the humanizing aspect of the school, of welcoming, as a foundation, with the objective of including one and all in the maintenance of teaching in the context of the pandemic, in a creative look that crosses being. It is proposed to seek strategies for engagement with the entire community, to enable the largest number of people included in the learning process. Moreover, the reception of presence, in turn, is only possible when considering the social reality in decision-making and action planning. Empowerment, mutual support and collaboration are strategies that strengthen the entanglement of the school community.

In short, in understanding of these reflections, emerged as fundamental dialogues and exchanges of experiences between researchers, students, educators and other individuals in transdisciplinary studies, about the relations with Education, with mutual respect regarding different cultures, in the different dimensions of being, whether ontological, ethical, epistemological or aesthetic. Still, we can infer that the

dialogues built in co-creation need to have complex thinking as a strategy to (re)invent teaching practice, from the wholeness of those involved, based on mutual respect and the empowerment of these subjects. May the image of the figures we present show us new ways to co-build knowledge and practices, as human beings living together, so that, with mutual respect, we can generate a society in which we can feel welcomed and live fully.

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## **ECONOMIC REALITIES AS DEPICTED IN `KUUSAA GADOO`**

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### **Abstract**

*The purpose of this study is to show how Gadisa Biru who wrote the novel `Kuusaa Gadoo` represents the Oromo`s economic issues realistically in the life of characters and the major themes of the novel. The study is qualitative research, it involves textual analysis method together with relevant conceptual tools and frameworks and therefore it is analytical. Furthermore, the data used for the research is taken from a primary source which is `Kuusaa Gadoo`. From the novel, different extracts are taken based on the research questions. Extracts used as data were classified under each topic and analyzed using textual analysis methods and realism theory. Then, the analysis and discussion were undertaken by using the concept of scholars to make the research more visible and logical. As a philosophy of realism theory, realism portrays the world as it appears. Therefore, to evaluate the realistic representations of different agendas of the research, it is crucial to bring the idea in the text to the actual world. From the analysis and discussion made it is found that, in `Kuusaa Gadoo`, all events and episodes were realized in the novel without any fantasy and extraordinary overstatement. Oromos were not economically beneficial during the Derg; the economies of Oromo peoples were used by others i.e. by leaders and investors from other ethnic groups. The Oromo`s resources especially land is highly corrupted by leaders of the time. Oromo peasants had no legal protection for their economy. Hence, the novel `Kuusaa Gadoo` reflects the real-life situation of Oromo peoples during the Derg regime. The author critically observes the real economic picture of society and portrayed it logically.*

Keywords: depicted, economic, `Kuusaa Gadoo`, realities

### **1. INTRODUCTION**

Scholastic definitions of literature present its uses, importance, or social functions. Such social functions reveal literature as a living course that is capable of educating or instructing its readers by way of informing, socializing, amusing, or entertaining. It is also capable of criticizing social vices and proffer solutions to

such societal problems. It creates socio-political consciousness among the community, exposing both local and foreign cultures, improving language acquisition, learning and proficiency, increasing and improving vocabulary development and reading or comprehension skills in the readers among other functions. Other social relevance of literature includes its ability to reveal both the good and bad potentials in human nature and subtly present models to follow. It sharpens intelligence and a good sense of judgment; at the same time, it awakens people's creative potentials (Stockiest, 2014).

In the other way, Meyer (2005) explains literature as fiction consisting of carefully arranged words designed to show the imagination, prose narratives, poems, and plays. These genres represent imagination based on actual historical events. Imaginative writing differs from other kinds of writing. Like other art forms, they offer pleasure and usually attempt to convey a perspective, mood, feeling, or experience. Writers transform the facts the world provides people, places, and objects into experiences that suggest meanings. The writers express society's accumulated experience and passions like love, appreciation, hatred, gratitude, apology, etc. through literature. This can be in the form of prose or verse. The prose form of literature which is the focus of this research is the novel.

Literature is linguistically documented facts and ideas through which people used to preserve their deeds and worldviews from one generation to the other (Owamoyala, 1993). This shows the close relationship existing between literature and society; hence literature is a product of society. They also show literature's sensitivity to the society, not only in recording events and situations through language but as an agent of promoting development in all its implication by propagating the social values. The thematic preoccupation of literary artists generally over the years varied from one duration to another, depending on the prevailing socio-economic, political, and cultural circumstances of the time. "Literature is a social institution, using as its medium language, a social creation...Literature represents life and life is in large measure, a social reality, even though the natural world and the inner or subjective world of the individual have also been objects of literary imitation" (Wellek and Warren, 1968, p. 228). The term 'reality' in this study is used 'to present an accurate imitation of life as it is'. When we think of realism in fiction, we are thinking about the imitation of life a concept that at once implies the existence of something outside the writer's mind which he or she is trying to imitate.

In short, literature in general and novel, in particular, has its contribution in documenting, preserving, and transmitting the sociology of a given society. However, Oromo literature is very young in serving the society in this regard and it is difficult to say Oromo literature is well developed. Also, there were no comprehensive studies that dealt with the socio-cultural, economic, political realities represented in the novel. Even though novel emerges as a powerful medium to present the age descriptively and analytically and represents the social, political, cultural, and historical growth of the society at great length, Oromo novels were not analyzed in a wide range to realize these facts.

Therefore, the main objective of the study is to analyze the economic realities depicted by the author Gadisa Biru in 'Kuusaa Gadoo'

## **2. RATIONALE**

The study investigates economic realities in one Oromo novel. The researchers believe that the critics of the novel help to address the quality of the novel and to indicate where the problem is. This may help in the development of Oromo novels. As David (1997) states, "Literary criticism is the discussion of the literature undertaken to interpret its meaning and to evaluate its quality" (p.48), and it is also true that "the purpose of criticism is to promote high standards in literature and to encourage a general appreciation of literature among readers" (p. 48).

The study is expected to contribute to literary studies and the knowledge of readers. In this regard contribute towards the knowledge of Oromo's economy in general life experience and values of the society during the dictator government as they are portrayed in the selected novel. It is also believed to help readers as a springboard for further studies on the same text or other text on related issues. In addition to this, no one analyzed the realistic aspects of the Oromo novel 'Kuusaa Gadoo.' Hence, the authors of the novel and the readers can be beneficial in identifying the strength and weakness of the novel and understand how Oromo's economy realistically reflected. Likewise, it is useful for Oromo society; criticism has a positive influence on the development of a society's literature. It adds value in indicating the quality of the novels to the readers and writers. The study will also contribute to the study of Oromo literature which has not yet received due consideration so far. Apart from this, this research can serve as reference material to enhance ones' awareness in the area of realism and its manifestations in literary works. This study also is positively estimated to stimulate researchers to conduct further research on Oromo literary writing in general, specifically Oromo literary writings from a realism perspective.

## **3. REVIEW OF RELATED LITERATURE**

### **I. Novel**

Novels are dedicated to narrating the individual experiences of characters, creating a closer, more complex portrait of these characters and the world they live in. Inner feelings and thoughts, as well as complex, even conflicting ideas or values are typically explored in novels, more so than in preceding forms of literature. It's not just the stories themselves that are more personal, but the experience of reading them as well. Where epic poetry and similar forms of storytelling were designed to be publicly read or consumed as an audience, novels are geared more towards an individual reader. It is the real imitations of life.

According to Baldick (1990), Realism is a system of conventions producing a lifelike illusion of some "real" world outside the text. It is often identified in terms of the effects on the reader, giving the impression that such characters and events might exist in real life. It is about an effect of resemblance between two heterogeneous worlds: the linguistic world of the text and that of "beyond the text" (linguistic or nonlinguistic).

In addition to this, Realism is the theory of writing in which the familiar, ordinary aspects of life are depicted in a matter of fact, straightforward manner designed to reflect life as it is. Realism often presents a careful description of everyday life, often concerning itself with the lives of the so-called middle or lower

classes. Abrams (1971: 141) noted that the term 'realistic novel' "is more usefully applied to works which are realistic both in subject and manner ... throughout the whole rather in parts ...." Additionally, Gray (1992: 241) has noted that Realism "is best used for writers who show explicit concern to convey an authentic impression of actuality, either in their narrative style or by their serious approach to their subject matter".

The main tenet of Realism is that writers must not select facts in accord with preconceived aesthetics or ethical ideals but, rather, record their observations impartially and objectively. Realism downplays the plot in favor of character and concentrates on ordinary situations. Realism in literature aimed at describing the horrors of modern civilization as seen in the lives of the poor victims who labored in mines of factories of prostitutes, degenerates, and criminals (Ronald N. Stromberg, 1968).

## **II. Literature and Economy**

Literature is pre-eminently concerned with man's social world, his adaptation to it, and his desire to change it. Man and his society is the material out of which literature is constructed. So, literature is regarded as the expression or representation of human life through the medium of social creation viz. language Wellek and Warren (1994). In the words of Hudson (2006), "literature is a vital record of what men have seen in life, what they have experienced of it, what they have thought and felt about those aspects of it which have the most immediate and enduring interest for all of us. It is thus fundamentally, an expression of life through the medium of language" (p. 10). In short, literature grows out of life, reacts upon life, and is fed by life.

Society and individuals are the materials of literature. The outer world gets transformed within the author's mind and heart and these transformed elements become reality in literature and a source of our pleasure. However, it is hardly possible to define literature precisely because the different critics and scholars from Plato down to the present age have defined literature diversely. These diverse views state different theories of literature. In *Theory of Literature* Wellek and Warren (1994) attempt to focus on the several ways of defining literature and finally conclude that the nature of literature can be understood through the particular use of literary or connotative language. They define literature as the reproduction of life. While defining the nature of literature they remark: "Literature is a social institution, using as its medium language, a social creation . . . literature represents life; and 'life' is, in large measure, a social reality, even though the natural world and inner or subjective world of the individual have also been objects of literary imitation" (p. 94).

There are different norms of behavior in different societies and they are reflected in their respective literature. This reflection shows the reciprocal relationship between literature and society. Literature is a social phenomenon and it differs from one social system to another because social institutions and forces directly influence literary works. Every society has its characteristic structure having norms of behavior, values, ideas, and problems. These norms provide different ideas, themes, symbols, images, and other aspects of literature. Therefore, the literary work of one country differs from that of other countries. The root cause of this difference is the impact of the particular social structure.



The great literary works contain social, political, environmental, religious, economic, and domestic values of the day. The form and style of literature change with the changes in the temper of the age and society. So literature is regarded as the expression of society. The relationship between literature and society is two way. It influences society and gets influenced by society. For instance, society provides the raw material to the writers, but the same type of raw material does not produce the same type of literary works. The nature of literary form and style depends upon the worldview and creativity of the writer.

The geographical environment and scientific developments also, in some way, influence literature and determine its shape and character. The geographical environment provides images while scientific inventions provide new thoughts and ideas to literature. Modern scientific inventions have enormously changed the entire social structure and brought about new trends in literature. The twentieth-century novel has reflected these changes in cultural practices in society. For instance, the renaissance movement brought a humanistic trend in literature whereas the industrial revolution in the modern age has made literature more inclined towards materialism. As literary work is the result of the entire social structure and social forces, it cannot be excluded from society. Therefore, any attempt to analyze and interpret literature excluding society and life will not give justice to literary works.

#### **4. METHOD OF THE STUDY**

A type of study is qualitative, hence the textual analysis method together with relevant conceptual tools and frameworks are used for the study. In qualitative research data are often in the form of descriptions, rather than numbers. Document analysis, the process of using any kind of documents, can be used as a methodology in qualitative research as a singular method of research or as a supplementary form of inquiry. Hence textual analysis method is best fit with the objective of the research since the main focus of the research is examining realistic representations of the economy in 'Kuusaa Gadoo' that needs detailed understanding and interpretation of the text.

The novel 'Kuusaa Gadoo' is used as a primary source of data. Through intensive reading extracts taken based on the social realities identified in research questions. The extracts are used as representative data of the novel used for the study. Analysis and interpretation have been used as analytical procedures in this research. Extracts are taken from the novel 'Kuusaa Gadoo' translated from the source language 'Afaan Oromo' to target language English, using the communicative translation method. This translation method attempts to produce the exact message of the source text with emphasis on acceptability to the target text readership (Newmark, 1991). The data obtained from the novel has been analyzed and interpreted by the concepts and frameworks discussed in the review of related literature part.

#### **5. ANALYSIS AND DISCUSSION**

Ethiopia is a country that nature in his infinite Mercy has blessed so much, with both human and material resources. It is however paradoxical to note with at all that Ethiopia has blessed with are not put into proper use by the various leaders of Ethiopia due to miss use of political powers, leading to the nose-diving

dimension of the economy of the Ethiopian. The writer of 'Kuusaa Gadoo' seems to notice the luxurious lifestyle of the Ethiopian leaders at the expense of the economy of Ethiopia, corruption, and unfair economic distribution especially the land of Oromo's.

## **I. Corruption**

In many Episodes in 'Kuusaa Gadoo,' Gadisa Biru posted the fact that Ethiopian politicians are indeed very corrupt. Gadisa used the character Asfawu in this novel to depict the way Ethiopian politicians often depend on public funds to enrich themselves at the expense of the ordinary people in the society specifically Oromo's. This can be realized from an extract taken from the novel:

Hojjettoonni mana maazzagaajjaa Boqojjii yoo namni tokkoofi lama hafan mooji malee marti isaanii aduu sanbata duraafi Lammaffoo gabaa keecha yaa'aniiti qaraxa guuraa oolan. Asfaaw Haayilee namoonni gabaa dhaabbatan marti quncisee nu fixe jedhanii haa itti boowan malee gaafuma tokkollee ganzabni inni guru mootummaa gammachiisee hinbeeku. Miindaan isaa moora isaa garaa jigsuu dhiisii akaayiidhaa hinguubsu ture.

... nyaata garaa duwwaa odoo hinta'iin oggasuu ganzaba maqaa qabu gudunfate Asfaaw (f.31).

Rather than the absence of one or two persons, all the workers of Bokoji's municipality were collected income tax on Saturday and Tuesday by moving here and there through the market. Even though everybody claimed Asfawu Hayile because of feeling discomfort about the money collected, he didn't satisfy the government with the money collected even a single day. His monthly income was very few but his belly looks like a pregnant woman.

...it was not only eating to his stomach but also he saved meaningful money in a short period for himself (p.31).

In the episode above, Gadisa revealed how Asfawu corrupts the country's economy by using his power. As it is evident from the story Asfawu was the employer of Bokoji municipality on the sector of land division. Originally, he was from the Amhara region and came to Oromia to work daily laborer especially to collect coffee. Since the Derg admires Amharas he got a position at Oromia region Arsi zone Bokoji town. This by itself shows how much the Oromo society overlooked by the Derg; in the presence of a huge number of Oromos, the government gives power to any layperson who comes from somewhere else.

By using this opportunity Asfawu extremely corrupts the Bokoji peoples. The income tax collected from the individuals by the workers of the municipality of Bokoji town not deposit to the government account. Nobody audits where the money goes. Asfawu uses his power and manipulate the economy of the country for his purpose rather than evolving the country. He lives a luxurious life at the expense of poor farmers. He can eat and drink whatever he needs; he also deposits limitless money to his account in a very short period.

...lafa nama mana ijaarrachuu barbaaduuf akka hiru shumata argate. Shumata kanaanis duruu duri Asfaaw namoota Boqojjii quncisuutti gadi taa'e ( f. 31).

... He has got the position of land division for those who need to build a home. As he was familiar with the corruption he also highly used this power and corrupt Bokoji's society (p.31).

Among the different resources, the Oromo societies have landed is one and the very important one. As to the idea from the extract this land management undertakes by Asfawu. But, he was not used his power for management according to the rule, he misused his power and mischief the land of the society for his advantage. He deeds corruption to give the land for a person; it was a must to gate money from the person who seeks land to build a home. This showed the irresponsibility of the Ethiopian leader of the socialist system. Hence, the economy of the country was under the control of the leaders than the other society.

...Asfaawfi Tulluun waan hunda dhiyeenyatti to'atanii kan calqaban fiixa baasuuf dafanii ol timan. Seennanis qawwees ta'e shiguxii amma baafachuuf humni isaanii danda'e guurratanii balbala banumatti gatanii badani (f.122).

...Asfawu and Tulu take everything under their control in the remote distance to be successful with what they have begun and entered the polis station at once. After that, they took a lot of guns and pistols to their capacity and leave the room with an opened door (p.122).

Asfawu the leader of Bokoji municipality and boss Tulu the commander of Lemu and Bilbilo woreda used their power and harm the governments' economy. Both of the leaders agreed and theft military materials from the polis station to get money. Both are leaders and they are responsible to protect government resources, but they were doing against their responsibility which is a paradox. Both guns and pistols were the economies of society. They took out of the police station and sales for their purpose. This showed how much the leaders of Ethiopia corrupt the economy of the country by using their power rather than protecting the resource of the country from the harming body. Hence the leaders of the time were self-centered and irresponsible.

“Maal yeroon akkanaa? Kan beeku beekumsa isaatiin , kan qabu qabeenya isaatiin, abbaan humnaa humna isaatiin, dubartiin dubartummaa isheetiin, hunduu kan isaa gadii ofjala oolchuuf ifaaja...” (f. 138).

“What type of time it is? The knowledgeable by their knowledge, the wealthier by their wealth, the stronger by their force, females by their sex, all tried to control the one who was not equal to them...” (p.138).

At the time of rules and regulations have no value and the system of the time is controlled by the power of leaders and money, the poor society has no sound. To accomplish any activity power or money is used as a means. Therefore, everybody used what he or she thinks is power or as money to get a benefit or to dominate the powerless society. Such a system corrupts not only the economy but also individuals' way of positive thinking and leading to the immoral deed.

Using manipulation, politics may construct the stories in which societies are developed. Control over collective memory, including forgetfulness of peoples, is an important element that serves the interests of dominant classes. According to Jacques Le Goff, "Becoming lords of memory and forgetfulness is one of the greatest concerns of historical societies. The forgetfulness and the silences of history reveal those mechanisms of manipulation of collective memory." (Jacques, 2008, p. 422.).

Literary works may provide readers with an important opportunity to become aware of the violence that people had to endure, even when it is accomplished or endorsed by the power that is supposed to protect them. Hence, if Oromos were not tolerating the dictatorial government it was difficult to continue with different nation nationalities of the country.

## **II. The Luxurious LifeStyle**

In the novel, the Ethiopian economy was wrongly used by the character Asfawu Haylie. He used the money of the country for his family and again used as a means to take others' wife by giving support. The woman called Yadeshshi was living at Bokoji town living by sealing 'cathicala' (local alcoholic drink). She is living with her son Gezahegn while her husband Dechasa was living in Addis Ababa for education. Using this opportunity Asfawu started to love Yadeshshi by showing his thick pocket to her. Since her income was from hand to mouth she gets funny and started living with him, he also told her as his main objective is to help her family since she is living without a husband. Look at his direct saying:

"Manni dhugaatii kan baay'ee o'ee akka yaada garaa kiyyaatiitti seenee taphachuu danda'u baay'eedha. San hunda keecha darbee as dhufuun si qarqaaruufi. Si qarqaaruun immoo ilma keetiifi dhirsa kee qarqaaruu kiyya" jedhe (f.32).

"There are a lot of interesting bars where I can freely go and play. I came here leaving these all to help you. For me helping your senses, it is helping your husband and your son" he said (p.32).

The quotation depicts that the innocence of Asfawu to support Yadeshshi and her family. But his objective was not supporting Yadesh and her family rather than using her economic gap to convince her to make his own.

Asfaaw yeroo baay'ee hiriyyoota isaa wajjin dhufee amma waariin qaari'utti dhuganii taphatanii yoo deeman ganzaba baase deebin (malsiin) isaa keechaa deebi'u yoo Birrii kudhanii gadi ta'e tole jedhee hinfudhatu (f. 32)

Most of the time Asfawu came with his friends and drink also chat up-to-the mid-night. When they go back to their home he paid for all people, and if the many he paid for all beverage had extra birr which is less than ten to be returned he was not positive to receive from Yadeshshi (p.32).

In this novel, Gadisa Biru revealed how Ethiopian leaders live a luxurious life at the cost of the other ordinary peoples. He used the character Asfawu Hayile, the leader to reveal this when "he was paid for all person and if the money he paid for beverage had extra birr which is less than ten to be

returned he was not positive to take." This implies that Asfawu has been collecting an extra many from the very excessive society. That is why he invites every of his friend and he didn't consider the return of the payment which is less than ten birds. In addition to this, he deeds this for two reasons: first, the money was not collected by his effort. Since he was joking about the wealth of the country, meaning he did not worry about the money shortage. Second, he was showing his prosperity to Yadeshi to stimulate her interest in money and to control her heart.

Asfaw Haayilee ...kanamalee isheen tole jettee haa nyaachuu baattu malee waan nyaataa bifa bifaan dhiyaachaafii ture, Nyaata duwwaa odoo hintaane gatii qorichaatiif gatii siree hospitaalaa akkanumaanis horii obbolaawwan Yaadashii baasan mara kan kenne isaayyu (f.80)

Asfaw Hayile... more than that, even though she was not okay to eat the food, different food was presented for her. Not only food but also the cost of medicine and bed of the hospital, in general, every payment that Yadeshi's brothers and sisters made was covered by him (p.80).

Abusing the country's economy was not terminated only on supporting his loved ones, friends, and families. He used further funding and covers any payment made by Yadeshi's family for food, bed of hospital, and medicine when she was staying in the hospital for treatment.

This was all done for individual purposes, the society had no benefit from every pleasure of Asfawu. In a country like Ethiopia in which someone can't appropriately feed his family two times a day, Asfawu feeds everybody in a way they want. This shows the highest level of corruption in our country. The resource of the country served few individuals at the governmental position and the massive number of society in the country lives in a tedious life.

...Yaadashiin duurecha birrii qabuun isa geeddaruun ishee baay'ee garaaisa gube (f.81)

... The exchange made by Yadeshi between Dechasa and the rich person makes him painful(p.81)

During the Dergi regime, the one who had power and economy can do what he was interested in. Asfawu also used those two instruments to take Dechasa's wife. Such a deed is not acceptable in Oromo's culture and is seen as bad practices. But, since the leader of the time was looking through the lens of money other than valuing the family of others, therefore he didn't bother about anything other than achieving his goal which was enjoying with Yadeshi. Deceased was hurting in Yadeshi's deed which is getting in love with the richest person; she changed her husband with money and distracts her family.

Similarly, the other person who was an administrative leader took Guta's fiancé using his power and the money he got through corruption.

"Namichi sun irree isaatiifi kiisii isaa furdaa abdateeti maal na godha jedhee Gaashe Guutaa tuffatee intala inni jaallatu humnaan irraa fudhate"Dachasaa(f.37)

"The person develops trust on his force and his full pocket abnegate Mr. Guta and take the girl he loved very much" Dechasa (p.37).

Like Asfawu the other government leader also used the same tools to take Guta's loved one. They were doing crime using government power and society's economy. Their deed was not only living a luxurious life by enjoying with different ladies. Beyond that, they were distorting others' family life. The one who has power and money may not worry about the others than making what he is interested in to make. From this, one can understand how much the corrupted person had the power and right to do any crime. There were no rules and laws that govern them; they were beyond anything to exercise their feeling on anybody. The system was very difficult for those who are requesting and seeking reality. The one who lost truth accumulated revenge and take measures when he got an opportunity through time. That is the message of 'Kuusaa Gadoo'.

### **III. Unfair Distribution of Land**

As it is revealed from the story, the economic distribution of the time specifically land distribution in Oromia regional state looks injustice. The land of ownerships' taken irrationally through corruption that took place between the leaders of the Woreda, municipality, and capitalists. The leaders make biases for the rich person rather than protecting the resource of the farmers of the country. The capitalist uses his money to simply access the land of a poor farmer; as soon as the leaders of the Woreda and the city promised by the capitalist they facilitate everything overnight. For instance, see the case between Kiro and Fitawrari Aweke from the next extract :

Kadiroon bosonatti galuu kan danda'eef balaa lafaatiini. Huseen Roobaa abbaan Kadiroo ijoollee isaanii shananiin kan dhiisanii du'an lafa waantaa tokko. Lafa kana hundi isaaniiituu amma danda'an qotatanii jiraatan. Odoo akkanumatti jiraatanuu Fitaawraarii Awaqaa kan jedhamu Addis Ababaadhaa dhufee bulchaa waradaa qabatee, "Lafa kana mootummaan naaf kennee jira, siisoo akka safartan, kana kanaan dura ittiin maayii baataniifis mata mataan birrii dhibba sadii akka qopheechitan, inta'u yoo jettan hardharraa qabdanii lafa koo akka gadi lakkiftanii deemtan" jedheen (f. 124).

The reason why Kiro was forced to live in the jungle as their land was taken away by the government. Husen Roba the father of Kiro had one-hectare land, after his death his five sons were plow and used it. As they were living in such a way the person who called Fitewrari Aweke came from Addis Ababa with the Woreda manager, he said: "The government gives me this land, you have to pay pension, each of you has to prepare three hundred birrs for the past service, if you have not agreed with this idea you have to leave my land starting from today." (p.124).

In the episode, Kiro becomes homeless because of the injustice deed of the Woreda manager and Fitewrari Aweke "the person from the higher class". The land Fitewrari asked Kiro and his brothers legally belonged to their parents. But, Ferrari Aweke communicates with the Woreda leader and agreed to take the land by



saying this land was given to him by the government, which is false but through corruption. He also asked them to pay tax and serves charges. This shows that less respect is given to poor farmers on their land. The land was managed and used by those who had power. The peasants have no sound; nobody listens to them. This reflects the unfair land distribution between the peasants and the higher class or the capitalist.

The Oromos were forced to leave their land for the others. As it is clear from the story Kadiro and his brothers were from the Oromo family. But, Ferrari Aweke was from the other most probably Amharas' which was assumed as "higher class" during the socialist system and before. The socialist system was the system that considers societal equality but the reality was opposing the ideology.

The owner of the land Kiro and his brothers were resisting not giving their land to other bodies. But it was beyond their capacity not to give for Fitewrari Aweke. See the next extract:

Kadirooniifi obbolaawwansaatiis, "lafa abbaa keennaa, akaakileefi abaabilee keennaa kan itti gabbaaraa turre akkamitti isinii kennama? Lafti keena waan ta'eef siisoos insafarru, irraas inkaanu," jedhan (f. 124).

Kediro and his brothers said, "The land of our Father, grandfathers, and ancestor that they paid tax for a long period, how we give you? Since the land is ours we couldn't give you a pension, we couldn't leave it," (p.124).

Kediro and his brothers were approved as the land was their own for a long time. It passed to them from their ancestor, grandfather, and father. Hence they have used the land for a long period through the legal payment or tax for the government. Kiro's family were farmers and have no other option to use for farming and other incomes. That is the reason why they resist not leaving it. It is the issue of living or not. However, their resistance cannot be the solution not to leave their land. The leaders of the government have no ear to listen to the peasants' heartbeat since they were standing at the side of what they called "the higher class." They used their potency make them to leave the land.

Bultii sadiin booda poolisiin itti ergamee dubartiifi daa'ima xixiqqoo yoo dhiisan warra kaan mara isaanii qabanii Boqojjii geechanii hidhaatti naqan (f, 134.)

After three days, the police came and took all other people to Bokoji jail other than females and children (p.134).

Things are going in a reverse way. The persons were forced to leave their land; their land was taken by other bodies, finally, they were taken to prison. This was the reality that Oromos practicing throughout their life because of their motherland. Every government leaders were exercising their power over the owner of the land. Since the power was in their hand there was nothing that can be done rather than accepting any measure or decision. At the time to be free from prison the only option was corruption, hence

the relatives of Kiro and his brothers discussed and decided to give bribes for the leader to make him free of jail. See the extract:

Warri gosaa horii gurguranii gubboo kennanii ji`a sadiin booda lafa gadi lakkisuuf farramanii mana hidhaatii bahan (f.134).

The relatives sold cows and gave bribes to the leaders and they agreed and signed to leave the land after three months and become free of the prison well (p.134).

To make their family out of jail cows were sold to collect money. As soon as the bribe was given to the leaders of Bokoji they get free of jail by assigning to leave the land after three months. This shows us how much the system of that time was suitable for corruption. The leaders were collecting society's money illogically by using their power. The peasants have loosed two things (i.e. their land and money); nobody can feel sorry for them rather than facilitating for their own and the one who had an agreement with the leaders and the upper class of the time. Through such cruelty, they throw out the owner of the land and replaces them with the one who was good for them.

Such a bad deed leads Kediwo to take revenge. After he became free of the jail Kediwo shoot both the Bokoji Woreda leader and Fitewurari Aweke. Then he went to Wabe forces and become a bandit with his brothers.

Kadiroon mana hidhaatii bahee ji`a sadiin booda baay`ee tokko adamsee Fitewuraariifi bulchaa waradaa bakka tokkotti argatee xiyiitii tokko tokkoon gombisee oboleewwansaa wajjin wabeetti gale (f. 125).

After three months of Kediwo became free of the jail, he seriously followed Fitewurari and the Woreda leader and gets them at the same place and faired by one bullet each of them and he interned in the jungle with his brothers (p.125)

Kadiwo was forced to take such harsh judgment because of the cruelty of both Fetwurari and the Woreda leader. They used their power and forced them to be homeless and landless. The landowners were tried to give justification and resist not leaving the land since it was their property starting a long time. But, both Fetwurari and the leader didn't consider their idea. Such bad activities are stored and lead Kediwo to take revenge on them.

To sum up, in the novel 'Kusaa Gadoo', the clear picture of the Oromo economy during the dictatorial government was realistically reflected. The Oromo were corrupted by the leaders of that time, they paid income tax, and their land was used by political leaders, by relatives of leaders, and by Amhara investors illegally. The Oromo were forced to leave their land and migrated to other area or to take revenge and becomes a bandit. The political leaders live a luxurious life using the economy of Oromo society, whereas

the Oromo pushed to lose his life completely. The income tax collected from the society was deposited in individuals account, and then the bribe for land sharing also goes to their account. It was difficult for poor peasants of Oromo society since their life is depending on land; they used it for every income-generating their land. The Oromo peasants had no legal protection for their land use. This can be supported by the next quotation:

The Derg regime (1974–1991) had introduced a public land tenure system. Land laws currently in force also do not sufficiently protect the rights of rural land users. In March 1975, the Provisional Military Administration Council (PMAC), or Derg, proclaimed a sweeping land reform which aimed at bringing about a complete transformation in the country's complex land tenure system and its social and political structure. More than land reform, the measure should be called a land revolution, for there was nothing reformist in Derg's approach (Marina, 1977, p.79). 1975, Land Reform Proclamation effectively destroyed the landlord-tenant relationship that had caused massive suffering and exploitation especially in the southern part of Ethiopia (John, 1996).

The land is not only a vital livelihood asset but also indispensable for the enjoyment of several human rights including the right to life, the right to food, the right to housing, the right to property, the right to development, and the right to self-determination. However, smallholder farmers do not have adequate legislative protection as laws and practices facilitate arbitrary expropriations and land grabbing, which induces an economic marginalization of most ethnic groups in Ethiopia especially Oromo (Solomon,2020).

## **5. CONCLUSION**

From the analysis and discussion made it is found that, in 'Kuusaa Gadoo', all events and episodes were realized in the novel without any fantasy and extraordinary overstatement. The economic situation of the Derg regime as reflected in 'Kuusaa Gadoo' was not fairly distributed. The economy is dominated by a specific ethnic group and the Oromo were under domination. Oromo's economy was corrupted by the political leaders, they were forced to leave their land and migrate to other places. So, the leaders of the dictator governments live a luxurious life at the expense of poor peasants.

Most of the economy of the Oromo people depends on land. However, the political leadership of the Derg regime degraded Oromo's economy and used it for their personal life. Hence, Oromo were not economically beneficial during the Derg; the economies of Oromo peoples were used by others i.e. by leaders and investors from other ethnic groups.

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# Incidence of multiresistant antimicrobial *Staphylococcus* in the hands of Health Basic Unit professionals

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## Abstract

*Staphylococcus* is an important etiologic agent of infections in hospital and healthcare settings. One of the means of proliferation of these agents is the contamination of the hands of professionals who perform health care. This research aimed to identify the possible incidence of multiresistant *Staphylococcus aureus* colonized in the hands of health professionals, before and after hand hygiene, and its correlation with the spread of infections in these environments. The research was carried out by biochemical tests in the laboratory, of which results indicated the colonization by *Staphylococcus* even after hand hygiene (88.3% positive and 11.7% negative); this allows the dissemination of the bacteria to other patients and environments. The samples were submitted to the multiple antimicrobial resistance index, and data showed the persistence of microorganisms resistant to the 15 antimicrobials used. So additional studies need to be done in order to suggest effective actions and awareness of health professionals about hand hygiene as an important preventive action in hospital and health care settings.

**Keywords:** *Staphylococcus*; Infections, Hand disinfection; Pathogenic bioagents; Human microbiota; Antibiotics.

## 1. Introduction

Health care workers are constantly exposed to pathogenic bioagents in their different jobs, but most of the time they do not get sick. This does not indicate that health care workers are more resistant, but because the normal microbiome is intrinsically resistant to colonization and infection by external microorganisms. A number of factors, including hand hygiene, the range of their exposure to contagious agents, modifies this intrinsic resistance and the inherent immunocompetence associated with the ecological relationships between the pathogen and the host microbiome<sup>[1]</sup>.

The human microbiome is associated with host health and disease, but most of the evidence supporting this association is based on studies of intestine microorganisms. For the microbiome of other body parts, including the skin, it is not clear to what extent it influences a person's ability to carry or resist a pathogen<sup>[2,3,4]</sup>. However, there is evidence that health care workers' hands are the most common transmission vector of microorganisms from patient to patient, as well as within the hospital environment<sup>[5,6]</sup>. Human skin is permanently colonized by physiological or resident microbiome and, temporarily, depending on nature and its characteristics by several pathogenic agents that belong to the transient microbiome<sup>[7,8]</sup>. The microorganisms of the resident microbiome are found mainly on the skin surface and under the superficial cells of the stratum corneum, and are not considered pathogenic in intact skin, but can cause infections in sterile body cavities, in the eyes, or the skin with the presence of lesions<sup>[9]</sup>.

It is important to highlight that the transitory microbiome is composed of microorganisms that colonize the more superficial layers of the skin, considered potential infectious pathogens<sup>[10]</sup>. It can be acquired from the hospital environment, by direct contact between professionals and patients, by contact with contaminated surfaces or objects, or as a consequence of poor hygiene, thus being responsible for cross-infection<sup>[8,11]</sup>. The predominance of gram-negative bacteria, especially Enterobacteriaceae, bacteria type *Pseudomonas* and *Acinetobacter*, gram-positive bacteria of *Staphylococcus* and spore-forming anaerobic, and, fungi and viruses, with higher pathogenicity, are commonly associated with outbreaks of severe nosocomial infection due to their high and multiple antimicrobial resistance patterns<sup>[9,10,12]</sup>. About 20% of individuals are carriers of *Staphylococcus*, called persistent carriers; however, approximately 60% are considered intermittent carriers, and the others never show up as colonized<sup>[13]</sup>.

The species *Staphylococcus aureus* has shown to be an important etiological agent of nosocomial infections with the ability to acquire resistance to antimicrobials. The Intensive Care Units (ICU) stand out as the place of the predominance of such microorganisms associated with the most relevant adverse events related to the care of patients<sup>[14-17]</sup>. In synthesis, professionals working in ICUs and internal medical rooms are more prone to contamination. This can be explained by the more frequent contact with patients and other unidentified factors<sup>[15]</sup>.

Hand hygiene has been identified as one of the most effective procedures to control the transmission of infections in hospital environments, and educating professionals about it is an important tool to ensure its successful implementation. To persuade users, and as part of education, it is important to provide evidence on the importance of hand hygiene in reducing bacterial microbiota<sup>[11,18-20]</sup>. Evidence-based hand hygiene can prevent the transmission of nosocomial pathogens and, also, keep the health care team's skin healthy. In most clinical scenarios, antisepsis is recommended for hand decontamination for better efficacy and cutaneous tolerance. Whereas conformity could be improved by the knowledge of the main clinical circumstances, in which hand antisepsis by health care professionals really benefits the patient<sup>[8]</sup>.

Due to the patient's safety barrier failures and prevention control errors concerning hand hygiene, the present objective of the study was to verify the incidence of multidrug-resistant *Staphylococcus* antimicrobials in the hands of the Basic Health Unit (BHU) professionals.



## 2. Materials and methods

Sixty professionals from BHU Fernandópolis/SP collaborated in this study, being nurses, technicians and nursing assistants, resident doctors, pharmacists, pharmacy and medicine interns, clerks, dentists, X-Ray technicians, of both genders. The Research Ethics Committee of the Camilo Castelo Branco University under the ruling 1.560.268 and CAAE number 54979316.4.0000.5494 approved the study. Professionals who agreed to participate and signed the Free and Informed Consent Term were included in the study. Professionals who were in skin treatment were excluded.

The samples were collected with the help of a sterile Swab before and after the participants' hands were sanitized. The Swab was rubbed on the hand palm and the inter-digitals in zigzag, in one direction, deposited in a sterile test tube and taken to the microbiology laboratory for dilutions. This technique followed the methodology described by Alwis et al<sup>[6]</sup>. For hand hygiene, it was used soap and water for a period of thirty seconds, following the BHU routine. The study was carried out in triplicate.

The samples were submitted to serial dilutions in 0.5% NaCl solution for culture in Baird Parker Agar environment, incubated at 37°C for 24-48 hours. Colonies were counted and results were expressed in Colony Forming Units (CFU).

Typical *Staphylococcus* colonies were submitted to Gram staining and observed under a light microscope. Once the morphological characteristics were confirmed, these colonies were sub cultivated in the Baird Parker Agar environment and submitted to biochemical catalase and coagulase tests<sup>[21]</sup>.

The identified *Staphylococcus* were evaluated regarding the susceptibility profile to antimicrobials. The disk diffusion method was used, and the antimicrobials evaluated were: amoxicillin (AMC) 30µg, Ampicillin (AMP) 10µg, Cephalothin (CPL) 30µg, Ciprofloxacin (CIP) 5µg, Clindamycin (CLI) 2µg, chloramphenicol (CLO) 30µg, erythromycin (ERY) 15µg, gentamicin (GEN) 10µg, oxacillin (OXA) 1µg, cefoxitin (CFO) 30µg, penicillin G (PEN) 10µg, rifampicin (RIF) 5µg, sulfazotrim (SUT) 25µg, tetracycline (TET) 30µg, and vancomycin (VAN) 30µg. The results were interpreted in accordance with the parameters established by the Clinical and Laboratory Standards Institute (CLSI)<sup>[22]</sup>.

The multiple antimicrobials resistance (MAR) index was calculated according to the methodology described by Krumperman<sup>[23]</sup>. It was calculated by the ratio between the numbers of antibiotics to which the isolated one showed resistance and the number of antibiotics to which the isolated one was exposed, MAR greater than 0.2 showed multidrug resistance.

For statistical analysis, Fisher's exact test and tests for one and two proportions were applied to observe significant differences between frequencies; Wilcoxon's test to observe significant differences between the *Staphylococcus* count before and after sanitization; and Kruskal-Wallis test to compare antibiogram results. All statistical tests were performed at a 5% or ( $P < 0.05$ ) significance level, and the software used was Minitab 17 (Minitab Inc.).

## 3. Results

Most of the professionals evaluated were female ( $n=44$  - 73.3%), as for employees were pharmaceutical and medicine interns ( $n=25$  - 41.7%), physicians ( $n=15$  - 25.0%), nursing assistants ( $n=5$  -

8.3%), clerks (n=5 - 8.3%), nurses (n=4 - 6.7%), dentists (n=2 - 3.3%), pharmacist (n=2 - 3.3%), X-ray technician (n=1 - 1.7%) and nursing technician (n=1 - 1.7%).

The percentages referring to the *Staphylococcus* presence analysis before and after sanitizing the hands were also analyzed (Table 1), and it was possible to observe that, through the test for two proportions, there was no difference between the presence of *Staphylococcus* before and after health care professionals hand sanitizing since the resulting p-value was higher than the level of significance used for the test.

**Table 1.** Occurrence percentage of *Staphylococcus* before and after sanitizing the health care professionals' hands assessed in the study.

<i>Staphylococcus</i>	Before	After	p <sup>1</sup> Value
presence	45 (75,0%)	53 (88,3%)	0,097
absence	15 (25,0%)	7 (11,7%)	

<sup>1</sup>p value referring to the Fisher's exact test at p<0,05.

One result that deserves to be highlighted in this analysis was the increased occurrence of *Staphylococcus* in the hands of the health care professionals evaluated after the sanitizing, due to the expectation of opposite result. This outcome can be justified by the fact that 52 (86.7%) professionals evaluated did not sanitize their hands with the correct technique, and only 8 (13.3%) health care professionals sanitized their hands using the appropriate procedure.

The colonies with *Staphylococcus* morphology characteristic, confirmed by Gram staining and light microscopic observation, verified that 66.1% presented positive results for the coagulase enzyme while 33.9% were negative for this test (p=0.015).

Table 2 shows the descriptive statistics of the *Staphylococcus* count on the hands of the 60 professionals evaluated before and after sanitization.

**Table 2.** Descriptive statistics of *Staphylococcus* count of the health care professionals' hands assessed before and after sanitization.

Sanitization	Rate $\pm$ Pattern Deviation	Median	(Min; Max)	p <sup>1</sup> Value
before	2,4.10 <sup>3</sup> $\pm$ 6,3.10 <sup>3</sup>	0,4.10 <sup>1</sup>	(0,0;4.10 <sup>4</sup> )	<0,001
after	2,8.10 <sup>3</sup> $\pm$ 3,0.10 <sup>4</sup>	0,1.10 <sup>1</sup>	(0,0;4,1.10 <sup>5</sup> )	

<sup>1</sup>p value referring to the Wilcoxon test at p<0,05.

The data in Table 2 show that the count of *Staphylococcus* before and after hand sanitation showed significant differences (p<0.001), assuming that the count after sanitation was significantly lower than the count before sanitation. Such a result was possible to be observed due to the median values, since the statistical test applied was non-parametric, precluding the average analysis due to the high pattern deviation and coefficient of variation of data distributions. It was verified that 41 (68.33%) health care professionals presented *Staphylococcus aureus* before and after hand sanitation.

A total of 15 antibiotics were evaluated to observe *Staphylococcus* resistance to these compounds. Results showed that the bacteria multidrug resistance was significant compared to the antibiotics assessed,

since the proportion of resistant bacteria (64.5%) was significantly higher, ( $p=0.030$ ), than the sensitive bacteria proportion (33.5%).

Table 3 displays the antibiogram descriptive statistics of the bacteria evaluated in relation to antibiotics investigated. Antibiogram results demonstrated that there were no significant differences in the antibiogram of the bacteria when all antibiotics were compared ( $p=0.091$ ). The high data variation showed the need to use a non-parametric comparison test to support the statistical result. As the p-value was higher than the significance level ( $p<0.05$ ), there were no significant differences in the comparison of the antibiograms.

**Table 3.** *Staphylococcus* antibiogram about the antibiotics studied.

Antibiotics	Rate $\pm$ Pattern Deviation	Median	(Min; Max)	p <sup>1</sup> Value
AMC	11,17 $\pm$ 12,64	3,00	(0,0;32,0)	0,091
SUT	7,65 $\pm$ 12,14	0,00	(0,0;35,0)	
CIP	13,22 $\pm$ 12,91	14,50	(0,0;35,0)	
CPL	15,65 $\pm$ 16,84	5,00	(0,0;44,0)	
GEN	9,85 $\pm$ 10,84	0,00	(0,0;27,0)	
AMP	8,76 $\pm$ 11,53	0,00	(0,0;39,0)	
OXA	8,39 $\pm$ 10,19	0,00	(0,0;33,0)	
CLI	9,46 $\pm$ 10,67	0,00	(0,0;30,0)	
VAN	10,33 $\pm$ 10,61	10,00	(0,0;30,0)	
CLO	8,02 $\pm$ 11,72	0,00	(0,0;35,0)	
RIF	10,35 $\pm$ 14,31	0,00	(0,0;40,0)	
ERY	6,61 $\pm$ 9,51	0,00	(0,0;30,0)	
PEN	8,43 $\pm$ 12,25	0,00	(0,0;33,0)	
TET	5,54 $\pm$ 9,72	0,00	(0,0;35,0)	
CFO	9,65 $\pm$ 12,57	0,00	(0,0;33,0)	

<sup>1</sup>p value referring to the Kruskal-Wallis test at  $p<0,05$ .

Table 4 shows the percentages of bacteria resistance to each of the antibiotics evaluated. The results show that seven antibiotics (SUT, AMP, CLO, ERY, PEN, TET, and CFO) presented proportions that differed significantly when compared between resistant and non-resistant microorganisms. In all cases that this difference was significant, the proportion of resistant microorganisms was significantly higher than the proportion of non-resistant microorganisms.

**Table 4.** Occurrence percentage of *Staphylococcus* resistance in relation to the antibiotics studied.

Antibiotics	Non-resistant		Resistant		p Value
	N	%	N	%	
AMC	18	39,13	28	60,87	0,184
SUT	13	28,26	33	71,74	0,005
CIP	23	50,00	23	50,00	1,000
CPL	21	45,65	25	54,35	0,659
GEN	21	45,65	25	54,35	0,659
AMP	13	28,26	33	71,74	0,005
OXA	19	41,30	27	58,70	0,302
CLI	18	39,13	28	60,87	0,184
VAN	21	45,65	25	54,35	0,659
CLO	15	32,61	31	67,39	0,026
RIF	17	36,96	29	63,04	0,104
ERY	14	30,43	32	69,57	0,011
PEN	6	13,04	40	89,96	<0,001
TET	10	21,74	36	78,26	<0,001
CFO	13	28,26	33	71,74	0,005

By analyzing the average and median values it was possible to observe that the great majority of the evaluated microorganisms were classified as multidrug-resistant, because, on average, the multidrug resistance index resulted in a value much higher than 0.2 (Figure 1).

**Figure 1.** Individual values for the multidrug resistance index of the evaluated microorganisms.

## 4. Discussion

Infection transmission by contaminated hands of health care workers is a common pattern observed in most health care facilities<sup>[1-3,8,15,19,24,25]</sup>. The failure to ensure proper hand hygiene practices is one of the main causes of infections associated with health care and the spread of multidrug-resistant organisms and has been recognized as an important contributor to outbreaks of infectious diseases by the World Health Organization (WHO). The WHO recognizes that health care professionals washing hands with soap can prevent infection in patients and is the most effective and cheapest way to prevent pathogenic microorganism transmission<sup>[11]</sup>.

The hands of health care workers might be colonized by *Staphylococcus aureus*, *Streptococcus pneumoniae*, *Enterococcus spp*, *Escherichia coli*, *Pseudomonas aeruginosa*, *Clostridium difficile*, *Candida albicans* among other microorganisms<sup>[1,5,9,15,18-20]</sup>.

*S. aureus* colony is asymptomatic, which makes it possible to contaminate other parts of the body, particularly the hands, which become vectors of microorganism contamination by contact. Since the presence of *Staphylococcus* is high in a hospital environment, this bacterium is responsible for the majority of infections by contamination, especially through the hands of contaminated professionals and patients/users<sup>[15,24]</sup>. In this study, the hands of the evaluated health care workers were colonized by *Staphylococcus* (Table 1), however *S. aureus* was isolated in most of the participants, (n=41 - 68.33%).

Considering that the health care professionals' hands represent the main transmission route of nosocomial pathogens and are permanently colonized by the resident microbiota and temporarily, by the transitory microbiome, the survival time of microorganisms in tissues must be considered. *Staphylococcus aureus*, for example, can survive for 120 minutes on the hands and is found in 10% to 78% of professionals, *Pseudomonas spp* from 30-180 minutes being isolated in 1-25% of individuals, while *Escherichia coli* from 60-90 minutes not being known the isolations percentage<sup>[8]</sup>.

After hand sanitization, the inefficiency of the technique used by the participants was verified, since the presence of *Staphylococcus* percentages after hand sanitization of the professionals evaluated in the study showed an increase in the occurrence of the microorganism, in contrast to the expected result. From the professionals evaluated, 11.7% (n=7) do not show isolated from the microorganism, while 88.3% (n=53) with the presence of *Staphylococcus* on the hands (Table 1). This finding may be associated with incorrect hand sanitizing techniques or contamination by the material used in the procedure, as well as the age of the professional, and the work shift, significantly favoring transportation of pathogens<sup>[1]</sup>.

In a study performed by Tselebonis et al.<sup>[15]</sup> *Staphylococcus spp.* was verified that the prevailing microorganism (60.8%), followed by different Gram-negative pathogens (45.6%). ICU staff had a significant probability of contamination with Gram-negative bacteria (95%), regardless of gender or occupation. These authors observed the presence of *Staphylococcus spp* was associated with the work in the internal medicine ward (95%) and the surgical ward (95%), is prevalent in males versus females (81.3% vs. 54.9%,  $p = 0.008$ ) and doctors versus nursing staff (76.9% vs. 54.8,  $p = 0.019$ ). Similar results were obtained by Alwis et al.<sup>[6]</sup>, who found that out of 60 medical students, only 40 (66.7%) said they had washed their hands with soap after using the toilet and that more women (83%) used soap to wash their hands than men (50%). The bacterial load on the hands of both sexes showed an increase after the use of the toilet,

being greater among male students, *Staphylococcus aureus* was isolated from the hands of 21 students from both genders.

The infective dose, or number of CFU for most microorganisms, capable of inducing infection in individuals in the local community and/or hospital, is not yet established. The higher the number of CFU (microbial load), the greater the risk of contamination/infection<sup>[10,19]</sup>. *Staphylococcus* count before and after hand sanitization showed significant differences ( $p < 0.001$ , Table 2). The participants' hands before sanitizing showed counts ranging from  $2.4$  to  $6.3 \times 10^3$  CFU, while after hand washing there was a significant increase in CFU ( $2.8 \times 10^3$ – $3.0 \times 10^4$ ). These results are probably related to inadequate use of procedures or materials contamination<sup>[6]</sup>, or even due to superficial hand layers peeling, which bacteria adhered to the deeper strata of the corneal layers survived, or were transferred from one hand to another<sup>[10]</sup>.

Numerous researches have documented that the number of transient and resident microbiome varies considerably from person to person and is relatively constant<sup>[3-5,8,9,13,15,18-20,25]</sup>. A higher prevalence of antibiotic-resistant microorganisms in the workers' hands related to patient care compared to non-patients and/or outpatients<sup>[1,5,14-16]</sup>. In the antimicrobial sensitivity tests, it was verified that the majority of *Staphylococcus* isolated patients presented a pattern of multidrug resistance, considering the MAR test, which considers antibiotic-resistant the isolated ones with an index greater than 0.2<sup>[23]</sup>. The average and median values showed that the great majority of the evaluated microorganisms were classified as multidrug-resistant, because, on average, the multidrug resistance index resulted in a value much higher than 0.2 (Figure 1). Thus, it was found that seven isolated patients did not present multidrug resistance, and the other isolated ones had indexes greater than 0.2, highlighting that, among these, thirteen isolated patients whose MAR was 1.0.

Methicillin-resistant *Staphylococcus aureus* (MRSA) is the most common agent associated with nosocomial infections, as well as significant morbidity and mortality. Health care workers act as carriers of MRSA and transmit the disease between individuals<sup>[1,9]</sup>. Antibiotic-resistant microorganisms directly influence increased morbidity, mortality, hospitalization duration and economic burden in hospitals has been significantly noted with such infections. Health care workers play the main role among the various microorganisms' dissemination routes. Studies conducted to assess the prevalence of MRSA carriers among health care workers have found an estimated 10-40%<sup>[15,16,20]</sup>.

Hand sanitization, as a preventive measure against microorganisms' contamination, is indispensable before and after a hospital or health care procedures, with the correct technique and materials. It acts to reduce the potentially pathogenic bacteria transmission, including those resistant to antimicrobials, and the risk of morbidity and mortality due to these infections, in addition to preventing the microorganism's contamination and the infections proliferation, which can considerably reduce their occurrence<sup>[3-5,18,25]</sup>.

Although some difficulties in adhering to hand sanitizing are recognized, most infection control specialists agree that it is a simple and effective method for preventing bacteria transmission and the infection occurrence outbreaks in health care environments<sup>[8,18-20]</sup>.



## **5. Conclusion**

Health care professionals, when providing the patient's safety, should have greater preventive care in the elimination of the microorganisms located in the hand, wrist, and interdigital skin areas. It is reaffirmed that the adhering to the hand sanitizing practices, simple and with antiseptic friction, besides the routine to be followed in the daily life of the health care team, reduces the contamination risks to the patients, to the professionals themselves in the patient-professional relation and the global costs of health care.

In this regard, it is attributed as a preponderant factor to the training of health professionals, enabling them to understand the contagion risks and proliferation, since they are vectors that carry pathogenic bio agents, due to prevention errors and infection control. It is worthy remembering that the adhesion to the practice of hand sanitization enables, besides complying with the prevention norms established for health care, it offers protection and safety to the patient and the professional, extended to the community that, ultimately, may become a repository of these microorganisms when they spread in the environment.

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## **DECLARATION OF POTENTIAL CONFLICT OF INTEREST**

The authors declare no conflict of interest.

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# **PARFOR AND THE CHALLENGES FACED BY TEACHER-STUDENTS IN THE PEDAGOGY COURSE IN CAPITÃO POÇO, PARÁ**

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## **Abstract**

*This research aimed to approach Plano Nacional de Formação de Professores da Educação Básica*

(PARFOR<sup>1</sup>) and the challenges faced by teacher-students in the Pedagogy Undergraduate Course, Class 3, Capitão Poço, Campus of Bragança - Federal University of Pará/Brazil. In synergy, the study evolves from the two main issues: what are the challenges faced by the teacher-student of the Pedagogy Undergraduate Course between the years 2015 and 2019? and, To what extent, did these challenges affect (or not) the academic education process? The research methodology was characterized by a qualitative approach involving observation and participatory research, with the application of a semi structured questionnaire, answered by six teacher-students from the studied class. Data analyses approached the content of the informants' narratives. Results revealed that the challenges faced, extended beyond the classroom context, methodological and evaluation processes handled by course professors, encompassing issues of family absence, financial limitations and political reverberations. The study evidenced situations involving employment bonds that greatly influenced academic and psychological performances of the teacher-students. As a conclusive evidence, we can affirm that challenges led to evasion of some teacher-students, but for the majority of the class, they became fuel for resilience and permanence until the end of the Course.

**Keywords:** PARFOR; teacher education; challenges; teacher-students.

## 1. Introduction

Teacher education in Brazil is a topic under constant discussion and has been gaining even more strength in the last decades in the political-educational national agenda. Despite the recognition, albeit timid, of the importance of the teacher's role in public schools in Brazil, public policies still call for contextualized guidelines so that this importance – so emphasized in political party discourses – may effectively result in better working conditions and professional valorization, avoiding, for example, the usual 'transference of responsibilities' [of the educational failure]. From students' literacy to social, political and educational conditions, every underachievement has been conferred to teachers.

Education is a fundamentally important factor in the life of each and every citizen. It is constitutionally guaranteed in Article 205 of the Federal Constitution of 1988, which reads "Education, the right of all and the duty of the State and the family, will be promoted and encouraged with the collaboration of society, aiming at the full development of the person, their preparation for the exercise of citizenship and their qualification for work". Based on this premise, Gatti (2008, p. 62, our translation), points out that

During the last decade, the concern with teacher education has entered the world agenda due to the combination of two movements: On the one hand, the pressures of the world of work, which has been structured under new conditions, following a computerized model and regarding the value acquired by knowledge, on the other hand, the ascertainment of the extent assumed by the precarious school performance of a large part of the population by the government systems. One contradiction and one dead end. Public policies and political actions then, move towards curricular reforms and changes in the education of teachers who are in

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<sup>1</sup> National Plan for the Development of Basic Education Teachers

charge of forming new generations.

Faced with a scenario of shortages and emergencies that accumulated in the educational sphere, in April 2007, the Federal Government launched the *Plano de Desenvolvimento da Educação*<sup>2</sup> (PDE), articulated with Decree No. 6,094, of April 24, 2007, which provides for the implementation of “*Plano de Metas Compromisso Todos pela Educação*”<sup>3</sup>, in collaboration with municipalities, Federal District and states.

Subsequently, the program entitled *Plano Nacional de Formação de Professores da Educação Básica*<sup>4</sup> (PARFOR) emerges under the label of ‘emergency program’ created by the Federal Government and which was materialized by Decree No. 6,755, of January 29, 2009, and implemented in collaboration with *Coordenação de Aperfeiçoamento de Pessoal de Nível Superior*<sup>5</sup> (CAPES), the states, the municipalities, the Federal District and the higher education institutions, aiming to offer free and quality higher education for teachers without proper qualifications, but already in-service in the public basic education sector. PARFOR represents a policy that offers the opportunity of access to higher education to professionals who have not yet had the required instruction foreseen by *Lei de Diretrizes e Bases da Educação Nacional*<sup>6</sup> (LDB), No. 9.394 / 96.

In this sense, the state of Pará adhered to this policy of teacher education and several of its municipalities were covered, including Capitão de Poço, which received some undergraduate courses, such as the Pedagogy Course managed by the Federal University of Pará and hosted and delivered by the University Campus of Bragança, Department of Education, held at Capitão Poço.

The Pedagogy Course was established with the main purpose of improving the learning process of individuals, through reflection, systematization and knowledge production. As a social science, Pedagogy must be connected with the knowledge socially produced, as well as focused on meeting the educational standards of each country where it belongs to (SILVA, 1999).

According to Franco (2008, p. 149, our translation), the Pedagogy course...

Represents the only undergraduate course where the critical and contextualized analysis of education and teaching is carried out as a social praxis providing the future pedagogue with theoretical, scientific and technical development with a view to deepening pedagogical theory, educational research and the exercise of specific pedagogical activities.

Certainly, throughout history, Pedagogy has undergone significant changes before reaching the current scenario. It has become the most expressive course for the area of Early Childhood Education and Elementary Education, not to mention its dimensions in the fields of management, pedagogical coordination in school and non-school environments, which goes beyond didactics itself.

From this scenario, rises the motivation to research on this topic, a decision made for several reasons and, particularly, for the opportunity of sharing the daily experiences undertaken with Class 3, year 2015,

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<sup>2</sup> Education Development Plan

<sup>3</sup> Target Plan Commitment All for Education

<sup>4</sup> National Plan for the Development of Basic Education Teachers

<sup>5</sup> Council for the Improvement of Higher Education People

<sup>6</sup> Law of Directives and Bases of National Education



Captain Poço, Pedagogy Undergraduate Course (herein denominated PARFOR Class 3). These experiences involved the authors of the present paper in the roles of professors and students allowing us to realize from distinct points of view, the challenges faced, the students' anguish and their overcoming efforts through routs full of doubts and uncertainties all through the course length.

Right from the very beginning of the course, some problems emerged as a consequence of students' difficulties in adapting to the course demands and expectations. Some of these difficulties turned into limitations and challenges to be overcome along the academic trajectory. The adversities, which reflected political policies, began to increase in the period of transition from municipal governments. It is a common practice of local administrations to substitute the staff of collaborators when a new governor or mayor is elected. As many students from this class were and are teachers with temporary contracts in several municipalities, namely: Capitão Poço, Ourém, Garrafão do Norte, Irituia, São Miguel do Guamá, Igarapé Açu, Ipixuna and Mãe do Rio, these structural changes resulted in terminating employment contracts, thus affecting the lives of many who were taking part in PARFOR. The obvious consequences were teacher-students' dropouts, financial difficulties and impossibility to meet commitments involved in remaining in the host city of Capitão Poço for the month of classes<sup>7</sup>, which involved material acquisition, food, accommodation and transportation costs.

In view of this initial contextualization, our study proposes reflections about the PARFOR program, highlighting the challenges of the teacher-students enrolled in the Pedagogy course, Class CP03, Capitão Poço, PA. At this point, it's useful to clarify the denomination *teacher-student*, justified by the fact that the PARFOR students were prior *teachers in-service* who returned to the continuous education environment to obtain adequate qualification.

The relevance of the present study is reasonably sustained, as it demonstrates the profiles, the difficulties and academic performances of the teacher-students from PARFOR, and its results may foster insights and promote policies for adjusting the offer for the new classes, ensuring possibilities of employment bonds and students' permanence in the Course.

In these grounds, we present the following questions: a) *What were the challenges faced by the teacher-student of PARFOR Class 3, in Capitão Poço, between 2015-2019?* b) *To what extent did these challenges affect or not the academic education process?*

Our main objectives were: i) to access and apprehend the policies undertaken in the initial education of teachers in the northeastern region of Pará through the PARFOR program; and more specifically, ii) to identify the challenges faced by the teacher-students during the Pedagogy undergraduate course, and; iii) to reflect on the impacts of such challenges in the process of academic development of the teacher-students.

## 2. Theoretical references: principles and concepts in teacher education

Teacher education has been the focus of many debates and reflections considering the changes that have taken place in the educational scenario and, consequently, the recent transformations have aimed to achieve the quality of teaching and learning in Brazilian public schools, which, certainly, involves teacher's

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<sup>7</sup> Many of PARFOR teacher-students came from neighbouring towns to attend classes in Capitão Poço. Considering the daily course load of eight hours, they remained in Capitão Poço for the entire week.

educational development.

In this sense, Saviani (2009, p. 144, our translation) provides us with the arguments, “the issue of teacher qualification emerges explicitly after the independence [of the country], when considering the organization of popular education”. The same author argues that the following periods in the history of teacher education in Brazil can be distinguished:

1. Intermittent teacher education experiences (1827-1890). This period begins with provisions of *Lei das Escolas de Primeiras Letras*<sup>8</sup>, which obliged teachers to search for instruction using the method of mutual teaching, at their own expense; this period extends until 1890, when the model Normal School<sup>9</sup> prevails.
2. Establishment and expansion of the standard of the Normal Schools (1890-1932), whose initial landmark is the São Paulo’s reform of the Normal School having as annex ‘the model school’;
3. Organization of the Institutes of Education (1932-1939), whose milestones are the reforms of Anísio Teixeira in the Federal District, in 1932, and Fernando de Azevedo in São Paulo, in 1933;
4. Organization and implementation of Pedagogy and Teaching Courses and consolidation of the Normal Schools Model (1939-1971);
5. Replacement of the Normal school by the Specific Teaching Qualification (1971-1996);
6. Emergence of Higher Education Institutes, Normal Higher Schools and the new profile of the Pedagogy Course (1996-2006) (SAVIANI, 2009, 144, our translation).

In this perspective, many reformulations have taken place throughout the history of teacher education. In particular, in the context of the 1990s, with the reforms of the State, when new educational development policies started to be demanded to meet the needs for improvement in the educational scenario. The purpose was that of qualifying basic education teachers to face the new challenges presented by educational process. From then on, a set of guidelines, policies and State policies were set up to promote changes in the educational domain, especially with the enactment of *Lei de Diretrizes e Bases da Educação Nacional (LDB)*<sup>10</sup> No. 9,394 / 96, which introduced significant changes to Education.

It is worth mentioning that, despite the recent amendment to LDB No. 9,394 / 96 (Law No. 12,796, of April 4, 2013), the major education law, after seventeen years of validity, continues to admit professionals without higher instruction for teaching at the level of *early childhood* and *early years of elementary school*. The “normal modality”, is still legitimate. Opposing Article 62 §4 which states: “The Union, the Federal District, the states and the municipalities will adopt mechanisms that facilitate access and permanence of teachers in development courses at higher level [to qualify them] to work in public basic education. According to Aranha” (2006, p. 45, our translation):

The neglect towards the education of teachers was compatible to a society not committed to prioritizing elementary education. In addition, the pragmatic tradition of welcoming untrained

<sup>8</sup> Law of the Schools of First Letters

<sup>9</sup> A normal school is defined as a school designed to prepare future teachers in regency competences.

<sup>10</sup> the National Education Guidelines and Bases Law

teachers prevailed. According to the assumption that there was no need for any specific teaching method. This trend, although beginning to be criticized by the government, would still prevail for a long time, due to the “artisanal” conception of teacher education.

That way, a generalized idea of decline and failure of the public school was disseminated, calling for restoration policies and taking into account that, despite the guidelines highlighted by the LDB of 1996, no effective national policy aimed at developing these teachers until the mid 2009s had been implemented, despite the fact that data from the School Census of that year pointed out to 638,800 teachers working in basic education without proper qualification.

Historically observing the inequalities concerning the access to education, especially to higher education by the popular social strata, Santos (2018, p. 5, our translation), affirms that “for a long time, education was restricted to a small portion of the population and only those who had real wages achieved higher levels of instruction and, consequently, better positions in the job market”. Likewise, the educational development of teachers was also restricted to those who had good financial conditions to seek improvement. Concurrently, those who worked as teachers were not required by law to have a post-secondary degree nor to have attended college. According to Nóvoa (1995, p. 21, our translation),

There is a profusion of overlapping and repetitive discourses, which are translated into a poverty of practices. Thus, analyzing the past and looking at the teachers' present, we perceive ups and downs in teacher education, its weaknesses, its limits and possibilities. This way, the consolidation of the teacher as a professional is a path full of struggles and conflicts, excitement and setbacks.

Previous studies portray the entire historical process and, more precisely, over the past two centuries, it is noticeable that, despite the successive changes regarding the teacher education process, the central issues have not yet been hit, revealing the precariousness of educational policies.

According to Saviani (2009), the need for teacher education was advocated by Comenius in the 17th century, however, the issue has only deserved an institutional response in the 19th century, after the French Revolution, when the problem of the popular institution was raised, stimulating the creation of Normal Schools as institutions in charge of preparing teachers to work in basic education schools.

Thus, in order to structure and sustain the educational development of these teachers, a series of legal documents arose, unfolding into actions in line with Art. 211 of the Federal Constitution, which states as purposes of the Federal Union, to “(...) guarantee [the] equalization of educational opportunities, and minimum quality standards of education by providing technical and financial assistance to states, the Federal District and Municipalities”.

In this perspective, the decisive policy for teacher education in recent decades has been dictated by the LDB No. 9,394 / 96. Following the world trend, the LDB determines that teachers of all educational levels should undergo higher education as recommended in Art. 87, § 4th, that is, after the ‘decade of education’ (1997-2007) was instituted, the admission of teachers to work at any education level began to require higher qualification or in-service training (BRASIL, 1996). However, the intended goal was not achieved and the “lay” teachers continued to work without the qualification required by law. As a

consequence, Art. 87 and § 4 were revoked by Law No. 12,796, of April 4, 2013.

In view of this scenario, the PARFOR project emerges – an emergency program created to comply with the provisions of Art. 11, Item III, of Decree No. 6,755, of January 29, 2009 – implemented in collaboration with CAPES, the states, municipalities, Federal District and Higher Education Institutions. The PARFOR program aims to offer higher education opportunities to teachers in service in basic education at public schools. CAPES data reveal that:

By the end of 2016, 2,890 courses had been implemented in 509 municipalities, located in 24 states of the Federal Union. During this period, PARFOR benefited teachers from 3,282 Brazilian municipalities belonging to 28,925 schools. Up to that year, the Program had registered 36,871 teachers taking a degree and 34,549 undergraduates (CAPES / BRASIL, 2016).

PARFOR was, then, planned among the actions of the PDE as one of the policies focused on improving the quality of Brazilian education. As a result of the joint action of the Ministry of Education (MEC), Public Institutions of Higher Education (IPES) and the Education Secretariats (SED), PARFOR has sought to put into practice the pact of collaboration signed among the Union, states and municipalities, at the same time that it has granted the federated entities autonomy and responsibility in the teacher education process.

PARFOR has been implemented with the objective of qualifying, within a certain period of time, as many teachers (as possible) among those who are teaching without an undergraduate degree, in compliance with Decree No. 6,755, of January 29, 2009. From 2016 on, the program started to be governed by Decree No. 8,752 / 2016, offering teacher education in the following modalities:

- I – Licenciature degree [teaching courses] for teachers or LIBRAS interpreters working in the public sector of basic education who do not hold a higher education degree or for those with a degree but willing to take a course in [and qualify for] the discipline they [effectively] teach;
- II - Second Degree, for undergraduate teachers who have been working for at least three years in the public basic education sector and who teach in a different area from that of their first degree, or for licenciature professionals who act as translator, interpreting Libras in the Public Basic Education sector;
- III - Pedagogical Degree, for undergraduate professors or translators interpreting LIBRAS who do not have teaching qualification [licenciature degree] to the exercise in the public basic education sector (BRASIL, 2009. Our translation and expansions).

Imbernón (2011) argues that the improvement in quality necessarily depends on teamwork becoming truly collaborative. It is up to the public administration – in the case of Brazil, the state and municipal education departments – to offer solid support to schools, so that the real transformation occurs in the performance of teachers. In addition, the author advocates,

In-service education requires an effective collaboration environment among peers. Whoever is not willing to change oneself will not transform the practice. Whoever thinks all they do is right, does not question their own actions. It is also necessary that the school or the education unit

has a stable organization – based on principles of respect, democratic leadership and collaborative participation – and admits that there is diversity among educators, which leads to different ways of thinking and acting (IMBERNÓN, 2011, p. 46. Our translation).

However, Gatti and Barreto (2009), emphasize that due to the very recent implementation of PARFOR, it would be necessary to wait a little longer to evaluate the effectiveness of what had been proposed, achieved and expected for the coming years, in reference to what reads in Decree 6,755 / 2009. However, there is strong evidence of limitations and contradictions that may compromise the quality of instruction offered by Higher Education Institutions, and therefore, such evidences must be subject of critical appraisal, as is the case under focus in the present study.

According to Demo (2000), the pillar of educational quality is the teacher – seen as someone who learns to learn, who thinks, educates others and is concurrently educated – a professional aiming at transforming the context, in which he exercises his profession.

In respect to this issue, Nóvoa (1995, p. 25, our translation) argues that ...

To undergo a degree implies a personal investment, free and creative work [in terms of selecting] the routes and projects, with a view to building an identity, which is also a professional identity (...). Consolidating a profession is not a process of accumulation (of courses, knowledge or techniques), but it requires critical reflection over practices and the permanent construction of a personal identity. That is why it is so important to invest in people and grant a status to the knowledge of the experience.

In view of the above foreshortened history, although in brief analysis, several changes in teachers' education policies are taking place and gaining more and more space in the scene of educational discussions and, in face of these changes and transitions, the history of Brazilian education – teachers' qualifications for the early years, for example – went through many transformations, implying new assignments to teaching practice.

### **3 Methodological Procedures**

#### ***3.1 Locus of the study***

The present study took place in the municipality of Capitão Poço, Pará, located in northeastern Pará, 224 km from the capital, Belém (Figure 1). According to IBGE (2018), the estimated population of Capitão Poço is 54,179 inhabitants.



**Figure 1.** Location of Capitão Poço. Source (Google maps 2019).

The economy of the municipality is based on cattle farming, vegetable extraction, commerce and agriculture. However, over time, a new source of economic activity has emerged – orange production – thus, upgrading Capitão Poço to the status of ‘the largest orange producer in the State of Pará’. Black pepper has also contributed significantly to the growth and development of the local economy. Its production takes place on short and large scales and its commercialization is aimed at export.

The culture of Capitão Poço is frequently highlighted in local festivities, among which are: the religious manifestations – as the celebration to pay homage to the city's patron, Santo Antonio Maria Zaccaria in the month of July and the Procession of Nossa Senhora do Perpétuo Socorro, usually in November. In addition, there is the Livestock Exhibition of Capitão Poço (EXPOCAP) and the Enduro das Águas (EA), with musical performances, agricultural fairs and cycling tracks. Local handicrafts, with emphasis to wood carving, are also of great importance in Capitão Poço.

The education scene in Capitão Poço has undergone great changes over the years, always prioritizing its guarantee and quality, especially regarding issues of schools infrastructure and improvement of teaching and learning methodology, with emphasis placed on the presence of public universities in the municipality. It is important to remark that education in Capitão Poço covers the rural and urban areas. In the rural environment, although improvements have taken place, an expected and greater difficulty result from factors such as poorly maintained roads and school physical conditions, a curriculum that has not yet been properly designed for the rural reality.

PARFOR Class 3, the object of the present study, is composed of twenty-nine (29) teacher-students, out of which 02 (two) are men and 27 (twenty-seven) women. The class originally started with thirty-five (35) students, however, six of them dropped out due to the alleged reasons: (i) long distances between the municipalities; (ii) lack of financial resources to cope with travels, accommodation, food and study materials expenses.

### 3.2 Data collection

Data collection took place between the years 2018 and 2019. The research employed a qualitative approach defined by Minayo (2009, p. 21, our translation) as that which “deals with the universe of



meanings, aspirations, beliefs, values and attitudes”. Therefore, the study was carried out with total respect to the informants' narratives and opinions, following the principles of research transparency and objectivity.

We used participatory research and observation techniques, defined by Martins (2008, p. 24, our translation) as “the period during which “the observer must be competent enough to observe and obtain unbiased information, avoiding interference of their own opinions and interpretations. Patience, impartiality and ethics are necessary attributes to the researcher”.

Sequentially, a questionnaire was conceived and applied with semi structured questions, aiming to build up the teacher-student profiles as well as to collect information about the challenges faced along the academic trajectory. According to Marconi and Lakatos (2013, p. 86, our translation) the “questionnaire is a data collection tool constituted by a sequenced set of questions supposed to be answered in the written form and without the presence of the researcher”.

The questionnaire was sent to the subjects by e-mail to enable them to provide information from their own distinct hometowns, as their presence in Capitão Poço was restricted to the class period (January-February and July- August), in compliance to the academic calendar offered by UFPA.

### **3.3 Sampling**

Sampling is a fundamental stage of the research, at this moment the researcher has to be aware that it is not possible to cover the entire universe of the research focus, and thus it is necessary [to crop the corpus] and analyze a small portion of this universe (MARCONI & LAKATOS, 2013).

The target audience of this research are the teacher-students enrolled in PARFOR Class 03. Out of the 29 teacher-students, 06 (six) were selected to constitute the corpus of analysis of the present study [02 (two) men and 04 (four) women] belonging to the municipalities of Igarapé Açu, Garrafão do Norte, Irituia, Capitão Poço, respectively.

The criteria used to choose the selected subjects were: the distance between the municipalities of origin and Capitão Poço (closer and more distant); the length of experience in teaching (novice and experienced teachers) and the situation of employment (employed and unemployed).

### **3.4 Data analysis**

Data processing was carried out through content analysis, which is one fruitful way to interpret the researched knowledge. Chizzotti (1998, p. 115, our translation) comments, it is “content analysis that builds a set of procedures and techniques to extract the meaning of a text by means of elementary units”.

## **4 Results and discussion**

### **4.1 Informants Profiles**

Concerning the profile of the informants, ages ranged from 36 to 44 years (average age is 38 years old), which means they are within the “productive stage” in the job market. Regarding the time of effective teaching, we have found it to vary from 3 to 18 years (teaching experience average is 13 years) in public institutions. In addition, Table 1 presents other necessary elements to compose the teacher-students' profiles.

**TABLE 1. PARFOR Class 3 Teacher-Students' Profiles**

RESEARCH SUBJECTS	AGE	GENDER	TEACHING EXPERIENCE	SCHOOLING LEVEL BEFORE PARFOR
Teach-Std 01	36	F	03 yrs.	Regular Upper Secondary Education
Teach-Std 02	37	M	14 yrs.	Higher Education Biology
Teach-Std 03	37	F	08 yrs.	Higher Education Geography
Teach-Std 04	38	F	08 yrs.	Regular Upper Secondary Education
Teach-Std 05	44	F	25 yrs.	Secondary level - Normal course (regency)
Teach-Std 06	37	M	18 yrs.	Secondary level - Normal course (regency)

Collected data allowed us to figure out that of the six informants, three are employed and the other half, unemployed. We were also able to confirm this circumstance of unemployment came forward after these professionals joined the PARFOR program, as a result of political changes in public administrators in their municipalities. Table 2 presents elements that sustain the arguments made so far.

**TABLE 2. PARFOR Class 3 Teacher-Students' Origins, Distances, Employment bonds, Incomes and Expenditures**

Informants	Origin and Distance	KM	Employment bonds	Monthly income	Afforded Expenditures
Teach-Std 01	Capitão Poço	13	Unemployed	Below one minimum wage <sup>11</sup>	Own and Familial resources
Teach-Std 02	Garrafão do Norte	36	Employed (Temporary contr.)	Over one minimum wage	Own resources
Teach-Std 03	Capitão Poço	3	Unemployed	None	Family Support
Teach-Std 04	Irituia	58	Unemployed	Below one minimum wage	Own and Familial resources
Teach-Std 05	Garrafão do Norte	36	Employed (Civil servant)	Over one minimum wage	Own resources
Teach-Std 06	Igarapé-Açu	110	Employed (Civil servant)	Over one minimum wage	Own resources

The table above allow us to visualize some of the challenges faced by teacher-students of PARFOR Class 3. Distances vary considerably according to the origin of the municipality. Some have to travel up to 110 km to reach the city of Capitão Poço where classes are held.

Furthermore, we must emphasize that the challenges imposed to teacher education today, go far beyond the logistic and financial issues mentioned above. They also reverberate, with greater intensity, on subjective, political and ideological issues such as 'what it means being a teacher today in our country'. About that Nóvoa (2009) affirms

We all know that it is impossible to define the << good teacher >>, except through these endless lists of competences, whose mere exhausting enumeration becomes unbearable. But it is possible, perhaps, to outline some simple behaviors, suggesting principles that characterize the teaching work in contemporary societies (NÓVOA, 2009, p. 28, our translation).

Some elements to overcome the pedagogical difficulties and characterize the professional profile, are put, not as a recipe, but in the category of possible indicators, namely: "knowledge, professional culture,

<sup>11</sup> Minimum wage in Brazil by the time of this research is R\$ 1.045,00 (One thousand and forty-five reais) per month

the pedagogical touch, the teamwork and social commitment” (NÓVOA, 2009, p. 30, our translation). In other words, based on these indicators, teacher education should be particularly thought and conceived, especially for the PARFOR target audience (teacher-students, who are already in service and looking for theoretical support to their pedagogical praxis). We would boldly risk to describe this movement towards further professional development as ‘theoretical deepening’ and ‘improvement of practices’ in the education context of basic education.

#### **4.2 The challenges revealed in the academic development of PARFOR teacher-students**

Undeniably, the fact of being a professional in the field of education and being compelled by law to carry out the required qualification, provokes anxiety and expectations in anyone who has already developed contextualized pedagogical practices. To be exposed to the theoretical burden that a higher education course curriculum requires, means to undress oneself of previously acquired knowledges and beliefs. It means to deconstruct attitudes and to question oneself about what underlies certain pedagogical choices and decisions, and this is not an easy task. It is, at some extent, what PARFOR teacher-students feel and deal with.

This scenario marked by personal and professional achievements and critical thinking brings frustration as well. In view of this argument, the researched subjects were asked: *Are you currently working as a teacher? If not, explain why.* The responses showed that 50% were employed teachers and the other 50% said they were not. Two informants whose answers reflected the direct and decisive political influence were selected to illustrate this point. The teacher-students justified their condition as follows:

*As I was not approved in a public contest, but contracted due to political indication, my contract was cancelled with the change of the administrator (teacher- student 1).*

*At the moment, I am not teaching because the candidate I voted lost (the election) and that is why I am unemployed (teacher- student 3). [Our translation]*

From the responses, one can see that the teacher-students have been targets, thus subject to the party policy processes, which certainly have directly impacted on the qualification process of these professionals.

Therefore, we question the primary objectives of PARFOR – to enable the qualification of a teacher-student whose profile demand them to be ‘in service’ and bring into the program, their professional identities, accumulated knowledge and their usual classroom practices, and ultimately, to face theories to support or reformulate such practices.

In this regard, we understand that:

Education processes are, in fact, self-education, since teachers rework their initial knowledge in contrast to their practical experiences, daily experienced in school contexts. In this confrontation and through a collaborative dynamics of exchanging experiences and practices, teachers build their knowledge as they practice, that is, constantly reflecting on and about practice (PIMENTA, 1999, p. 29, our translation).

Afterwards, the same informants were asked to mention the main expenses implicated in their maintenance in the PARFOR program considering all its specificities. Both described as their main expenses, the cost of transportation, food, accommodation and acquisition of study material.

In addition to these socioeconomic difficulties, the research revealed other challenges that are no less challenging and are related to time constraints, learning difficulties and interpersonal relationships, as we can see in three sample answers below:

Difficulties... all time, because it is very busy, and having to cope with a discipline in just one week, having to do the tasks in a hurry (teacher-student 2).

Time spent with travels, transportation cost, distance, little time for studies, physical and emotional exhaustion, insecurity to perform academic works, adaptation to academic routine, understanding the contents, and difficulties in public speaking in the explorations of the seminars (teacher-student 5).

The first challenge was to start over, then the distance from home, from the family, coming into daily contact with people who think completely different from you, having to do almost 100% of the activities in groups. The latter was the greatest difficulty of all (teacher-student 6).

The challenges go beyond budget limits – a dimension where the adaptive process to the academy is not easy. An attitude of strangeness, critical stance or disapproval naturally expected when there are daily obstacles to overcome, among PARFOR student-teachers represented a constant challenge.

In sequence, informants were asked: “*Did the methodologies used by PARFOR professors favor your learning?*”.

In this sense, the most significant responses were:

*To tell you the truth, I expected more. Regarding the methodologies, basically all used the same tiring methodologies: reading, discussion, group work, exposure ... Not to mention when the same teacher comes back to teach another subject, the subject changes, but the tiring methodology is always the same* (teacher-student 6, our translation).

*Some teachers brought methodologies that facilitated my learning, and the class was more productive, such as: discussion, lecture, integrated panel, work exhibition, field class, among others* (teacher-student 3, our translation).

By analyzing the responses, it is noticeable that for some, the methodologies were considered obsolete, meaningless for the learning process, however, others point out that they contributed to the education process. In other words, we may infer from those “apparent” discrepancies that the learning styles and expectations are very specific to each teacher-student, involving learning time and motivation levels, which impact teacher-students’ views of the methodological teaching process.

Certainly, these views raise other complex arguments and reverberate into the discussion about teaching methodologies and didactics. In that sense, Libâneo (2013) affirms “Didactics is characterized as mediation between the theoretical and scientific bases of school education and the teaching practice of school education and teaching practice. It operates as a bridge linking the ‘what’ and the ‘how’ of the school pedagogical process” (LIBÂNEO, 2013, p. 27, our translation).

Still on didactics, Zabala (1998), emphasizes “once the didactic units are determined as preferential units for the analysis of educational practice, it is necessary to search for their dimensions in order to be able to analyze the differential characteristics in each of the different ways of teaching” (ZABALA, 1998,

p. 19, our translation). In other words, it means that the methodological process of the teacher must be understood as capable of making the didactic transposition between the one who teaches and the one who learns, as a mediator and facilitator of the entire educational process.

#### ***4.3 Evaluation processes and their implications for learning***

The act of evaluating in higher education demands, as in any other level of education, that the teacher be aware of the movement and effort to be carried out, and that the process be understood, taking into account some indicators as proposed by Hoffmann (2003, p. 52, our translation). The author as affirms that evaluation is “movement, it is action and reflection”. Therefore, this dynamic requires multiple views from the professional, since evaluating “the other’ in the classroom is also evaluating the teaching process.

In light of this understanding, we asked the question: “*With regard to the evaluation criteria used by PARFOR professors, did you, at any time, feel wronged?*”. Two answers were selected to demonstrate that the evaluation process, at times, was considered unfair by some, while others, thought it contributed to their educational development, as shown in the statements below:

Yes. Because many of the teachers did not seem to take the evaluation criteria very seriously and, in a way, it caused a certain discouragement. It didn't seem worth it to try so hard and in the end the concepts were the same (teacher-student 5, our translation).

Yes, because some teachers did not manage to have a dialogue with the class, they did not accept the students' argument and this fact ended up implying the average, and there is also that teacher who does not stimulate the students and acts rudely, as if they possessed all the knowledge (teacher-student 3, our translation).

No, I believe that each teacher has his own way of evaluating (teacher-student 2, our translation).

We rationalize that the answers provided require detailed analysis, as some imply the idea of quantity and that their performance is measured. However, it should be noted that at the beginning of each discipline professors must make clear the criteria that will be used in the evaluation process, which, certainly, allows the teacher-student to have a parameter of his performance.

From this analysis, and from the informants' narratives, it becomes salutary to reflect over ‘evaluation’ as a process. Assuredly, when we assess “students mistakes, considering them essential for the 'future projections' of the educational process”, it leads us to expand understanding about “the possibility of uncertainties, doubts, questions that may affect us in the analysis of their responses, thus favoring the discussion about new and different ideas” (HOFFMANN, 2003, p. 53, our translation).

In addition, LDB No. 9.394 / 96, in its Article. 24, determines that “continuous and cumulative evaluation of student's performance, with the qualitative aspects prevailing over the quantitative ones and the results obtained throughout the period, prevailing over those of eventual final exams”, be the principles for the classroom evaluation process. Even recognizing that this Law outlines the guidelines for basic education and the topic under discussion in this paper is within the scope of higher education, we have the clear understanding that the development carried out in higher education will be reflected on the basic education, therefore, the analogy made here proves pertinent.

It is important to note that these elements revealing obstacles, corroborate to academic imbalance.

Therefore, we were motivated to ask the question: “*In view of all the challenges and difficulties revealed during the graduation process, do you think that these facts interfered with your academic performance? And, if so, how?*”. The responses demonstrated other additional elements to the challenges already referred above, as shown in the answers below:

*Yes, but I believe that these challenges must be faced and overcome, because they make us what we are. However, studying in another municipality, staying away from the family and, in a place where everything is done by yourself, makes learning difficult, because it is very tiring to study, do the tasks, prepare food, and do the cleaning among other domestic tasks* (teacher-student 2, our translation).

*Yes, because in the face of so many difficulties I went through during this course, my performance was certainly affected, and it was not possible to absorb the amount of knowledge I should have* (teacher-student 5, our translation).

*Yes, without a doubt, there is a phrase that marked my passage through the course and that I will never forget “I am no longer who I was. I am a little piece of each one who crossed my path and who somehow contributed with me” [...]. At each challenge overcome, a new way of seeing things* (teacher-student 6, our translation).

*Yes, in view of all challenges I am going through, this certainly affects my academic performance, as I am also concerned with other situations. I am a mother, daughter and housewife* (teacher-student 3, our translation).

Analytically, we can infer that the challenges imposed by the circumstances involved in attending PARFOR have been many. We emphasize the fact that they were presented as barriers beyond the classroom limits and factors such as “distance, family issues and financial conditions” were the central axis of the main difficulties mentioned by the teacher-students. However, their narratives reveal that these challenges were not strong enough to make them give up, they were fuel for persistence, instead. This is confirmed especially when meaningful words such as “faced and overcome” revealed they are people in difficulty, hardened of life, but sufficiently strong.

Finally, it becomes clear for us that other research possibilities emanate from the results discussed in this paper, which certainly should be explored by other academics who are interested in entering the world of PARFOR and its impacts on student-teachers.

## **5. Conclusion**

This research triggered several reflections, to the extent that it made it possible to understand how the PARFOR program was conceived, the teacher development policies aimed at basic education and the educational trajectory of its teacher-students. In addition, the main difficulties were evident both in what concerns taking the Course and also in remaining in teaching. However, despite the mandatory qualification for teachers at a higher level (in order to work in basic education) having already been legitimated through the LDB, there is still a great demand in the educational context for teachers without the adequate and required certification.



Therefore, it becomes evident in the present study that PARFOR turns up as an emergency and compensatory public policy and, as much as possible, it has contributed to an initial education phase for teachers in service in an attempt to correct historically rooted demands in Brazil. Nevertheless, it is recognized that neither laws nor teacher development courses alone can or will be able to guarantee the improvement and educational transformation that the country needs. Likewise, these changes cannot occur without the (trans)formation of these protagonist agents of education. Without the juxtaposition of laws and teacher development, the improvement of basic education will hardly occur.

On this grounds, this professional, who takes the role of teacher-student, needs to dive into a new formative universe striving to reconcile his personal routine with the demands of the job market and of the higher education, as clearly shown among the teacher-students of Class 3 from Captain Poço.

Teacher-students who volunteered for this research demonstrated in their responses that the main challenges faced were:

- a) The cancellation of employment contracts motivated by political reasons, thus affecting those who were temporarily hired;
- b) The financial issue affecting unemployed people who did not have the necessary conditions for their sustenance in the study city center, such as: food, accommodation, transportation and acquisition of didactic materials;
- c) The condensed feature of PARFOR disciplines, which cover an intensive period. Responses pointed out to the reduced time for the maturation of the information received;
- d) The methodology used by some the professors. Responses pointed out to a mismatch between pedagogical approaches and the intensive regime of classes;
- e) The evaluation process adopted by some professors. Responses revealed evaluation systems also represented challenges for the teacher-students.

In brief, it is undeniable that PARFOR has opened up a wide range of possibilities, however, we also recognize that much still needs to be implemented so that the proposed objectives are achieved in their entirety towards the improvement of basic education.

Finally, the present study suggests that reflections on the challenges posed to teacher-students should be seen as a set of indicators for improving policies and bringing together the issues of teacher development and the educational laws. Among these improvements, we emphasize, in particular, the need for state and municipal governments to guarantee that professionals seeking qualification through official initiatives remain at work and are provided with the necessary conditions to continue and succeed in their courses.

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# **“Skill, drill, and kill”: Zimbabwean Teachers’ views on once-off summative assessment**

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## **Abstract**

*This paper reports on teachers’ summative assessment experiences at grade seven level in selected primary schools in Chegutu District, Mashonaland West Province in Zimbabwe. The study’s purpose was to determine the effect and impact the final, standardised, and high-stakes assessment have on teaching and learning at grade seven level in these primary schools. Using a qualitative research design, we generated data from eight teachers who were purposefully selected from four of the different primary schools found in Zimbabwe (rural, farm, urban, and boarding). Semi-structured interviews, documents, and records analysis were employed as data generation to allow for rich and detailed information from all available sources for this research. This paper presents and discusses the data about teachers’ summative evaluation experiences at grade seven in the Zimbabwean education system. The findings reveal a severe effect and impact of end-of-year grade seven examinations on teachers, instructional practices, the curriculum, the learners, and the education system. It also shows that teachers depend excessively on drilling and repetitious revision practices to meet the standards required and expected by stakeholders. The findings further reveal contradicting responses from teachers on enhancing learners’ performance from drilling and coaching. There emerged from the findings a consensus among teachers on merging formative, continuous, and summative assessment forms. This paper suggests a more balanced and holistic assessment structure at grade seven level that caters to learners’ diverse populations and environments in Zimbabwe.*

**Keywords:** summative, experiences, high stakes testing, balanced, holistic assessment

## **1. Introduction**

Researchers worldwide concur that assessment is a critical and important function of any educational system (Brookhart & Nitko, 2014; Kizlik, 2012; Mussawy, 2009; Taras, 2008). Like any other examination-oriented society, Zimbabwe uses summative and standardised high-stakes tests as gatekeepers for selection or exit purposes for learners from one educational stage to the next. Assessment in this test-driven context is used to evaluate both the school and the learners’ effectiveness (Gebril & Brown, 2014). Judgements about the quality of a specific school and learners are directly based on scores from the summative standardised tests. End-of-year summative assessments are the only indicators used to graduate grade seven learners from primary to secondary in Zimbabwe. This single standardised examination is determinative of

the learners' future. The assessment system in Zimbabwe still solely depends on traditional testing in primary schools.

National grade seven examinations in Zimbabwe occur at the culmination of the primary level, that is, grade seven levels. Grade seven learners were, all along, being tested in four subjects, namely: Mathematics, English, indigenous language, and General Paper, which consisted of Environmental Science, Social Studies, Religious and Moral Education. In 2017, a fifth subject was added and examined, which is Agriculture. Candidates receive a different result for each subject in units on a nine-point grading scale from one to nine, with one being the highest possible grade and nine being the lowest. The learner with the best results will have five units (one point in each subject), and the one with the worst results will have forty-five units (nine points in each subject). The primary purpose of the grade seven examinations is to certificate the learners' level of educational achievement (Kanyongo, 2005). The results are also used for the selection of learners in secondary school education. Most so-called good secondary schools, mainly private and church schools, use these grade seven results as their form one learners' selection criteria. Muranda et al. (2016) confirm that grade seven results are used to determine the quality of secondary school that a learner will join. Chikowore (2012), quoted in Muranda et al. (2016), explains that parents whose children fail public examinations go through a stressful and challenging time trying in vain to secure places in good secondary schools. The rest of the schools, particularly those in rural areas, have a mass admission policy whereby they accept anybody regardless of their grade seven examination results. This is according to the government policy of Education for All (EFA).

Zimbabwe's curriculum has tremendous influence from examinations like in any other country. The aims, content, organisation, and evaluation of the curriculum are determined by the examination (Hedwick et al., 2013). According to these researchers, the curriculum aims to impart knowledge and skills through various subjects. The examination aims to assess the level of mastery of the acquired knowledge and skills. This is where the discrepancy exists; the few hours examination may not address all the skills and attitudes that the curriculum wants to be developed in the learners (Hedwick et al., 2013). Examinable classes and subjects are typically considered first and given first preference in terms of the best teachers, resource allocation, and timetable. Non-examinable subjects like Art, Music, and Physical Education are not put on the priority list, even though they contribute a lot to the learner's social and emotional well-being. Hedwick et al. (2013) also observe that teachers also tend to use methods that enable them to cover the syllabus in the shortest possible time so that their learners will have more time to revise for the examination. This is a form of drilling, and not much learning will be taking place.

As a primary school teacher and administrator in church day and boarding schools for twenty-eight years, one of the authors had opportunities to interact with, observe, even visit and compare teaching and learning in schools from different socio-economic backgrounds. She also had opportunities for staff development programmes with other school administrators and teachers from different schools, within and outside my district. From these experiences, she was struck by the most common Zimbabwean primary schools' adverse conditions, which still struggle to produce good results like any other primary school in Zimbabwe.

Against this background, we endeavour to explore from teachers' experiences the impact and effect of the continued final, once-off event of standardised high-stakes summative assessment per se at grade seven level in Zimbabwe. We anticipate that this paper will contribute more input into the fusion of formative assessment, merged into continuous and summative assessment for final evaluation and decisions for grade seven learners in Zimbabwe. This paper addresses the following research question: *What are teachers' experiences of summative evaluation at grade seven level in the Zimbabwean education system?*

It is hoped that this paper would give more insight to education authorities, the Zimbabwe Schools Examinations Council (ZIMSEC), school administrators, teachers, parents, and all stakeholders, for an overhaul of assessment practices from summative assessment to a consideration of a more balanced assessment mode at grade seven level. This paper seeks to contribute to the emerging awareness of the need to reconsider assessment practices that will benefit learner's future and the society as a whole at grade seven level as highlighted in the recommendations from the Commission of Inquiry into Education and Training of 1999 in Zimbabwe (Nziramasanga, 1999). It is envisaged that the teachers' experiences will give a clearer picture of the impact of the current summative assessment at grade seven level and prompt more research and action in this area in Zimbabwe.

## **2. Impact of high stakes testing**

Our paper takes cognisance of numerous studies that have been done worldwide on teachers' experiences concerning summative assessment at different levels in the education system. However, very few studies have explored this phenomenon at a grade seven level in the Zimbabwean context. It is envisioned that the teachers' experiences will contribute more information and shed more light regarding the turn that the Zimbabwe education system intends to take in to embrace continuous assessment and to merge it with summative assessment for a fairer assessment that considers all categories of learners and advances quality teaching and learning.

Researchers on modes of assessment in the past decade agree that summative assessment if used per se, encourages rote learning of facts and cramming of information rather than acquiring functional skills and knowledge (Blazer, 2011; Jones, 2007; Ritt, 2016; Spann & Kaufman, 2015). The CIET (Nziramasanga, 1999) reiterated the same sentiments and recommended that Zimbabwe's education system should move away from an examination-driven curriculum and adopt a system of assessment that would produce marketable learners. Teachers teach and coach for the examinations using various assessment strategies to make learners memorise the subject content taught to attain high scores in the final or summative examination.

Advocates contend that, although most consequences around summative high-stakes standardised assessments are negative, they have some positive effects on education. Blazer (2011) reports that some researchers argue that comprehensive standardised measures of testing can increase teachers' professional development. A survey of teachers in Florida where high-stakes standardised testing was practiced provided

evidence that these programs had created an increase in teachers' knowledge of testing. Teachers could differentiate between norm-referenced and criterion-referenced tests. The teachers could recognise, use, and develop high-quality tests and were able to score them. The tests helped the teachers to be focused and consistent in their teaching approaches. Polesel, Dulfer, and Turnbull (2012) argue that testing may result in teachers developing explicit expectations of what they should be teaching. The tests give clear signals of what is important in the curriculum, thereby directing both teachers and learners to those areas they need to concentrate on and guiding them on approaching them. Polesel, Rice, and Dulfer (2014) support the view that the alignment of the curriculum with high-stakes standardised testing may result in greater curriculum consistency within and across schools, ensuring a command of agreed competencies and transferability experiences across constituencies. The tests are matched to curricular standards, and all teachers teach to these standards. Standardised tests set standards to which teachers and schools can aspire. The tests are, therefore tools to maintain academic standards. Results of these tests can easily be compared within and across schools. Results can also accurately represent the effectiveness of teachers and schools, making them accountable for teaching and learning.

Polesel et al. (2012) assert that testing motivates learners to study and attain goals, working towards the set curriculum. The set targets provide learners with more precise information regarding their knowledge, skills, and potential. It was thus motivating them to work harder. The standardised measures of testing can be used as feedback, particularly to teachers, schools, and the entire system. For the grade seven exit classes in Zimbabwe, these tests may not be very beneficial since they will be a cohort exiting that level. The tests are more useful as feedback to the system and guide reform for the next cohort.

A recurring perspective in literature is the negative impact that high-stakes standardised testing can have on the curriculum, teaching, and learning. While standardised tests may offer excellent ways to assess learners without bias, these tests may have adverse effects on learners who take the tests and parents, teachers, and the schools. Teachers, parents, and the school are also exposed to pressures and stress due to high stakes testing demands. Teachers and the school pay the price if their learners do not perform well on standardised tests. They are accountable for the learners' results, hence the pressure and stress. Parents in Zimbabwe go through the same stress, as they have to help and support their grade seven children to pass, to secure a place for secondary education in good schools. This comprehensive testing has not been found to generate consistently positive effects on teaching and learning. Crocco and Costigan (2007) concur that the meaningfulness of standardised test scores as indicators of authentic learning has come under severe questioning in the literature. Questions arise on the curriculum depth covered and sound instructional practices reflected in the test content.

Blazer (2011), in a study on the unintended consequences of high-stakes tests, observes that teachers feel that instructional decisions are increasingly based on what is most likely to be included on high stakes tests. Teachers cannot rely much on their professional judgement and expertise. Repetitious instruction has become the dominating approach to teaching, aiming to make the learners pass the tests at all costs. Teachers abandoned more innovative instructional strategies, such as cooperative learning and creative



projects, favoring more traditional lectures, and recitation to prepare learners for the tests (Blazer, 2011). They have shifted from supportive and collaborative teaching approaches. High-stakes testing negatively impacts creative and effective teaching, leading to cramming for tests rather than instruction (Polesel et al., 2014). In a study by Jones (2007), teachers reported that the tests stifled their teaching ability and creativity. Teachers adopted teaching styles that emphasise transmission teaching of knowledge and drilling on test-taking skills. In this context, teaching and learning are focused on content rather than on the concepts' knowledge and skills.

Crocco and Costigan (2007) note that teachers report that testing has substantially influenced their instructional planning. In devising their plans for instruction, they look at previous tests to ensure that their curricula include most of the test content and test objectives. Teachers even adjust their instructional plans based on the previous class's test performance or the current class's most recent test performance. They can no longer meet learners' needs but rush through the curriculum to cover content before the test. Polesel et al. (2014) comment that testing encourages teaching methods that promote shallow and superficial learning rather than a deep conceptual understanding of modern information-based societies' knowledge and skills. This focus on limited skills deprives the learner of broader and personal development. The learners experience a limited range of classroom activities and have fewer opportunities to link their learning with the world beyond school activities, such as excursions (Polesel et al., 2014). Teaching is limited to narrow test preparation. Rather than developing the learners, the focus is placed on improving test scores.

Minarechová (2012) points out that teachers emphasise learners are achieving maximum test scores in their national test results through "teaching to the test" and coaching learners in how to answer questions. The trend is to increase emphasis on tested content, with most teaching time devoted to preparing for the testing. Spann and Kaufman (2015) observe that teachers focus on subjects that are tested and teach test-taking skills. Mussawy (2009) sees this as the diversion of classroom instruction to emphasise low-level content and necessary skills. The test dictates what to teach and how to get learners to pass the test. This increases the redundancy of instruction in teachers.

Teaching to the test leads to narrowing and re-aligning the curriculum (Spann & Kaufman, 2015). The pressure to improve test scores causes some teachers to neglect material that the external test does not include. They redefine course objectives and re-sequence course content in an attempt to improve test scores.

Test scores are used to rate teachers, administrators, and schools (Jones, 2007). This development gives the impression that quality teaching and quality education are measured through learners' performance in high-stakes standardised tests. Jones (2007) further compares measuring temperature with a tablespoon with ascertaining education quality through test scores. How good or how bad a school is cannot be judged by a one-time standardised test.

A further argument is that Zimbabwe's primary curriculum, which stretches from ECD to grade seven, might be too big and extensive to be measured with a one-time summative standardised test at the end of

grade seven.

In Australia, Klenowski and Wyatt-Smith (2012) confirm that schools are judged on published results and placed on league tables. Comparing test scores among teachers and schools can lead to some teachers blaming colleagues or lower grade levels for poorly preparing learners (Russell, Madaus, & Higgins, 2009). Publishing or displaying results can humiliate some teachers or schools. Publishing results also creates pressure on teachers and schools. Similar observations were made by Polesel et al. (2012), that publishing result has a danger of the potential for the naming and shaming of poorly performing schools, which most likely would be disadvantaged schools. Literature confirms that there is a strong relationship between socio-economic status and student performance. This must be recognised in the comparison of schools' performance. The publication of results very much influences parental perception and choice of school. Klenowski and Wyatt-Smith (2012) add that parental access to information about schools' results becomes codes or indexes for individual schools and education systems' quality. These labels can result in detrimental effects to the low economic schools or those in disadvantaged communities.

Russell et al. (2009) argue that it is not the test per se that causes disorders in teaching and learning assessments, but the stakes associated with the test scores that drive teachers, learners, and other stakeholders into behaviour that results in the many unintended outcomes discussed so far. Much of the research at an international level raises legitimate questions and deep concern regarding the impact of standardised summative tests on the curriculum and pedagogical experiences. Looking at Zimbabwe's test practices, there is a need to ascertain from the teachers' experiences, whether improvement in test score performance is actual evidence for improvement in learning. For those schools that perform well, there is also a need to determine whether the good test scores reflect the schools' intensive test preparation practices or of an emphasis on necessary skills and deep learning.

### **3. Methodology**

A qualitative study approach was chosen. This approach sought to understand the phenomenon in its context settings; hence, the study was conducted in schools where the teachers operated. The teachers themselves brought their voices, elucidating their experiences with a summative assessment at grade seven level. A qualitative case study methodology was employed involving four schools from four different primary schools in their socioeconomic categories: rural, urban, farm, and boarding schools. Two participants from each school were then selected purposefully for their potential and experience with a summative assessment at grade seven level. We managed to collect rich, up-close information of the teachers' experiences right at their sites, in their classrooms.

Semi-structured interviews were used to allow the teachers to freely express themselves at length though guided but laid down questions to control aimless deviation. Face to face, conversations were made in a flexible and unconstrained atmosphere. Teachers were free to share at length their experiences with a summative assessment at grade seven level. Documents and records analyses were the other data collection

instruments used in this study. The documents and records gave ample evidence and confirmed findings in this study, particularly on practices promoted in summative assessment in Zimbabwe's primary schools.

Credibility, transferability, dependability, and confirmability were also considered to show the extent to which the results of this study were trustworthy. The use of multiple methods and multiple sources in collecting data helped confirm the participants' experiences. The wide range of different sites selected, from the rural, urban, farm, and boarding schools, helped identify common patterns in primary schools in Zimbabwe, thereby justifying the application of this study to similar settings. Semi-structured interviews, documents, and records helped to develop a dependable, detailed account of the teachers' experiences with summative assessment. We used triangulation to reduce the effect of biases as researchers. Audio tapping was another technique that we used to be able to capture the teachers' responses verbatim. Reflexivity helped us remain focused and eliminate our personal beliefs, interpretations, and summative assessment experiences.

Ethical issues in conducting empirical studies were considered too. In response to our request, teachers voluntarily signed the consent forms to participate in the study. Permission was sought and granted from the Head office, provincial and district offices to conduct the research. Permission was also sought and granted from all the four schools that were sampled for the study. In introducing the study to each of the respondents, we assured them first of our respect of confidentiality and anonymity in their responses to the research questions. All this was to ensure that we abide by the legal requirements binding research processes.

The sample size came as a limitation in that the number was too small to generalise for all schools in Zimbabwe. However, the study may be a revelation to schools, teachers, education authorities, and all stakeholders, particularly those who decide on Zimbabwe's assessment practices. We encountered another limitation in financial provisions for the research. Accessing the farm, rural and boarding schools was very expensive due to the distances between the schools. This, therefore, determined our sample size to one school per category. However, the shared experiences of summative assessment that the teachers from the different categories of schools shared may confirm a reflection of other schools of the same categories in Zimbabwe. To minimise our influence on the teachers' responses in the study, we emphasised free, honest, and accurate information from the participants while assuring them of anonymity and use of their contributions for purposes of research only.

In the next section, we present selected data followed by a theorised discussion.

#### **4. Discussion of data**

This section of the paper addresses the research question, which reads: *What is the impact of teachers' experiences of summative evaluation at grade seven level in the Zimbabwean education system?*

The first sub-theme reveals the teachers' experiences of the effects and impact of the end of year grade seven examinations.

#### **4.1 The effects and impact of the end of year grade seven examinations**

In response to the teachers' experiences of the effects and impact of end-of-year grade seven examinations, four out of the eight participants expressed concern that the non-consideration of learners' different backgrounds regarding questions and comprehension of the second language, which is English. The concern was on differences between urban and rural learners regarding access to technology and exposure, with the rural learners disadvantaged. These participants had this to say:

*Some years examinations seem to cater mostly for urban schools than rural schools (Mr. Chipe)*

*There is more general knowledge, particularly in the general paper, which becomes an advantage for the urban learners who get information from televisions and other media sources. (Mrs. Nhao)*

*The system seems to favour learners who are mainly in urban areas while maybe neglecting those who are in rural areas, considering that the modern-day world is fast changing in terms of technology. Learners in urban areas have access to new technology, which allows them to explore more areas of learning than those in a rural setup. Their performance differs. (Mr. Manga)*

*The performance at grade seven level in most rural areas remains poor most of the time. (Mr. Pindi)*

As reiterated in the literature review, Jones (2007), in his Florida study, confirms that there is a correlation between the status of the school and academic achievement. Environmental factors around the urban, rural, farm, or boarding schools in this study could interfere with performance in the standardised summative examinations they are all exposed to at grade seven. Hedwick et al. (2013), in their study on the impact of examinations on the curriculum in Zimbabwe, also contend that poor performance is high in rural areas, mainly because of the unavailability of adequate material and human resources. Spann and Kaufman (2015) also confirm that standardised summative examinations have constricting effects on learning among the poor, minority, and English second language learners, particularly in under-resourced schools. The two researchers also believe that culture and exposure can also interfere with standardised summative assessments, as expressed by the participants regarding differences in environmental setups and exposure for the learners.

Five of the eight participants were concerned about the inadequate time to cover all the content that would suffice for the end of the year or summative examination at the end of grade seven.

One teacher made the following comment:

*There is not enough time for the teacher to prepare for the examinations. There is too much pressure on the teacher and the learners. (Mr. Chipe)*

This could be why Kirkpatrick and Zang (2011) assert that exam-oriented education systems are second to none as causes of anxiety. Teachers are worried about target setting and concerned about the school's league table position. The end of year grade seven results ranking for schools in the district under study confirm the teachers' anxiety.

The response from one of the teacher participants was:

*You will not have ample time to teach the non-readers to read and grasp concepts they need for the*

*examinations simultaneously. You have to drill the concepts. (Mr. Chipe)*

Mr. Manzu (a participant) added that their classes were too big, for example, 54 learners, and the teacher had no time for all the learners. Regarding the practice of rushing through the curriculum to cover content before the examinations, Polesel et al. (2012) contend that the needs of the learners cannot be met with such big classes, which, worse still, include non-readers.

Another participant had this to say:

*....at grade seven-level, we are worried about revision and preparation for the examinations. Teaching ends in grade six. There are too many subjects examined with extensive coverage, particularly in the general paper. (Mrs. Nhao)*

Due to the pressure of work at grade seven-level, another participant expressed:

*You not only use the stipulated time but also to sacrifice your own time, even going to teach during study time. (Mr. Musi)*

Hedwick et al. (2013) confirm that in Zimbabwe, examination classes do not enjoy the holidays. They are called back to school to rush over the syllabuses and revise the past papers, confirming Mr. Musi's response in the interview that they teach for examinations even during study time for the learners. Every single opportunity is utilised in preparation for examinations. Extra lessons are common, particularly for examination classes, thereby overburdening the learners, the parents, and the teachers themselves. Jones (2007) expresses such practices are inappropriate for the teachers and the learners because they emphasise 'skill, drill, and kill.' Teachers get over-concerned about attaining good results at the end of year examinations yet depriving learners of other developmental skills and killing the teachers' creativity and initiative in competent teaching (Jones, 2007).

Mrs. Meye, a participant in this study, acknowledged that they teach focusing on examinable subjects at grade seven. In Zimbabwe, the examinable subjects at grade seven are English, Mathematics, General Paper, Agriculture, and one vernacular language. This is a confirmation of Hedwick et al.'s (2013) observation that, even in primary schools, non-examinable subjects like Physical Education, though timetabled, are not taken seriously and are unfortunately substituted by the examinable subjects.

There was also concern about the many subjects and the amount of matter that the primary school child was expected to master and write the final examination at the end of grade seven. One participant had this to say:

*I also believe there are too many subjects examined, extensive coverage, particularly in general. (Mrs. Nhao)*

The concern of inadequate teaching and learning materials like textbooks, stationery, library, as expressed by Mr. Manzu in the interview, is supported by Spann and Kaufman (2014) as typical in poorly funded schools like the rural and farm schools. Polesel et al. (2012) recommend that such complexities in different school populations need to be considered in establishing assessment structures. Popham (2008) condemned the unfairness in measuring teachers' competencies and learners' abilities on a mere test score. This researcher advised that schools, teachers, and learners' unique challenges needed to be addressed in

considering assessment systems.

The findings on teachers' experiences in this study have demonstrated the severe effect and impact of end-of-year grade seven examinations on teachers, instructional practices, the curriculum, the learners, and the education system. The evidence in these findings was that the effect and impact were far-reaching and gloomy, particularly for learners and schools from low socio-economic backgrounds. The examination performance and results confirmed this negative impact on low-income schools.

Ritt (2016) refers to the low-income and marginalised learners as 'at risk' sub-groups who are portrayed by standardised tests as failures due to their nationwide test scores. As shown in the findings for this study, outside environmental risk factors were not recognised by standardised end of year grade seven examinations. The 'one size fits all' approach in the grade seven final examinations understudy did not fully and fairly represent all learners of different backgrounds in Zimbabwe's primary schools. Findings from this study showed that, as long as the personal and school environmental characteristics that affect learners are not addressed, these 'at risk' sub-groups will continually fail academically. The final examinations will continue to affect learners' success, even after the primary level. The environmental factors include teaching and learning resources both at home and school, parents' income, parents' support to the school, parents' level of education, community support, among many other factors. Ritt (2016) emphasises that today's summative testing creates an environment that marginalises learners due to factors out of their control. Low-income schools in this study were quite inadequately resourced due to the environments around them, which were primarily determined by the income of their parents. Unless the government intervened in support of the schools, there would be very little chance of getting support from the parents in terms of material and human resources towards summative assessment. Hence, learners would continue to be disadvantaged and fail the summative examinations. There is a need to understand and consider these diverse environments and backgrounds of learners and schools in this study to help all learners meet their full potential academically and socially in any assessment.

#### **4.2 Teachers and maintenance of standards**

Responses from almost all participants' experiences with performances in their respective schools reflected an acknowledgment that both teachers' and learners' hard work, cooperation, and support from fellow teachers, parents, and administration contributed significantly to improvement and exemplary performance summative examinations for grade sevens in their schools. The following statements revealed the teachers' experiences on attributions to improvements and exemplary performance in their schools:

*Collective action and hard work by teachers, learners, and administrators... (Mr. Chipe)*

*Hard work from teachers, cooperation from parents, as well as support from the administration. (Mrs. Nhao)*

*The extra mile from the grade seven teachers themselves, support from all stakeholders. (Mrs. Nhao)*

*The school head motivates teachers. (Mr. Manzu)*

*Hard work from the teacher... have a supportive administration... (Mrs. Meye)*

*It is hard work from the teachers.... knowing that they have been trusted to be given grade seven classes....*



*It is the mirror of the school. (Mr. Musi)*

*Hard work on the part of the learners as well..... Parents initiated individual or group support to the particular classes in which their children are. They support supplementary textbooks and any other needs that will contribute to a conducive environment for the learning of their children in the classroom. (Mr. Musi)*

According to the participants, another contributing factor to improvement and good performance was the utilisation of weekends and holidays for extra lessons, drills, and revisions. Some of the teachers gave statements like:

*We also teach during weekends and school holidays. (Mr. Manzu)*

*Learners come to school during weekends and holidays. (Mr. Manga)*

However, Hedwick et al. (2013) perceive the use of weekends and holidays for lessons, coaching, and revisions for examinations as deprivation of resting time and enjoyment of school holidays for both the teachers and the learners.

At the same time, teachers with reasonable percentage pass rates had encouraging everyday experiences like:

*Good learning and working environments.... vast resources, such as textbooks and learning materials. (Mrs. Meye)*

*Students are encouraged to speak in English.... working and sharing ideas in groups. (Mrs. Meye)*

*The school has almost adequate resources. Teaching and learning environments are conducive. We encourage our learners to speak in English. (Mr. Musi)*

Mr. Musi, a participant in this study, added that they had a library, and library reading time was officially timetabled, which contributed to the pass rate. According to Mr. Musi, more activities, like public speaking and quiz competitions in their school, were advantageous to exposure to more information and expression in English for their learners. Supporting researchers like Gorman, (2015) believe that suitable social and emotional environments contribute to learners' academic achievement.

One participant, however, openly expressed that there was no improvement in their school. He attributed this to a lack of adequate learning materials, particularly those that would help in mastering English. According to him, English, being a second language, was the leading cause for the low pass rate. Researchers such as Jones (2007) and Spann and Kaufman (2014) support this teacher's view that using English in teaching and learning for non-English speakers can be a barrier and disadvantaging factor, particularly with the low socio-economic learners often found in under-resourced schools. The rural school in this case study is a good example.

The participant also added that parents contributed to the low pass rate by allowing and, unfortunately, at times facilitating absenteeism of their children. Another participant also emphasised the high absenteeism rate, sometimes initiated by the parents themselves, who gave their children chores at home when they were supposed to be at school, particularly during weekends and holidays, for extra lessons and revisions.

He added that their farm community did not prioritise education at all. Berliner (2011) believes that teachers need not be blamed for lack of success in using summative assessment with learner populations of different social and economic statuses. Still, the whole community must be held accountable for inadequate support in the whole teaching and learning process. However, despite the discouraging circumstances, the teachers enhance their learners' performance, as shown in the next section.

Based on high scores in the summative examinations or end-of-year examinations for grade sevens, judgments on a good teacher or school in Zimbabwe are based on high scores in the summative end-of-year examinations. Parents also expect teachers and schools to produce and maintain high standards of performance on the grade seven results to secure places for form one in excellent and prestigious schools that are also better performing. The findings revealed that these expectations made it imperative for the teachers to work extra hard and under pressure to produce the expected results. The grade seven teachers went an extra mile and utilised all available time, including holidays and weekends, to prepare the learners for the examinations and maintain high pass rates. Mussawy (2009) reiterates that accountability is central to these high stakes summative examinations. Therefore, this study's findings depict teachers who depend excessively on drilling and repetitious revision practices to meet the standards required and expected by stakeholders. According to the findings, some schools even engage ZIMSEC examiners to give teachers and learners workshops on test-taking skills.

#### ***4.3 Strategies used by the teachers to enhance the performance of learners***

Asked about strategies they employ to enhance their learners' performance because of summative assessment at grade seven-level, almost all participants alluded to how they vary their use of teaching methods. The variety ranged from group activities, creating conducive learning environments, magazines and newspapers, participatory activities like discussions, peer teaching, question and answer sessions, debates, dialogues, and revisions in various forms.

Extra time and lessons were a common practice for all the eight participants. All the participants work flat out to utilise all the time they have with the grade seven classes to prepare for their summative final examinations. Hedwick et al. (2013) confirm this common practice for grade seven classes in Zimbabwe, where the teachers and the learners have to forfeit their holidays and resting time to complete the syllabus and revise past examination papers preparation for final examinations. The following extracts were examples of the teachers' responses, which included early morning lessons, extra afternoons, and study times, weekend and holiday sessions:

*We also have holiday lessons, but the challenge is that not all pupils are coming for the lessons. (Mr. Chipe)*  
*We encourage the pupils to come early in the morning, but the challenge is the distance because the pupils are walking long distances. (Mr. Pindi)*

*.....and extra time, particularly weekend school (Mrs. Nhao).*

*We come early and start lessons earlier than in other classes. (Mr. Manzu)*

*I encourage them to come early to school and start lessons at 7:15 am. We also have studies during the evening about an hour and a half or two... (Mrs. Meye)*

*I also create extra time with the pupils, starting school earlier than the stipulated time, meeting them in the afternoons during the weekend. During weekends, I take them for discussions and revisions. (Mr. Musi)*  
*We have weekend school, particularly in areas that need a lot of attention. We also apply for holiday lessons for the ministry. (Mr. Manga)*

*Yeah, we do morning work early in the morning. By 7 o'clock, learners must be seated in class doing morning work. Every morning they write a test in Shona, English, or Mathematics. (Mr. Sile)*

However, despite the prospect that extra time and holidays could help raise the pass rate in schools, as reiterated by the teachers, this practice also worked to the detriment of the disadvantaged rural and farm learners in terms of their school distances. The second participant lamented over this challenge as a contributing factor to low pass rates in their school. Their boarding and urban schools' counterparts could be in the classrooms as early and as much as they could to prepare for the same final examinations. Dutro and Seland (2012) observe that schools and these forms of assessment no longer consider the child and their environment but rather focus merely on tests. Dodge (2007) describes it as the one-size-fits-all notion embedded in standardised summative testing.

There was also a general practice by some of the participants of daily, weekly, and monthly tests as a strategy to enhance performance in examinations for the grade sevens. Progress record books from the participants reflected and confirmed these weekly and monthly tests. This practice could be what Blazer (2011) refers to as repetitious instruction, which has dominated teaching in examination classes intending to make the learners pass tests at all costs. Due to the demands that come with public examinations, the summative assessment, in this case, teachers are compelled to spend more time preparing their learners to master the national examination content and coach their learners on test-taking strategies (Dhindsa, Omar, & Waldrup, 2007). The following extracts from some of the participants confirm this observation:

*I also give weekly tests to assess my learners. (Mr. Manzu)*  
*I also employ many weekly assessments, testing on concepts that they will have covered that week, i.e., repetitive learning. (Mr. Manga)*  
*I borrow tests from other schools as far as Masvingo. They sometimes give me their weekly tests, their monthly tests, and from Bindura. (Mr. Sile)*

The findings reveal contradicting responses from teachers on how they enhance learners' performance from the drilling and coaching they allude to in working towards high scores in their schools. Teachers talk about varied teaching methods like group activities, magazines, and newspapers for practice in English, employing participatory activities in teaching, and various forms of revisions. However, coaching and drilling are still portrayed generally in repetitious instructional practices, like intensive revision sessions during holidays, weekends, and any other extra time, as revealed in the teachers' responses on strategies they use to enhance learners' performance. By this, teachers focus their teaching on what is to be assessed as studied in the trend of past examination papers. The teaching is teacher-centered, mainly the lecture method, to cover as much content as possible for the examinations (Muranda et al., 2014).

Another strategy from the findings is on weekly and fortnight tests given as practice for the summative

examinations. However, as Aftab, Qureshi, and William (2014) observe, no individual or diverse learning styles are considered in this approach. According to the findings, the numerous tests aim to identify areas not mastered and drill on them to prepare for final examinations. In their study on examinations washback, Andrews, Fullilove, and Wong (2002) discovered that teachers spent about two-thirds of their teaching time working on examination-related material and concentrating on past examination papers in their teaching. Teachers in this study were not spared in this regard. Therefore, quality control in teaching and learning is necessary to balance all curriculum content and benefit even the low performing learners in these findings.

## 5. Conclusion

The main objective in assessment is to improve learner performance and teaching effectiveness, not merely for auditing teachers' and learners' performance. Therefore, this paper recommends assessment that provides an ongoing source of information to teachers about learners' understanding to adjust instruction, develop interventions, inform the teachers where the learners are concerning the targeted learning goals, and improve subsequent performance. As shown in the related literature, assessment should increase learners' motivation to learn rather than demotivate them.

The paper also recommends that continuous assessment be factored into the final grade, which is the summative assessment. The use of continuous assessment can give a clearer picture of the learner's performance over a long period and over several assessments, which can be an advantage to all learners' categories in ensuring that they achieve something out of their seven years of primary education. There need for a balance in assessment modes for a more comprehensive and more authentic picture of a learner's performance and achievement.

The paper has shown that total dependence on only the final examination at the end of grade seven is unfair and inadequate as a means to evaluate and grade the whole seven-year primary course for the diverse populations of learners in Zimbabwe. Some of the challenges cited with the standardised high-stakes summative assessment at grade seven level include:

- large class sizes that hinder the implementation of a variety of continuous and formative activities
- the use of English as the only examination language in all subjects except for the vernacular subject
- diverse populations of learners who are expected to sit for one examination despite their different and sometimes disadvantaged categories
- comparison of grade seven results for these diverse populations
- lack of adequate resources to cope with the standardised high-stakes summative assessment
- intensive preparations for the one final external examination at the end of grade seven

Building teacher capacity in continuous and formative assessment is recommended for adoption to improve assessment skills and, subsequently, learners' achievement. Considerable changes in the Zimbabwean system of assessment are needed to avoid the only considered external examination at grade seven. A range of assessments would present better and holistic information on what learners can achieve their experiences, skills, and abilities within their diverse environments.

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# **ECHO360 Active Learning Platform in Health Sciences education: How, when and why to use it?**

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## **Abstract**

*The ECHO360 Active Learning Platform (ALP) is an online active learning platform allowing the creation of interactive multimedia content for anytime student learning, with the potential for comprehensive analytics. This ALP has previously been shown to enhance student participation and engagement during in-class activities however it can be challenging to use at first. To enhance the uptake of ECHO360 ALP in and out of the classroom a simplified guide with clear instructions on the most useful aspects of the platform was developed and shared with staff, successfully creating a community of instructors. A student guide was also prepared which showcased the methods for gaining the most from its use in and out of lectures. These resources are available in the appendix.*

**Keywords:** ECHO360, online platform, lecture capture, active learning platform, education methodology

## **1. Introduction**

Learning in science heavily relies on past knowledge to be able to enhance this understanding. As is evident from Blooms taxonomy (Bloom, 1956), learning is progressive starting with acquisition of basic knowledge on a topic (eg. Basic heart anatomy and function), before gradual progression towards more complex concepts, such as mechanisms of heart disease; this corresponds to the next stage of SOLO Taxonomy and Perry theory “multi-structural” and “multiplicity” respectively (Biggs and Collis 1982). If a student does not have the basic knowledge, they will not be able to move onto the next stage of SOLO Taxonomy and will disengage with material (Biggs and Collis 1982). The use of online pre-class activities providing basic knowledge before face to face classes has been highly employed during the last decade however such activities can be challenging and often do not occur (Nulty, 2011). Due to the challenge presented with pre-reading class activities, providing support and tools to enhance higher order thinking skills is both topical and timely (Biggs and Collis, 1982; Bloom, 1956). Technology-enhanced learning (TEL) has been growing in popularity and use for several years as new platforms have been developed, hence helping to stimulate active student learning. The process of active learning reposes student engagement with the material, participation in the class and collaboration with his/her peers (Topping and Ehly, 1998).

The ECHO360 platform, one of the latest TEL platforms, has been shown to promote student engagement and participation during face-to-face lecture time (Shaw et al., 2015; Green and Whitburn, 2016), and has

the potential to: (1) deliver excellent learning experiences that can be achieved by providing choice in learning and having blended learning options for all students; (2) increase the uptake and use of educational technologies to allow students to learn in different environments (and receive immediate feedback from both instructors and peers); (3) devise and deliver processes to ensure consistent, rigorous and whole-of-university implementation of educational technology as measured by the timely delivery of the technologies and staff satisfaction with educational technology platform; (4) devise and deliver mechanisms to showcase educational technology good practice linked to the product and services support processes.

The overall aims of this study was to show that the development of clear instructions for ECHO360 users (students and instructors) was essential in the use and success of ECHO 360 platform for the first year students in health sciences.

## **2. Methods**

The ECHO360 Active Learning Platform (ALP) enables academic staff to deliver lectures in a blended or flipped learning environment which promotes student engagement in the classroom. The platform contains a variety of features that can enhance active learning and engagement: (1) Question and answer: students can ask and answer questions during the lecture thus minimising the potential embarrassment of interrupting classes, and students can actively answer one another's questions thus enhancing peer learning; (2) Note taking: students can write notes next to each slide whilst watching presentations and videos, thus keeping all content in one place at a specific point in the lecture – this becomes particularly useful when reviewing a session and during revision; (3) Flags and bookmarking: a confusion flag alerts academics to content that may be confusing for students thus enabling them to explain content in a different way immediately or after the session. Students can also bookmark pages which may be a useful prompt to revisit specific content; (4) In and out of class polls: the platform has multiple polling modalities such as multiple choice questions, short answer questions, click and drag and number lists, to name but a few. This allows academics to gauge how students are performing on the fly and can indicate content that may or may not be fully understood, thus gaining rapid and effective feedback; (5) Analytics: academics can track video views, post-delivery views, asynchronous comments and feedback and students who may not be fully engaging.

This case study trialled the use of ECHO360 ALP in health science courses with large numbers of students at an Australian tertiary education University. Formative questions (polling) were inserted at key locations in Powerpoint-generated lectures using ECHO360 and students asked to provide answers live. Students could also 'flag' slides that were confusing allowing staff to provide additional resources or explanations to enhance clarity; this was done either live or after the event. Students were provided with clear instructions (Appendix 1) on how to best use the platform to their benefit such as the ability to ask questions during, or after sessions. Academics, who also received a set of instructions (Appendix 2), could then respond to these questions, thus giving both synchronous and/or asynchronous feedback to student queries.

## **3. Results and Discussion**

Traditional lecture delivery is often didactic and unengaging for students, leading to less than ideal student learning and subsequent performance (Price and Kirkwood, 2013). The benefit of student engagement in their learning has been demonstrated over the past decade, and use of the ECHO 360 platform during lectures has the potential to promote this active learning concept (Shaw et al., 2015; Green and Whitburn, 2016).

The use of ECHO 360 provided students with a collaborative and distinct learning environment to enhance student learning, engagement and improve lecture quality. When it was used during lectures it assisted in identifying specific issues encountered by students, particularly in relation to content understanding. Quick feedback and clarification provided to students allowed immediate adjustments in response to students' difficulties and/or suggestions. This practice has been beneficial for both students, who benefit from immediate feedback and so increase their learning (Chickering and Gamson, 1987), and the teacher in being able to identify student difficulties that they were otherwise unaware of.

The possibility for students to answer questions from other students of the same cohort enhanced peer to peer collaboration, which has been shown to informally offer an effective support in student learning experience, while providing a "sense of belonging", and helping first year students adapt to an unfamiliar environment (Huijser et al., 2008). There is an upsurge of literature illustrating the benefits of supporting sessions for first year undergraduate students (McGuire, 2006; Huijser et al., 2008; Ning and Downing, 2010), and ECHO360 offers this possibility while keeping questions anonymous if desired. Altogether, this ECHO 360 platform has significantly improved student engagement, understanding and peer to peer collaboration which may benefit their learning (Thallhri, 2016).

Consistent with our observations, ECHO360 ALP has also been shown to increase student participation and engagement in class at the University of Adelaide (Adelaide), University of Canberra (Canberra, 2016) and the University of New South Wales (Medicine, 2016). Some suggested uses of the ECHO360 ALP include taking attendance, analysing learner behaviour through learning analytics and for peer instruction (ECHO360, 2015). A previous study of an older version of ECHO360 ALP termed "Learning Tools" showed that there was enhanced student-teacher relationships and student engagement in large classes (Shaw et al., 2015). Time will tell whether similar benefits are also acquired due to its integration at this establishment but early feedback from students suggests that this will be the case. The learning environment became more collaborative between student and academic staff due to feedback provision during and after class via polling, annotating slides in lecture presentations and participating in discussion boards during and after class.

## **5. Acknowledgement**

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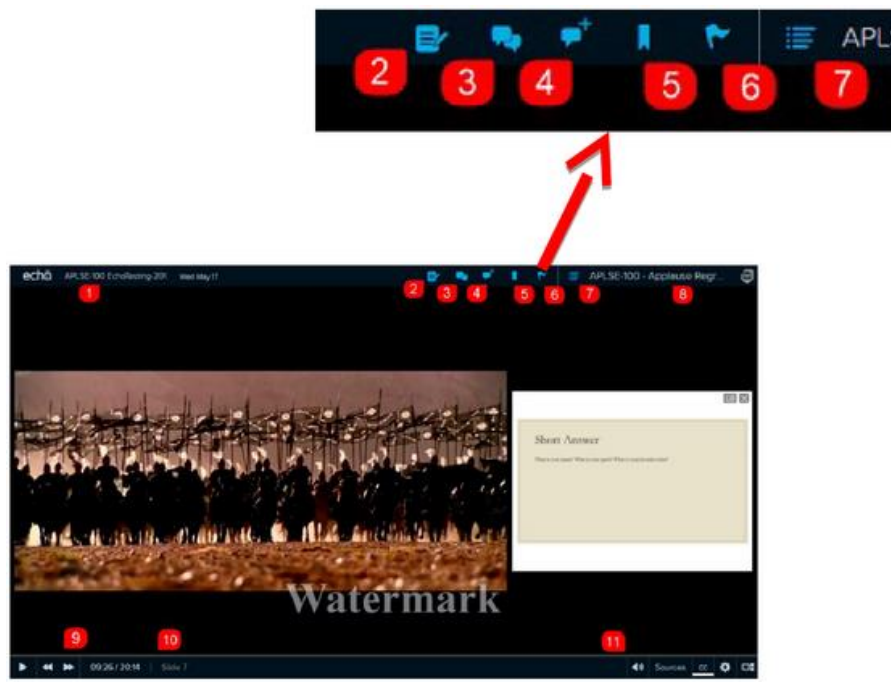
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## **Appendix**

### **Appendix 1. Echo360 Instructions for students**

We are going to trial the Echo360 Active Learning system in BIOL126 - please read the notes below which will enable you to gain the following benefits from this new lecture format:

- Flag a slide as confusing so staff can respond to this
  - Take notes next to the lecture slides (your notes remain available while you have access to the unit)
  - Bookmark important slides for revision
  - Ask questions about a slide (you can also answer questions with your peers)
  - Answer interactive questions the lecturer has prepared
- 
1. Bring a computer, tablet or smart phone to your lecture
  2. Log into LEO and then BIOL126
  3. Click on Lecture Recordings; this should open the ECHO360.org website with lecture recordings preloaded
  4. The green 'play' button is the recording. The interactive presentation where you can ask questions, give feedback or answer MCQ questions is shown by a green 'screen'
  5. Press the green screen of the relevant session (date and time) –and then press 'view'
  6. You now have the slides in front of you; you can move through these 'live' as the presenter clicks from one slide to another. Alternatively you can work through these slides in your own time
  7. You can make posts, ask questions or start discussions on each slide, therefore giving staff the opportunity to see where you may be struggling. Other students are also able to respond to your questions
  8. Staff will respond to any questions posted here for 1 week after the lecture was delivered so please use this opportunity to address areas that are confusing you
  9. What can you see when you open up the lecture on ECHO360, and what does it mean?



2 = *Notes*: open this to take notes in class. Each entry is tagged to the current slide

3 = *Conversation bubble*: opens a discussion panel allowing you to view any questions or comments others may have entered and to respond or ask your own questions

4 = *Conversation bubble with plus sign*: opens the discussion panel but with a new question entry box for input; if relevant, please select 'reference class content' so your question is linked to that slide. You can also post anonymously if you wish

5 = *Bookmark*: use this to bookmark a slide; this will appear in your study guide so you can return to the location and view it as necessary

6 = *Flag*: use this to mark any content you find confusing

7 = *List*: returns you to the list of lectures/recordings for the unit

## Appendix 2. Echo360 Instructions for staff

Echo360 ALP is a suite of add-ons designed to help academics engage students and includes video, engagement and analytic tools.

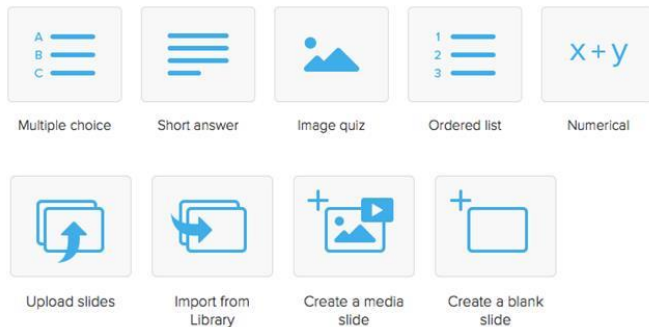
**Video tools:** enable lecture recording (Lecture capture), recording from your desktop or laptop (Personal capture) or from a mobile device (Mobile capture).

**Engagement tools:** During your lecture presentation on Echo360 you are able to engage students with the addition of media slides or activities, for example polling activities of MCQs, SAQs, images, or numerical quizzes. Students are also able to start and/or respond to discussion points, make contextual notes and provide confusion alerts (eg. Students may alert you to a confusing slide).

## How do I use ECHO360 to engage students?



Slides can be created as usual in PowerPoint and uploaded into your Echo360 library where you can add engagement tools to your slide images. Alternatively, a tool called the ribbon (see below) can be downloaded and added to your PowerPoint allowing you to add these features from within PowerPoint – this can then be uploaded to your library. Once you have uploaded your slides you can add activities or more slides.



### ***The ECHO360 ribbon allows you to:***

- Prepare ECHO360 interactive slides in PowerPoint
- Upload your presentation to ECHO360 with a single button (or update it if you change the PowerPoint)
- Use PowerPoint to show your presentation in the lecture which allows you to use all PowerPoint features (eg. Transitions, embeds, links etc) along with the ECHO360 interactive slides to gain student feedback

### ***How do I create my PowerPoint using the ribbon?***

1. First you need to get the ribbon
2. Log into LEO and then the unit you want to use ECHO360 functionality
3. Click on Lecture Recording; this should open the ECHO360.org website with lecture recordings preloaded
4. Click on the cogwheel in the top right corner, click download and then download the version appropriate to your computer (usually 32 bit). Instructions are found at: [http://help.echo360.org/#t=Instructor\\_Guide%2FIGTopics%2FWorking\\_with\\_Slides%2FUsing\\_the\\_PowerPoint\\_Ribbon.htm](http://help.echo360.org/#t=Instructor_Guide%2FIGTopics%2FWorking_with_Slides%2FUsing_the_PowerPoint_Ribbon.htm)
5. [Once the ECHO ribbon is installed into PowerPoint you need to log in \(top left hand side in PowerPoint\); use your ACU email address and create a password](#)
6. [You can now add questions \(eg. MCQs\) using the 'add activity' tab into your already prepared PowerPoint presentation](#)
7. [When finished, click 'publish' and follow the instructions to upload onto LEO \(note that the quality is not as good using the 'publish' route in PowerPoint as it is uploading directly via the Echo360 website; see below\)](#)

### ***How do I upload my powerpoint presentation NOT using the ribbon?***

1. Log into LEO and then the unit you want to use Echo360 functionality
2. Click on Lecture Recording; this should open the Echo360.org website with lecture recordings preloaded
3. Press the blue 'plus' button
4. You can now choose to upload a file, import from your library or create a new presentation
5. If you want to upload a file (the most likely scenario) please click 'upload' and then drag your Powerpoint across
6. It is now ready for you to add questions if required

### ***How can this help my students?***

- You can add questions which students can respond to live
- Students can use their smart phone, tablet or laptop to:
  - Flag a slide as confusing so you can respond to this
  - Take notes next to the lecture slides
  - Bookmark important slides for revision
  - Ask questions about a slide or respond to their peers queries
  - Answer interactive questions you have prepared
  - You can use the analytics to see how your students are interacting with the learning materials (eg. which slides were viewed or were confusing for students, which students engaged with your lecture)

### ***Why might you not use Echo360 to deliver your lectures?***

- If you need to fade in diagrams, flow charts, etc at different times delivery via Echo360 may not be for you; the version on Echo360 is a single image and this functionality is absent. Think of each slide having been converted to a single image file. However, you can still upload your file for students to use in Echo360 whilst delivering your PowerPoint at the same time; this allows the best of both Worlds and this is recommended.
- The internet is down; your Echo360 presentations are saved in the cloud. **Always take a backup of your presentation on a USB stick**

### ***Issues we have discovered***

- When you upload your PowerPoint sometimes it will not format correctly – this is frequently observed with tables and when text overlays images (for example this text may disappear); therefore please ensure you check your slides before giving access to students. If you upload your file as a PDF file instead of a PowerPoint this issue will be resolved.
- You can't see the 'student view' so you just have to presume it will work for them!!

### ***Useful links and webpages:***

- Instructions on how to use the powerpoint ribbon  
[http://help.echo360.org/#t=Instructor\\_Guide%2FIGTopics%2FWorking\\_with\\_Slides%2FUsing\\_the\\_PowerPoint\\_Ribbon.htm](http://help.echo360.org/#t=Instructor_Guide%2FIGTopics%2FWorking_with_Slides%2FUsing_the_PowerPoint_Ribbon.htm)
- [Creating a password for direct Echo360 login](http://help.echo360.org/#t=Creating_or_Changing_Your_Echo360_Password.htm%23Create_direct_password)  
[http://help.echo360.org/#t=Creating\\_or\\_Changing\\_Your\\_Echo360\\_Password.htm%23Create\\_direct\\_password](http://help.echo360.org/#t=Creating_or_Changing_Your_Echo360_Password.htm%23Create_direct_password)

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# AN AUTHENTICATION FOR GROUP COMMUNICATIONS IN AD-HOC NETWORKS.

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## ABSTRACT

*Group communication implies a many-to-many communication and it goes beyond both one-to-one communication (i.e., unicast) and one-to-many communication (i.e., multicast). Unlike most user authentication protocols that authenticate a single user each time, we propose a new type of authentication, called **group authentication** that authenticates all users in a group at once. The group authentication protocol is specially designed to support group communications. There is a group manager who is responsible to manage the group communication. During registration, each user of a group obtains an unique token from the group manager. Users present their tokens to determine whether they all belong to the same group or not. The group authentication protocol allows users to reuse their tokens without compromising the security of tokens. In addition, the group authentication can protect the identity of each user.*

**KEYWORDS:** *User authentication; Group communication; secret sharing; Ad hoc network; Strong t - consistency*

## 1. INTRODUCTION

User authentication is one of the most important security services in computer and communication application. Knowledge based authentication (e.g., password) [16, 9] and key based authentication (e.g., public/private key) [7,12] are the two most popular approaches. Knowledge based authentication has some security flaws. Most users like to use simple and short passwords. However, Internet hackers can easily crack simple passwords. Public-key based authentication needs a certificate authority (CA) to provide the authenticity of public keys. In addition, public-key computations involve large integers. Computational time is one of the main concerns for public-key based authentication.

All user authentication protocols [10,6] are one-to-one type of authentication where the prover interacts with the verifier to prove the identity of the prover. For example, the RSA digital signature [13] is used to authenticate the signer of the signature. In this approach, the verifier sends a random challenge to the prover. Then, the prover digitally signs the random challenge and returns the digital signature of the challenge to the verifier. After successfully verifying the digital signature, the verifier is convinced that the prover is the one with the identity of the public key used to verify the digital

signature. In wireless communications, when a mobile subscriber wants to establish a connection with the base station, the subscriber and the base station interact to DOI: 10.5121/ijnsa.2013.530209 establish mutual authentication. Mutual authentication can prevent an illegitimate subscriber from using the service and prevent the fake base station from harming the subscriber.

Network applications are no longer just one-to-one communication; but involve multiple users (□2). Group communication [14,2] implies a many-to-many communication and it goes beyond both one-to-one communication (i.e., unicast) and one-to-many communication (i.e., multicast). In this paper, we propose a new type of authentication, called **group authentication**, which authenticates all users in a group at once. The group authentication protocol is specially designed to support group communications. The group authentication is defined to involve multiple users and users want to convince each other that they all belong to the same group without revealing their identities. In the group authentication, each user acts as both the prover and the verifier. Group authentication is extremely important in an ad hoc network because this network is temporarily established by multiple users and these users want to use this network to exchange secret information.

Devising protocols to provide group authentication in ad hoc networks is extremely challenging due to highly dynamic and unpredictable topological changes. As a result, there are two popular models to provide group authentication services in an ad hoc network. The first model involves a centralized authentication server (AS) [11,3] and the second model has no AS [5,4]. In the first model, AS manages the access rights of the network. For example, Bhakti et al. [3] proposed to adopt Extensible Authentication Protocol (EAP) in the IEEE 802.1x standard for wireless ad hoc network. This approach requires to set up the AS and have mobile users to access to the AS service. In fact, in some situations, the second model is the only way to provide group authentication. For example, in an ad-hoc network communication, there has no AS service available to mobile users. In the second model, each user needs to take in charge of authenticating other users. In a straightforward approach, if there are  $n$  users in the group, each user can use the one-to-one authentication protocol for  $n - 1$  times to authenticate other users. Computational time is one of the major concerns in this approach.

In this paper, we introduce a special type of group authentication which provides an efficient way to authenticate multiple users belonging to the same group without revealing identity of each user. Our proposed protocol is no longer a one-to-one type of authentication. It is a many-to-many type of authentication. Unlike most user authentication protocols that authenticate a single user each time, our proposed protocol authenticates all users of a group at once. In our proposal, each user needs to register with a group manager (GM) to become a group user. Like the trusted dealer in Shamir's  $(t, n)$  secret sharing scheme [15], the GM needs to select a secret polynomial and compute token for each user. Based on these tokens, our protocol can establish group authentication for all users at once. The group authentication protocol allows users to reuse their tokens without compromising the security of tokens. Our proposed protocol supports existing wireless communication network including wireless ad hoc network.

**The rest of this paper is organized as follows.** In next section, we include some preliminaries. In Section 3, we introduce the model of our proposed group authentication. In Section 4, we present basic one-time group authentication protocol; in Section 5, we present group authentication protocol without revealing tokens. We conclude in Section 6.

## 1. PRELIMINARIES

### 2. Review of Shamir's secret sharing scheme [15]

In Shamir's  $(t, n)$  secret sharing scheme based on the polynomial, there are  $n$  shareholders and a mutually trusted dealer. The scheme consists of two algorithms:

- a) **Share generation algorithm:** the dealer first picks a random polynomial of degree  $t-1$ ,  $f(x) = a_{t-1}x^{t-1} + \dots + a_1x + a_0 \pmod{p}$ , such that the secret  $s$  satisfies  $f(0) = a_0 = s$  and all coefficients,  $a_0, a_1, \dots, a_{t-1} \in \mathbb{Z}_p$ ,  $p$  is a prime with  $p > s$ . The dealer computes shares,  $f(x_i)$ , for  $i = 1, 2, \dots, n$ , and distributes each share  $f(x_i)$  to shareholder  $U_i$  secretly.
- b) **Secret reconstruction algorithm:** it takes any  $t$  or more than  $t$  shares, for example,  $j$  shares (i.e.,  $t \leq j \leq n$ ),  $(x_1, f(x_1)), (x_2, f(x_2)), \dots, (x_j, f(x_j))$ , as inputs, and outputs the secret  $s$  using Lagrange interpolating formula as

$$s = \sum_{i=1}^j f(x_i) \prod_{r=1, r \neq i}^j \frac{x_r - 0}{x_r - x_i} \pmod{p}.$$

We note that the above algorithms satisfy the basic requirements of the secret sharing scheme, that are, (1) with the knowledge of any  $t$  or more than  $t$  shares, shareholders can reconstruct the secret  $s$ ; and (2) with the knowledge of any  $t-1$  or fewer than  $t-1$  shares, shareholders cannot obtain the secret  $s$ . Shamir's secret sharing scheme is unconditionally secure since the scheme satisfies these two requirements without making any computational assumption. For more information on this scheme, please refer to the original paper [15].

### Harn and Lin's definition on strong $t$ -consistency [8]

Benaloh [1] presented a notion of  $t$ -consistency to determine whether a set of shares is generated from a polynomial of degree  $t-1$  at most. Recently, Harn and Lin [8] proposed a new definition of strong  $t$ -consistency which is the extension of Benaloh's definition.

**Definition 1 (Strong  $t$ -consistency [8]).** A set of  $n$  shares (i.e.,  $t < n$ ) is said to be strong  $t$ -consistent if (a) any subset of  $t$  or more than  $t$  shares can reconstruct the secret, and (b) any subset of fewer than  $t$  shares cannot reconstruct the secret.

It is obvious that if shares in Shamir's secret sharing scheme are generated by a polynomial with degree  $t-1$

exactly, then shares satisfy the security requirements of a  $(t, n)$  secret sharing scheme and these shares are also strong  $t$ -consistent.

Checking strong  $t$ -consistency of  $n$  shares can be executed very efficiently by using Lagrange interpolating formula. In fact, to check whether  $n$  shares are strong  $t$ -consistent or not, it only needs to check whether the interpolation of  $n$  shares yields a polynomial with degree  $t-1$  exactly. If this



condition is satisfied, we can conclude that all shares are strong  $t$ -consistent. However, if there are some illegitimate shares, the degree of the interpolating polynomial of these  $n$  shares is more than  $t$  with very high probability. In other words, these  $n$  shares are most likely to be not strong  $t$ -consistent. The property of strong  $t$ -consistency will be used in Section 5 of our protocol to check strong  $t$ -consistency of  $n$  shares without revealing tokens.

## 1. MODEL

### Entities

- a) **Group Manager (GM):** A group manager is responsible to register users to form a group. The responsibility of GM is to issue a secret token to each user during registration. Later, authentication is based on the secret tokens. Since tokens are used in authentication, identities of users are protected. In order to prevent malicious users to reveal their tokens to attackers, each token is a unique integer. The secret tokens are shares of the polynomial generated by the GM.
- b) **Group Users:** Join a group and become a group user, each user needs to register with the GM. After being successfully registered, each user receives a secret token from the GM. Each user with a unique token can prevent malicious users to give their tokens to impersonators.
- c) **Attackers:** We consider two types of attackers, the *inside attackers* and the *outside attackers*. The inside attackers are users who are legitimate users and own legitimate tokens from the GM. We consider that the insider attackers may collude to forge tokens for non-users. The outside attackers are impersonators who do not own any tokens and try to impersonate users to fail the authentication protocol. We also assume that the GM does not collude with any user. If the GM colludes with any user by revealing the secret of the GM to the user, the colluded user can do harm to the group. In addition, we assume all users act honestly in the authentication. If any user acts dishonestly by revealing an invalid value, the authentication is failed.

### Authentication outcomes

There are only two possible outcomes of a group authentication; that are, either “yes” or “no”. If the outcome is “yes”, it means that all users belong to the same group; otherwise, there are impersonators.

## 2. BASIC ONE-TIME GROUP AUTHENTICATION PROTOCOL

In the following discussion, we assume that there are  $n$  users,  $M_1, M_2, \dots, M_n$ , registered at the GM to form a group.

### System set up

During registration, GM constructs a random  $(t-1)$ -th (i.e.,  $t < n$ ) degree polynomial

$f(x)$  with

$f(0) = \sigma$ , and computes secret tokens of users as

$y_i = f(x_i)$ , for  $i = 1, 2, \dots, n$ , where  $x_i$

is the public information associated with user  $M_i$ . GM sends each token GM makes  $H(s)$  publicly known, where  $H$  is a one-way function.

$y_i$  to user  $M_i$  secretly.

*Remark 1.* The threshold  $t$  is an important security parameter that affects the security of group authentication protocols. Using a  $(t, n)$  secret sharing scheme to issue tokens in the registration can prevent up to  $t - 1$  inside attackers, who are legitimate users, colluded together to forge tokens.

### **Basic one-time group authentication protocol**

From now on, we assume that there are  $j$  users with their tokens  $t < j \leq n$ , who want to execute the group authentication protocol.

$f(x_1), f(x_2), \dots, f(x_j)$  where

The basic idea of this protocol is that each user releases the token obtained from the GM during registration. If all released tokens are valid, the interpolation of the released tokens can reconstruct the secret  $s$ . The published one-way hash of the secret is used to compare with the one-way hash of the reconstructed secret.

**Theorem 1.** *Protocol 1 can detect any number of illegitimate users.*

*Proof.* If there is illegitimate user who does not own a valid token on the polynomial

$f(x)$ , the

reconstructed secret will be different from the secret  $s$ . Thus, Protocol 1 can detect any number of illegitimate users.  $\square$

**Protocol 1: One-time group authentication protocol**

- **Step 1.** Each user  $M_i$  reveals his token  $f(x_i)$ , to all other users simultaneously.
- **Step 2.** After knowing all tokens,  $f(x_i)$ , for  $i = 1, 2, \dots, j$ , following Lagrange interpolating

formula, each user computes  $s' = \sum_{i=1}^j f(x_i) \frac{-x_r}{x_i - x_r} \pmod{p}$ . If  $H(s') = H(s)$ , all users have been authenticated successfully; otherwise, there are illegitimate users.

*Remark 2.* This is a one-time authentication protocol since the secret and tokens are revealed to all users in this protocol. The authentication is no longer a one-to-one authentication and it is a many-to-many authentication. The proposed protocol is very efficient to authenticate multiple users belonging to the same group without revealing identity of each user.

### 3. GROUP AUTHENTICATION PROTOCOL WITHOUT REVEALING TOKENS

In Protocol 1, since tokens are revealed to all users, each token can only be used for one-time authentication. In addition, the secret  $s$  is also exposed to users in Protocol 1. In the following discussion, we propose a way to protect tokens. In addition, the secret does not need to be recovered in each authentication. Our authentication is based on the property of strong  $t$ -consistency in Section 2.2.

#### Group authentication protocol without revealing tokens

In the following protocol, it can be achieved authentication without revealing tokens and the secret. The basic idea of our approach uses the property of strong  $t$ -consistency. Let each user select a random polynomial with  $(t-1)$ -th degree and generate shares for other users. Then, each user releases the additive sum of his own token obtained from the GM during the registration and sum of shares of polynomials generated by users. Due to the property of secret

**Protocol 2:** Group authentication protocol without revealing tokens

- **Step 1.** Each user  $M_i$  selects a random polynomial,  $f_i(x)$ , with  $(t-1)$ -th degree. For the polynomial  $f_i(x)$ , user  $M_i$  computes shares as  $f_i(x_r)$ , for  $r = 1, 2, \dots, j$ ,  $r \neq i$ , for other users. User  $M_i$  sends each share,  $f_i(x_r)$  to user  $M_r$  secretly.

- **Step 2.** After receiving  $f_r(x_i)$  for  $r = 1, 2, \dots, j$ , each user uses his token  $f(x_i)$  to compute

$$y_i'' = f_i(x) + \sum_{r=1}^j f_r(x_i) \pmod{p}$$

Each user releases his value  $y_i''$

- **Step 3.** After knowing  $y''$ , for  $i = 1, 2, \dots, j$ , each user checks whether they are strong  $t$ -consistent. If they are not strong  $t$ -consistent, there are illegitimate users; else, all users have been successfully authenticated belonging to the same group.

sharing homomorphism in Section 2.2, the released sums are shares of the secret polynomial  $f(x)$  of tokens and sum of polynomials generated by users. If all users act honestly and own valid tokens, the released sums should be strong  $t$ -consistent; otherwise, the released sums are not strong  $t$ -consistent. Since users do not need to reconstruct the secret in the protocol and the tokens have not been revealed directly, the dealer does not need to publish the one-way of the secret  $s$  during system set up and the tokens can be reused.

**Theorem 2.** Protocol 2 can detect any number of illegitimate users.

*Proof.* Due to the property of secret sharing homomorphism, each released value,

$y_i''$  in Step 2 is

the share of additive sum of polynomials,

$$f(x) + \sum_{r=1}^j f_r(x)$$

$r=1$

$\pmod{p}$ , with  $(t-1)$ -th degree.

Thus, in Step 3, all released values,

$y''$ , for  $i = 1, 2, \dots, j$ , are strong  $t$ -consistent. If there is any illegitimate user who does not own a valid token,

$f(x_i)$ , the released values,

$y''$ , for  $i = 1, 2, \dots, j$ , are not strong  $t$ -consistent with very high probability.  $\Upsilon$

**Remark 3.** In Step 2, the token

$j$

$f(x_i)$

cannot be computed from the revealed value

$$y'' = f(x) + \sum_{i=1}^r f(x_i) \pmod{p} \quad r=1$$

$(\text{mod } p)$ . Therefore, the tokens are protected unconditionally and can be reused for multiple authentications.

### Computational complexity

The most time-consuming operation for each user is to check the strong  $t$ -consistency of released values  $y_i$

" for

$i = 1, 2, \dots, j$ , in Step 3 of Protocol 2. Following our discussion presented in Section 2.2, checking strong  $t$ -consistency needs to compute the interpolating polynomial of values

$y''$ . The polynomial interpolation becomes the main computational task in our proposed protocol. However, the modulus  $p$  in our polynomial interpolation is much smaller than the modulus in most public-key cryptosystems, such as RSA cryptosystem [13]. In addition, not like conventional user authentication protocol that authenticates one user at a time, this proposed authentication protocol authenticates all users at once. Thus, the proposed authentication protocol is very efficient in comparing with all existing authentication protocols.

## 4. CONCLUSIONS

We propose a special type of group authentication which is specially designed for group communications such as the ad hoc wireless communication network. The proposed group authentication protocol is no longer a one-to-one type of user authentication and it is a many-to-many type of authentication that authenticates multiple users at once. We first propose a basic one-time group authentication protocol and then propose a general group authentication protocol without revealing tokens. Our proposed group authentication is very efficient since the computation is based on the computation of linear polynomial.

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# **TRENDS IN INFORMATION TECHNOLOGY MANAGEMENT**

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## **ABSTRACT**

*The paper presents an analytical exposition, critical context and integrative conclusion on the trends and best practices in Information Technology Management, and reviews and evaluates the key issues, trends and future direction of Modern Information Technology Management. IT is generally accepted as a key enabler of economic and technological growth. Managers implement new technology to change something: the organization, the nature of work, relationships with other organizations, or some other facet of business. Information Technology (IT) plays a vital role in leveraging productivity and efficiency in private organizations, governments and research. The value of IT in any organization depends on its infrastructure, which consists of computers, network and telecommunication technologies, data and core software applications. Information Technology (IT) is now a force and driver of modern technological development and globalization, and makes the management of information more efficient and effective. Technology management entails all management activities that determine the application of policy, objectives and responsibilities as well as their execution in an organization in terms of planning, allocating resources, organizing and ensuring outcomes that improve processes. The major IT Management issues are: Using technology to design efficient and effective organizations; Developing a plan for information technology in the organization; Using IT as a part of corporate strategy; Taking advantage of interorganizational systems; Deciding on and developing new applications of IT; Reengineering business processes; Adopting special applications; Changing the organization; Managing the IT infrastructure in a time of explosive growth and technological change; Deciding whether and what to outsource; and Deciding how much to invest in IT. Knowledge and skills are a necessary and sufficient condition for technological progress. Developing countries lack enough skilled IT persons who can design, program, install, configure and maintain Information Technology in this constantly changing industry. Accordingly, lack of qualified and globally recognized IT professionals is seriously hampering IT adoption and development. Management Information Systems refer to information management methods tied to the automation or support of human decision making, whereas IT Management refers to the IT related management activities in organizations.*

## **1. ANALYTICAL EXPOSITION**

The paper presents an analytical exposition, critical context and integrative conclusion on the trends and best practices in Information Technology Management, and reviews and evaluates the key issues, trends and future direction of **Modern Information Technology Management**. The introduction of computers and communication technologies and their constant improvements have

transformed the way organisations behave and conduct business. The importance of information technology cannot be over emphasized. Information technology is at the epicenter of global socio-economic transformation and is a strategic resource and foundation for every economic activity (Kabanda, G., 2014). According to Stallings, W. (2005), any business that ignores this fact will fall hopelessly behind in the global race for the competitive edge. While Stallings, W. (2005)'s assertion is true, developing countries face many challenges in trying to catch up with global trends and thus they will mostly occupy the tail end in this respect. Generally African countries are largely end consumers of technology and lag even further behind in terms of ICT innovations (Kabanda, G., 2014).

Information Technology (IT) is the set of tools for acquisition, processing, storage and dissemination of vocal, pictorial, textual and numerical information by a microelectronics-based combination of computing, telecommunications and video. In general IT represents the convergence of all types of computer equipment, certain electronic (audio and video) equipment, all types of software for use with computers, telecommunications equipment and software, and other automation techniques. The term information and communications technology (ICT) is generally used and usually refers to the integration of information and telecommunication technology sectors involving their convergence with the media technology sector based on common digital technology. ICT includes all types of telecommunication and broadcasting systems and services (wireline, wireless, mobile, satellite), computer hardware, software, networks and services, content producing and managing multimedia systems (Sallai, G., 2012, p.6). ICT, therefore, means any communication device, application, or service related to radio, television, cellular technology, computing, networking, and satellite systems, including services such as videoconferencing and distance learning. ICT has a tremendous impact on reducing costs and increasing the quality of management of business processes. Berisha-Shaqiri, A. (2015, p.166) argued that ICT has gained great importance when it comes to the success and efficiency of business helping business processes in the following areas:

- ❖ Information Technology positively affects the reduction of management costs, because its application improves the quality of management;
- ❖ In addition to revenue growth, ICT facilitates the communication between managers, by saving time and quality of communication within the enterprise;
- ❖ Through internal network and enterprise information the distribution between workers and managers at the right time and at the same time also affects the growth of their knowledge;
- ❖ ICT affects the reduction of workers in occupations where knowledge is not required;
- ❖ ICT increases the demand for knowledge workers;
- ❖ ICT and the use of computer networks affects revenue growth.

Modern information systems are largely driven by the development of the internet. The internet revolutionized how the world communicates, stores and accesses information. 'Faster computers and cheaper storage are useful in their own right. But the reason that all of these technologies have had such a massive impact on almost all aspects of life is that these devices are linked so that information can be distributed and accessed effortlessly from anywhere.' (World Bank Report, 2016, p.42). This development has brought with it several issues, positive and negative. The speed of development of technology has

increased exponentially over the last three decades since the invention of the World Wide Web (WWW) in 1989. The ease of sharing and accessing information across the globe has enabled technology developers to reduce their development time.

The internet brought with it inclusivity, helping to integrate African countries with the rest of the world digitally. 'Inclusion for the individual usually means expansion of a market by those on the other side of the transaction, such as a firm or a government that now serves more citizens', (World Bank Report, 2016, p.43).

The practice of technology management requires a better theoretical structure to avoid being blindsided by new technology (Dolinsek, S., and Strukelj, P., 2012, p.30). In the world of investments, monies flow in and out of technology-based companies more on the basis of fashion than on the basis of rational technology analysis. According to Dolinsek, S., and Strukelj, P. (2012, p.31) technology is a large and growing part of every manager's daily experience, where managers develop technology, use technology, buy technology and sell technology. On the contrary, the common observation is that key management decision makers have inadequate background and ability to make judgments and forecasts in the area of technology; and without that ability, their options in utilizing technology in corporate strategy are severely limited. Technology is addressed in strategic plans only implicitly, except in the case of special endeavors which are outside the main lines of production. Strategic management of technology and innovation is a young field and the domains of different in developing nations. Khalil (2012) cited in Dolinsek, S., and Strukelj, P. (2012, p.32) proposed a conception that any technology consists of four interdependent, codetermining, and equally important components:

- *Hardware*: The physical structure and logical layout of the equipment or machinery that is to be used to carry out the required tasks.
- *Software*: The knowledge of how to use the hardware in order to carry out the required tasks.
- *Brainware*: The reasons for using the technology in a particular way.
- *Know-how*: which covers the skills and technological achievements.

Computers have enhanced the speed and ease of communication between individuals and companies. Ideas spread quickly and easily, cutting across geographical boundaries at low cost. Companies save time and money in implementing their strategies as more and more transactions like sales and purchases are implemented over the phone or on the internet and managers are quickly aided in their decision making processes. Distributed information processing is used in most companies for both intra-company and inter-company exchange. Technology has also improved production in almost every industry in the world. It is used in the health sector in a way that has saved many lives and improved the quality of life and longevity (Stallings, W., 2005). Machines now carry out a lot of the work in the industrial and agricultural sectors and have led to increased outputs. Technology has provided better working environments, reduced human effort and improved efficiencies. With more technological advances taking place, organisations are able to store more information in smaller spaces and retrieve information at higher speeds. On the educational front, technology has improved access to knowledge and enhanced research efforts. The four types of information namely voice, data, image and video technology are dominating factors in shaping the

competitiveness of enterprises (Gudanowska, A.E.,2017).

Knowledge and skills are a necessary and sufficient condition for technological progress. Without knowledge and skills, machines, devices and processes of production would be just some unknown, unuseful, arbitrary and coincidental processes and pieces of material. Knowledge and skills are fundamental to consistently use machines, devices and processes of production rationally and effectively. According to Dolinsek, S., and Strukelj, P. (2012, p.35), technology refers to:

- machines and devices that are used in manufacturing (processing), storing and delivering of material products, energy and information,
- processes (with the use of machinery and devices) of manufacturing (processing), storing and delivering material products, energy and information,
- devices and their processes that are included as components in final products,
- advanced functional materials,
- most generally, devices that people and organizations use in their activities.

Dolinsek, S., and Strukelj, P. (2012, p.36) introduced a principal relationship between technology and wealth, which states that by inventing, developing technologies, by using them and by advancing, improving them, we can:

- produce existing goods more efficiently,
- produce more goods,
- produce better goods,
- produce new goods,
- save labor (though development, maintenance and advancement of technology requires labor) and increase leisure/spare time,
- make labor easier,
- improve goods,
- make activities easier,
- enable new activities.

How and to what extent a technology contributes to wealth in a society depends on the principles of the socio-economic order in that society, in which technology is developed, used and advanced. Technological capability is one of the central elements in the practice of technology management. Theory in management of technology should therefore pay sufficient attention to this phenomenon and provide some satisfying results. Technological capability refers to our capability (capacity) to use technologies (as well as knowledge and skills necessary for their proper use) in a way that contributes to effective and successful achievement of our purposes. Technological capability is not the same as technology or as knowledge and skills of how to use a technology in order to produce a desired product. Technological capability is our competence/capacity to purposefully use technology and the necessary knowledge and skills (Dolinsek, S., and Strukelj, P., 2012, p.41). Technological capability refers both to individuals and organizations/institutions, i.e., an individual as well as an organization/institution can have a technological

capability. According to Gallon *et al* (1995) cited in Dolinsek, S., and Strukelj, P. (2012, p.41), technological capabilities are then divided into:

- applied science capabilities (fundamental know-how derived from basic research),
- design and development capabilities (disciplines employed in converting a product idea into an operational reality),
- manufacturing capabilities (capabilities employed in, or directly supporting, established manufacturing or operations).

Management of technology links engineering, science and management disciplines to plan, develop, and implement technological capabilities to shape and accomplish the strategic and operational objectives of an organization. Managing technology implies managing the systems that enable the creation, acquisition and exploitation of technology. Management of technology is organizing, coordinating and leading the use/handling of technology (and technological knowledge and skills) in an organization. According to Dolinsek, S., and Strukelj, P. (2012, p.43), management of technology involves the following basic activities:

- planning of the use of technology,
- identification, selection and acquisition of technology,
- preparation and introduction of the use of technology,
- implementation, installation and control of the use of technology,
- motivating and maintaining the use of technology.
- technology auditing,
- scanning the technological environment and analyzing technology trends,
- technology forecasting and technology foresight,
- formulation of technology strategy,
- technology transfer,
- technology development.

However, developing countries usually lack the required resources for technological improvement. Employees need to be trained and retrained with every new breakthrough. According to Schiller, B.R. (2003), technological advances shrink the labour force while increasing output. The Behavioural Theory suggests that information systems could change the hierarchy of decision making thus reducing the need of middle management and clerical support to distribute information (Kabanda, G., 2019).

The modern practice of management of technology should take the following trends into account:

- production economies of scope are equally important with economies of scale, and production automation should be appropriately balanced between hard and soft automation (depending upon product volumes and product lifetimes),
- multi-core-technology product lines will have shorter product life times and should be planned as generations of products (paced by the most rapidly changing critical technology), and the organization must be flexibly organized for rapid and correct response,

- world markets and technology are now global, and enterprises should be globally based to ‘think globally and act locally’.

Information Technology Management is concerned with exploring and understanding Information Technology as a corporate resource that determines both the strategic and operational capabilities of the firm in designing and developing products and services for maximum customer satisfaction, corporate productivity, profitability and competitiveness (Catalin, P., and Alina, P., 2010, p.1). Management Information Systems refer to information management methods tied to the automation or support of human decision making, whereas IT Management refers to the IT related management activities in organizations.

Information Technology Management is heavily dependent upon the alignment of technology and business strategies, and includes considering the value creation that is created through technology. Technology plays an important role in improving the overall value chain of an organization, where the value creation for an organization is a network of relationships between internal and external environments. The IT Manager and the Project Manager have a lot in Common as both work to achieve organizational goals by directing the activities of people. According to Catalin, P., and Alina, P. (2010, p.2), the IT Manager is responsible for an ongoing program of IT services, while the Project Manager’s accountability and authority last only for the life of the project. Hence, it is the time-limited nature of projects that makes the role of Project Manager so important. What every IT Manager needs to know about Project Management is that there are best practices which when socialized into an organization can greatly enhance the success of projects. Therefore, adopting Project Management will make the work of effectively managing change in the IT environment easier and more consistent.

## **2. CRITICAL CONTEXT**

Information Technology (IT) is now a force and driver of modern technological development and globalization, and makes the management of information more efficient and effective (Ejiaku, S.A., 2014, p.61). IT is generally accepted as a key enabler of economic and technological growth. Information Technology has unlimited potential to improve business operations, education, technology and economic growth. However, this technology could help contribute to poverty alleviation in developing economies if used to meet local and national needs. Information Technology (IT) plays a vital role in leveraging productivity and efficiency in private organizations, governments and research. The value of IT in any organization depends on its infrastructure, which consists of computers, network and telecommunication technologies, data and core software applications. Developing countries lack enough skilled IT persons who can design, program, install, configure and maintain Information Technology in this constantly changing industry (Ejiaku, S.A., 2014, p.62). Accordingly, lack of qualified and globally recognized IT professionals is seriously hampering IT adoption and development. Ejiaku, S.A. (2014, p.63) observed that ineffective government policies, poor infrastructure and inadequate training and qualification are contributory factors in creating challenges in IT transfer and adoption in Africa. IT Management must take



into cognisance all these challenges and issues, especially in developing economies. Managers implement new technology to change something: the organization, the nature of work, relationships with other organizations, or some other facet of business (Lucas, H.C., 2009, p.x).

Technology management entails all management activities that determine the application of policy, objectives and responsibilities as well as their execution in an organization in terms of planning, allocating resources, organizing and ensuring outcomes that improve processes (Laudon, K.C., and Traver, C.G., 2008). Gudanowska, A.E. (2017), concurs adding that technology management should take into account the resources available, currently used technology, the future of the market and the social and economic environments. According to Kabanda, G., (2019), there are relevant theories that can be used to evaluate the impact of technology in an organization or country. The first one is the Microeconomic Model which looks at technology as a factor of production like labour and capital. The Cobb-Douglas production function is used to explain the relationship between the inputs of labour and capital to produce the output which can be significantly increased if technology is added as another form of input (Walsh, C., 2003).

A CEO understands the role and importance of information technology in managing a twenty-first century organization. Lucas, S.A. (2009, p.7) posits that IT

- Provides new ways to design organizations and new organizational structures.
- Creates new relationships between customers and suppliers who electronically link themselves together.
- Presents the opportunity for electronic commerce, which reduces purchasing cycle times, increases the exposure of suppliers to customers, and creates greater convenience for buyers.
- Enables tremendous efficiencies in production and service industries through electronic data interchange to facilitate just-in-time production.
- Changes the basis of competition and industry structure, for example, in the airline and securities industries.
- Provides mechanisms through groupware for coordinating work and creating a knowledge base of organizational intelligence.
- Makes it possible for the organization to capture the knowledge of its employees and provide access to it throughout the organization.
- Contributes to the productivity and flexibility of knowledge workers.
- Provides the manager with electronic alternatives to face-to-face communications and supervision.
- Provides developing countries with opportunities to compete with the industrialized nations.

Managers delegate tasks and decision making to lower levels of management, and information systems make data available at the level of management where it is needed to make decisions (Lucas, S.A., 2009, p.14). Technology-enabled firms feature highly automated production and electronic information handling to minimize the use of paper and rely extensively on images and optical data storage. According to Lucas, S.A. (2009, p.15), managers are challenged with decisions about:

- ❖ The use of technology to design and structure the organization.

- ❖ The creation of alliances and partnerships that include electronic linkages.
- ❖ The selection of systems to support different kinds of workers.
- ❖ The adoption of groupware or group-decision support systems for workers who share a common task.
- ❖ Determining a World Wide Web strategy.
- ❖ Routine transactions processing systems.
- ❖ Personal support systems.
- ❖ Reporting and control.
- ❖ Automated production processes.
- ❖ Embedded products.

Information Technology (IT), demands design, installation, configuration, training and maintenance of infrastructure (Ejiaku, S.A., 2014). Continuous IT adoption and development, in varying degrees is necessary in both developing and developed countries because IT is a major driver of modern technological development and globalization. Watson and Meyers (2001) identify three major factors that impact on the development of a successful IT industry in a developed country. These are the extent of IT promotion by governments, the level of research and development, and the existence of an education system that produces IT literate graduates. In developing countries, lack of resources to develop IT in their respective countries and a heavy dependence on foreign aid are important factors that impact on development. Poor basic IT infrastructure and networks in developing countries also hamper their ability to facilitate adequate IT transfer, implementation and development.

IT brings tremendous changes with respect to the following areas (Lucas, S.A., 2009, p.17):

- ❖ Within organizations  
Create new procedures, workflows, workgroups, the knowledge base, products and services, and communications.
- ❖ Organizational structure  
Facilitate new reporting relationships, increased spans of control, local decision rights, supervision, the formation of divisions, geographic scope, and "virtual" organizations.
- ❖ Interorganizational relations  
Create new customer-supplier relations, partnerships, and alliances.
- ❖ The economy  
Alter the nature of markets through electronic commerce, disintermediation, new forms of marketing and advertising, partnerships and alliances, the cost of transactions, and modes of governance in customer-supplier relationships.
- ❖ Education  
Enhance "on campus" education through videoconferencing, e-mail, electronic meetings, groupware, and electronic guest lectures.  
Facilitate distance learning through e-mail, groupware, and videoconferencing. Provide access to vast amounts of reference material; facilitate collaborative projects independent of time zones and distance.
- ❖ National development

Provide small companies with international presence and facilitate commerce.

Make large amounts of information available, perhaps to the consternation of certain governments.

Present opportunities to improve education.

Information technology today provides computational and communications capabilities that were inconceivable a decade ago. A manager has to know enough about technology to take advantage of the power IT offers. The major IT Management issues, according to Lucas, S.A. (2009, p.20), are :

- Using technology to design efficient and effective organizations
- Developing a plan for information technology in the organization
- Using IT as a part of corporate strategy
- Taking advantage of interorganizational systems
- Deciding on and developing new applications of IT
- Reengineering business processes
- Adopting special applications
- Changing the organization
- Managing the IT infrastructure in a time of explosive growth and technological change
- Deciding whether and what to outsource
- Deciding how much to invest in IT

Lucas, S.A. (2009, p.135) presented the following strategies to manage Global IT:

- Concentrate on interorganizational linkages
- Establish global systems development skills
- Build an infrastructure
- Take advantage of liberalized telecommunications
- Strive for uniform data
- Develop guidelines for shared versus local systems

Due to rapid technological changes, we now witness a phenomenal growth of global companies. A global company should have the following features:

- Treats the world as a single market.
- More products sold outside the home country than within the home country.
- Worldwide sourcing of customers, employees, suppliers and technology--sourcing with a total disregard for national boundaries

Technology management is an emerging field that combines multiple disciplines and can be defined in terms of identification, selection, acquisition, and exploitation as an ongoing process. Organizational performance is influenced by how strategies are implemented and the role technology plays in creating sustainable business models. Organizations learning to manage technology with internal and external sources and competing in complex and technological environments reach a critical point in obtaining knowledge. Management of technology education covers strategic management, project management, R&D management, new product development, innovation management, entrepreneurship, and information

management. These types of management are interconnected and interdependent on each other. Processing and storage capacities are rising exponentially, and knowledge is becoming accessible to more people than ever before in human history. The future holds an even higher potential for human development as the full effects of new technologies such as the Internet of Things, artificial intelligence, 3-D Printing, energy storage, and quantum computing unfold.

Artificial intelligence (AI) is one of the biggest areas of focus for future technology development. To make execution of tasks faster, simpler and cheaper, organisations are continuously exploring ways of enabling machines to do more and more of what humans currently do. This has the impact of reducing operational costs in the long run, while at the same time eliminating the need for some jobs held by humans. 'Machines are becoming smarter in that they can learn how to solve problems. One such system is a neural network, which is used to alert you that your credit card may have been used unlawfully,' (Cummings, M., 2012). Neural networks develop trends or patterns of user behaviour over time. When activity that is outside the normal pattern is detected, the neural network raises an alarm. These systems are growing in use in many different fields and will provide greater support to human beings in rapid decision making. As much as these developments positively impact MIS, they also affect people's cultures, raise legal questions in some areas and possibly national security concerns.

Terabytes of data are being created everyday globally, what is being referred as Big Data, and its storage and management is becoming increasingly complex with time. Its analysis and subsequent use has legal implications when it involves third parties. Lawyers will increasingly be burdened with the responsibility of determining what is legal and what is not from a privacy point of view. Banks across the world are setting up Compliance departments to manage among other issues, the collection, storage and usage of stakeholder information. It is the job of the Compliance department to ensure that MIS is in place to filter such clients from receiving international banking services that may result in heavy fines being imposed on the institution for violation.

Rainer, R.K. (2012) states that the following are the emerging technologies of the future: Artificial Intelligence (AI), Internet of Things (IoT), Blockchain, Financial Technology (FinTech) and Quantum Computing. The Internet of Things (IoT) is growing phenomenally. Almost any object that has some form of electrical current flowing through it will in future have sensors installed. These sensors will be linked to some system via the internet for various purposes, 'the rapid increase of placing sensors on all objects (animate and inanimate) is leading to a sense-and-respond environment', (Rainer, R.K., 2012).

Blockchain, or Distributed-ledger technology is developing into many areas of business, the most common currently is Cryptocurrency. This is disrupting the traditional regulated financial services system. This is an unregulated financial currency with no geographical jurisdiction as well. Most people are still sceptical about cryptocurrencies, governments are concerned about how it cannot be regulated, thereby making it difficult to deal with money-laundering, terrorism financing and sanctions busting transactions. This increases the need for organisations to closely monitor how these developments will impact them.

For decades, digital computing has been about bits which are either a '0' or a '1'. Quantum Computing

uses quantum bits (qubits), which can exist in any superposition of these values. It is still in its infancy, but the potential will provide a significant increase in computing speeds and vary computing parameters further without being limited to two states of '1' and '0'. Quantum computing is helping to improve other advanced technologies, such as Genetic Algorithms. These two have been combined to produce Quantum Genetic Algorithms (QGA), 'The efficiency of QGA is significantly better than the conventional genetic algorithm. The QGA is with a small value of the population, a fast speed of convergence, a great capability of global optimization, and a good robustness', (Wang, H., *et al*, 2013, p.1). as digital was a revolutionary development from analogue, quantum computing, once completely figured out, will be just as revolutionary from digital.

Sakovich, N. (2018), and Weldon, D. (2018), identify the following technological developments for 2019 and beyond:

- 1) **Cloud Computing** - According to Sakovich, N. (2018), more and more enterprises will have computing infrastructure in the cloud. The trend will actually lean towards the use of multi- clouds. With increased IT spending, there will be more breakthroughs in mobile internet which will affect cloud computing and stimulate other innovations.
- 2) **Artificial Intelligence (AI)** - AI will expand its presence in many sectors, making its way into more homes and offices and will be integrated in transport systems, healthcare, finance and education. AI will reshape the labour market causing some professions to disappear and new relevant ones to appear (Sakovich, N., 2018).
- 3) **5<sup>th</sup> Generation Wireless (5G)** - New generation networks and 5G smartphones are expected to bring broadband download speeds over mobile networks and provide 10x faster internet services than 4G. According to Sakovich, N. (2018), the use of new generation networks will be much wider with 5G providing impetus for further developments.
- 4) **Internet of Things** - This is the network of physical devices, vehicles, home appliances and many other items embedded with electronics, software sensors actuators and connectivity which enable these objects to connect and exchange data.
- 5) **Automation** - There will be widespread use of technology by which procedures are performed without human assistance. These include self-driven cars and robotic surgery.
- 6) **Drones** – These unmanned air vehicles or autonomous aircrafts are already being used for military surveillance and accident monitoring in developed countries.
- 7) **Augmented reality (AR) / Virtual reality (VR)** – AR is a direct or indirect live view of a physical, real world environment. VR is a computer-generated scenario that simulates a realistic experience.
- 8) **3D Printing** – This is a process where materials are joined or solidified under computer to create three-dimensional objects.
- 9) **Biometrics** – Future trends will include the wide spread of biometrics or realistic authentication as a form of identification and access control.
- 10) **Blockchain** – This is an information storage system for continuously growing number of records called blocks, which are linked and secured using cryptography.
- 11) **Quantum Computers** – This is computing using quantum mechanical phenomena such as

superposition and entanglement to achieve unprecedented levels of speed.

### 3. INTEGRATIVE CONCLUSION

The paper presented an analytical exposition, critical context and integrative conclusion on the trends and best practices in Information Technology Management, and reviewed and evaluated the key issues, trends and future direction of **Modern Information Technology Management**. Ejiaku, S.A., (2014) calls for involvement of government by introducing favourable policies, making more training efforts and leading by example in the diffusion and adoption of information technology developments. The private sector can also fully engage in the technological development efforts to enable their countries to experience the benefits that the developed countries are enjoying. The Agency Theory is the third theory that analyses the impact of technology suggesting that one company can introduce new ways of handling transactions and be the nexus or connection point with other smaller players in the market. This will expand the range of services thus perpetuating technology (Kabanda, G., 2019). An example of this in Zimbabwe is Econet which engaged many small players by developing several Ecocash outlets around Zimbabwe to make themselves the leading player in their arena. This same product, Ecocash led to ventures into other new products, within the organization, like Ecosure, Ecosure, Ecocash-Savings club and Ecocash Diaspora. Ecocash enables many transactions including the instant payment of utilities, groceries and other commodities and transfers of cash.

Information Technology (IT) is the set of tools for acquisition, processing, storage and dissemination of vocal, pictorial, textual and numerical information by a microelectronics-based combination of computing, telecommunications and video. The major IT Management issues, according to Lucas, S.A. (2009, p.20), are :

- Using technology to design efficient and effective organizations
- Developing a plan for information technology in the organization
- Using IT as a part of corporate strategy
- Taking advantage of interorganizational systems
- Deciding on and developing new applications of IT
- Reengineering business processes
- Adopting special applications
- Changing the organization
- Managing the IT infrastructure in a time of explosive growth and technological change
- Deciding whether and what to outsource
- Deciding how much to invest in IT

Lucas, S.A. (2009, p.135) presented the following strategies to manage Global IT:

- Concentrate on interorganizational linkages
- Establish global systems development skills
- Build an infrastructure



- Take advantage of liberalized telecommunications
- Strive for uniform data
- Develop guidelines for shared versus local systems

Information Technology Management is concerned with exploring and understanding Information Technology as a corporate resource that determines both the strategic and operational capabilities of the firm in designing and developing products and services for maximum customer satisfaction, corporate productivity, profitability and competitiveness (Catalin, P., and Alina, P., 2010, p.1). Management Information Systems refer to information management methods tied to the automation or support of human decision making, whereas IT Management refers to the IT related management activities in organizations.

ICT has gained great importance when it comes to the success and efficiency of business helping business processes in the following areas:

- Information Technology positively affects the reduction of management costs, because its application improves the quality of management;
- In addition to revenue growth, ICT facilitates the communication between managers, by saving time and quality of communication within the enterprise;
- Through internal network and enterprise information the distribution between workers and managers at the right time and at the same time also affects the growth of their knowledge;
- ICT affects the reduction of workers in occupations where knowledge is not required;
- ICT increases the demand for knowledge workers;
- ICT and the use of computer networks affects revenue growth.

The modern practice of management of technology should take the following trends into account: production economies of scope are equally important with economies of scale, and production automation should be appropriately balanced between hard and soft automation (depending upon product volumes and product lifetimes), multi-core-technology product lines will have shorter product life times and should be planned as generations of products (paced by the most rapidly changing critical technology), and the organization must be flexibly organized for rapid and correct response, world markets and technology are now global, and enterprises should be globally based to 'think globally and act locally'.

Information Technology (IT) is now a force and driver of modern technological development and globalization, and makes the management of information more efficient and effective. IT is generally accepted as a key enabler of economic and technological growth.

Managers implement new technology to change something: the organization, the nature of work, relationships with other organizations, or some other facet of business. Technology management entails all management activities that determine the application of policy, objectives and responsibilities as well as their execution in an organization in terms of planning, allocating resources, organizing and ensuring outcomes that improve processes (Laudon, K.C., and Traver, C.G., 2008). Information Technology (IT) plays a vital role in leveraging productivity and efficiency in private organizations, governments and

research. The value of IT in any organization depends on its infrastructure, which consists of computers, network and telecommunication technologies, data and core software applications. Management of technology education covers strategic management, project management, R&D management, new product development, innovation management, entrepreneurship, and information management.

Knowledge and skills are a necessary and sufficient condition for technological progress. Developing countries lack enough skilled IT persons who can design, program, install, configure and maintain Information Technology in this constantly changing industry (Ejiaku, S.A., 2014, p.62). Accordingly, lack of qualified and globally recognized IT professionals is seriously hampering IT adoption and development. Managers delegate tasks and decision making to lower levels of management, and information systems make data available at the level of management where it is needed to make decisions (Lucas, S.A., 2009, p.14). Technology-enabled firms feature highly automated production and electronic information handling to minimize the use of paper and rely extensively on images and optical data storage.

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# **Basic Sanitation and Health - Challenges and Perspectives in Brazil and Brazilian Federal District**

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## **Abstract**

*Basic sanitation has been considered an important environmental determinant of health. Mainly related to the services of drinking water availability, solid waste management, sanitation problems are aggravated by the unplanned growth of urban centers, affecting an important part of the total disease burden in the world. The Sanitation Ranking prepared by the Trata Brazil Institute (2020) was used as the basis for the studies presented here taking into account the data from the SNIS (National Sanitation Information System – Ministry of Regional Development, Brazil), which were consulted for the 100 largest Brazilian municipalities, in terms of inhabitants, in the year 2018. 27 out of the 100 largest municipalities in Brazil have 100% total water service, that is, they have universal water service. Only one municipality has 100% sewage collection (Piracicaba –SP). 14 municipalities have a sewage collection rate greater than or equal to 98%. The average indicator of sewage treatment in the municipalities is 56.07%, that is very worrying. According to SNIS 2018, the national average for the treatment of generated sewage is 46.3%; that is, the average of the 100 largest municipalities in the study is higher than the national average. However, in both cases, the indicator is at a very low level, pointing to an area whose challenges to be overcome are great. The Brazilian capital city (Brasília, Federal District of Brazil) in the sanitation is ranked 27<sup>th</sup> among Brazilian capitals based on data from the National Sanitation Information System (2018). The new Basic Sanitation Legal Framework, signed on July 15, 2020 has as its main objective to universalize and qualify the provision of services in the sector. The Federal Government's goal is to achieve universal access by 2033, ensuring that 99% of the Brazilian population has access to drinking water and 90% to sewage collection and treatment. The expectation is that the universalization of water and sewage services will reduce annual health costs by up to 290 million USD.*

**Key words:** Basic sanitation; Water; Sewer; Health; Brazil; Federal District.

## **INTRODUCTION**

Sanitation is a set of measures that aims to preserve or modify the conditions of the environment in order to prevent diseases and promote health, improve the population's quality of life and the individual's productivity, and facilitate economic activity (Manual do Saneamento, Instituto TrataBrasil, 2012)

One of the principles of Law no. 11,445 / 2007 (January 5, 2007, Casa Civil, Presidency of the Republic, Brazil) is the universalization of basic sanitation services, so that everyone has access to a quality water supply in sufficient quantity to their needs, to the collection and proper treatment of sewage and waste, and the correct management of rainwater.

The World Health Organization (WHO) points out the following data:

- In 2017, 45% of the global population (3.4 billion people) used a safely managed sanitation service.
- 31% of the global population (2.4 billion people) used private sanitation facilities connected to sewers from which wastewater was treated.
- 14% of the global population (1.0 billion people) used toilets or latrines where excreta were disposed in situ.
- 74% of the world population (5.5 billion people) used at least one basic sanitation service.
- 2.0 billion people still lack basic sanitation facilities, such as bathrooms or latrines.
- Of these, 673 million still defecate outdoors, for example in gutters, behind bushes or in open water courses.
- At least 10% of the world population is believed to consume food irrigated by wastewater.
- The cultivation area in peri-urban areas irrigated by untreated urban wastewater is estimated at approximately 36 million hectares (equivalent to the size of Germany).
- The lack of sanitation is linked to the transmission of diseases such as cholera, diarrhea, dysentery, hepatitis A, typhoid and polio and exacerbates short stature.
- Poor sanitation reduces human well-being and social and economic development due to impacts such as anxiety, risk of sexual assault and missed educational opportunities.
- Inadequate sanitation is estimated at 432,000 deaths from diarrhea annually and is an important factor in several neglected tropical diseases, including intestinal worms, schistosomiasis and trachoma. Poor sanitation also contributes to malnutrition.

In 2010, the UN General Assembly recognized access to safe and clean drinking water and sanitation as a human right and called for international efforts to help countries provide safe, clean, accessible and cheap drinking water and sanitation.

Goal 6.2 of the Sustainable Development Goal requires adequate and equitable sanitation for all. The goal is tracked with the “safely managed sanitation services” indicator – use of a type of improved sanitation facility that is not shared with other families and from which the excrement produced is safely treated on the spot or transported and treated off site.

## **Sanitation and health**

According to WHO (2015) about 827,000 people in low and middle income countries die as a result of inadequate water, sanitation and hygiene each year, representing 60% of the total deaths from diarrhea. Poor sanitation is believed to be the main cause of about 432,000 of these deaths.

Diarrhea remains a major cause of death, but it is largely preventable. Better water, sanitation and hygiene could prevent the deaths of 297,000 children under the age of 5 each year.

Open defecation perpetuates a vicious cycle of disease and poverty. Countries where open defecation is more widespread have the highest number of deaths of children under 5, as well as the highest levels of malnutrition and poverty and wide disparities in wealth.

According to data from the Ministry of Cities, the coverage of treated water in Brazil is 83.6%, which means that 35 million Brazilians do not even receive drinking water at home. With the sewage collection, the situation is more critical: not even half of the population (43.4%) has access to the system, that is, more than 100 million Brazilians throw the waste directly into rivers, pits or soil.

According to the United Nations Children's Fund (Unicef), every 15 seconds, a child dies from diseases related to the lack of drinking water, sanitation and hygiene conditions in the world.

A study by the Trata Brasil Institute (2020) showed a direct relationship between the scope of the sanitary sewage service and the number of hospitalizations for diarrhea, especially for factors related to the availability of drinking water, food poisoning, inadequate hygiene and cleaning of water reservoir tank.

This close relationship between “disease and lack of sanitation” affects the Brazilian constitutional right in two main spheres: the right to health and the right to sanitation.

The lack of sanitation is a problem commonly referred to in Brazil and contributes to the emergence of morbidities and even fatalities in our country, especially diseases associated with poverty such as intestinal parasites (PAIVA and SOUZA, 2018).

The World Health Organization recommends that actions to tackle this public health problem are aligned with the improvement of environmental conditions (WHO, 2012).

Basic sanitation, in addition to a sanitary and public health issue, is a matter related to the urbanization of social spaces. Brazilian cities have been subject to unbridled growth and without planning, which implies a series of deficiencies and demands public policies that conform to the forms of construction of cities arising from the urban expansion process.

Basic sanitation has been considered an important environmental determinant of health. Mainly related to the services of drinking water availability, sanitation and solid waste management, sanitation problems are aggravated by the unplanned growth of urban centers, currently affecting an important part of the total disease burden in the world. In this context, it is estimated that about 10% of the total volume of diseases could have been prevented by improving sanitation conditions (Oliveira, 2015).

Exposure to environmental risk factors, such as housing, water and sanitation conditions, is closely linked to social determinants of health. Less developed regions, with lower per capita income and education level, for example, have greater sanitation deficits. Another factor that can influence the coverage of sanitation services is the process of unsustainable urbanization, which provides an increase in housing in places without adequate infrastructure.



Although both the availability of drinking water and the extent of sanitary sewage have increased in recent decades in Brazil, the inefficiency in basic sanitation networks and inequalities in the availability of these services still represent an important field of action for public health policies. In 2013, the National Basic Sanitation Plan was published, which established goals for 2018, 2023 and 2033, with the objective of reducing the deficits present in sanitation services and with a view to universal water supply, collection sewage and garbage.

The deficiency in basic sanitation services in the residence is related to the increased susceptibility of individuals to Diseases Related to Inadequate Environmental Sanitation (DRIES). Among the main diseases associated with environmental sanitation conditions are diarrhea and dengue, responsible for more than 93% of hospitalizations for DRIES between 2001 and 2009 in Brazil. In 2013, there were significant rates of hospitalization for diarrheal diseases in the city of Belo Horizonte, with a mortality rate equal to 1.57 per 100,000 people. Dengue is another disease that has been a major public health concern, and there is an increase in its occurrence in cities such as Porto Alegre and Rio de Janeiro. The increase in the incidence of these diseases, in turn, has the ability to significantly influence the quality of life and health conditions of the population (Paiva and Souza, 2018).

In view of the above, this work proposed to summarize the situation on the relationship between basic sanitation and health issues in Brazil, particularly in the country's capital, and the challenges that arise.

## **METHODOLOGY**

The Sanitation Ranking prepared by the Institute Trata Brazil (2020) was used as the basis for the study presented here, taking into account the data from the SNIS (National Sanitation Information System - Ministry of Regional Development, Brazil), which were consulted for the 100 largest Brazilian municipalities in terms of inhabitants in 2018.

The database gathers information from state, regional and municipal service providers for access to water, sewage collection and treatment, and solid waste. The information computed by the SNIS is self-declared, that is, it is presented by the service providers themselves.

## **RESULTS**

### **Analysis of indicators**

#### *Coverage Level Water Access*

This indicator shows what percentage of the municipality's total population is served with water supply. 27 municipalities in the 100 largest in Brazil have 100% total water service, that is, they have universal water access. 18 municipalities have service values above 99%, being, in practice, very close to universal access. The minimum that a municipality has for water service in 2018 was 32.63%, which is the case of Ananindeua (PA). In the previous year, 2017, the lowest index found was 31.78% in Porto Velho (RO), which in 2018 had an indicator of 35.26%.

#### *Sewage Collection*

This indicator shows what percentage of the total population of the municipality has its sewage collected. Only one municipality has 100% sewage collection (Piracicaba –SP). 14 municipalities have a collection rate greater than or equal to 98% and can also be considered universal. The minimum population served with sewage collection service is 2.05% in the municipality of Ananindeua - PA.

The municipalities' average collection indicator is 73.30%, slightly more than the 72.77% observed in 2017. The total average for Brazil reported in SNIS 2018 is 53.2%.

#### *Treated Sewage Index Referring to Water Consumed*

This indicator shows, in relation to the water consumed, what percentage of the sewage is treated.

The average indicator of sewage treatment in the municipalities is 56.07%, that is, very worrying. According to SNIS 2018, the national average for treatment of generated sewage is 46.3%, that is, the average of the 100 largest municipalities in the study is higher than the national average. However, in both cases, the indicator is at a very low level, pointing to an area whose challenges to be overcome are great. Nineteen of the 100 largest Brazilian municipalities treat 20% or less of their sewage. Only 26 municipalities treat at least 80% of the sewage they produce. Thus, among the coverage level indicators, it is the sewage treatment that is farthest from universalization in the sample municipalities, proving to be the main bottleneck to be overcome.

In general, the Sanitation Ranking presented by the Trata Brazil Institute for the year 2020 (SNIS 2018) indicates that of the 20 best municipalities, 10 are in the state of São Paulo, including the city of São Paulo itself, which has 12,176,866 inhabitants (IBGE 2018). Most of the municipalities with the best conditions for basic sanitation are in the south and southeast of Brazil, and the worst in the north and northeast and central part of Brazil.

### ***SITUATION OF SANITATION IN THE CAPITAL OF BRAZIL, BRASÍLIA - DF***

Located at 1,130 meters above sea level, Brasília has the following geographical coordinates: Latitude: 15 ° 46 '48" South, Longitude: 47 ° 55' 45" West (Figure 1).

The country's capital, Brasília - DF, occupies an outstanding position in the list of the 100 most populous municipalities in Brazil due to its important population, 2,914,830 inhabitants (IBGE, 2015), being ranked in fourth place, just behind São Paulo, Rio de Janeiro and Salvador.

The Federal District traces its peculiarities in a different way, as it addresses a region whose urbanization was planned to receive the country's capital, and which, as a result of this decision, ended up being characterized by the predominance of economic activities, preferably directly or indirectly related to the public administration.

According to CODEPLAN (Federal District Planning Company), Brasília was planned as an organized city. Opened on April 21, 1960, after 1,000 days of construction.

The urban plan for the Federal District, most commonly “Plano Piloto”, was developed by Lúcio Costa and the architect Oscar Niemeyer. It was a milestone in the history of architecture and urbanism, and in December 1987, the capital was listed by UNESCO as a Cultural Heritage of Humanity.

Although the Federal District was a city designed under modern standards, the fact that it has accelerated growth, going from almost no population to almost 2.5 million (IBGE, 2010) in less than 50 years, has extrapolated population forecasts. This caused, in addition to invasions and uncontrolled urbanization in several areas, enormous social inequalities.

In the Federal District, the legal and institutional framework that governs the provision of water supply and sewage services, as well as their related areas, follows the guidelines of the Federal Government. The sanitation policy is the responsibility of the Secretariat for Urban Development, which is linked to the “Companhia de Saneamento Ambiental do Distrito Federal - CAESB”. The regulation of the management of water resources and sanitation services occurs through a single body, the “Federal District Water and Sanitation Agency - ADASA”. This body is responsible for regulating, controlling and inspecting the quality and quantity of surface water bodies in the territory of the Federal District, as well as water supply and sewage services.

In 1998, the “Integrated Development Region of the Federal District and Surroundings - RIDE” was created, with the objective of establishing an institutional mechanism designed to assist the public power in dealing with regional issues. The RIDE region covers an area of 55,400 km, comprising the Federal District itself and twenty-two municipalities, two of which are from the State of Minas-Gerais and 20 from the State of Goiás. It involves actions at three levels of government: i) Federal, through the Ministry of National Integration; ii) State, through the states of Minas Gerais and Goiás and the Federal District; and iii) Municipal, with the participation of twenty-two municipalities.

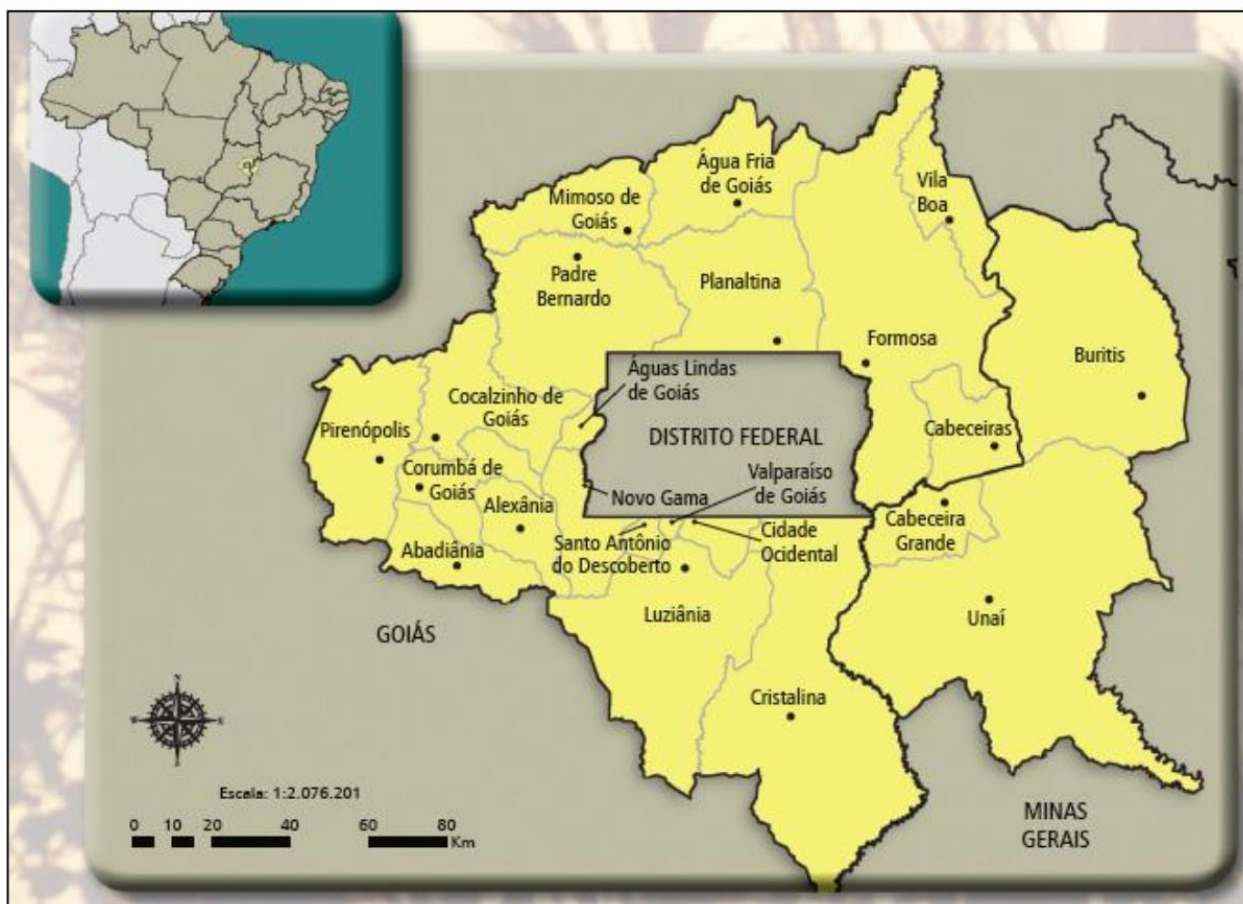


Figure 1. Location of the Federal District.



Figure 2. Health Regions - DF, 2016. Source: PDS / DF, 2016.

## Sanitation

Based on data by service providers and also on the general results of the PDAD (DF, 2013), carried out by CODEPLAN, which covered the 31 Administrative Regions and 7 Health Regions (see Figure 2), with regard to data related to the infrastructure available for basic sanitation services that households and the urban population of the Federal District have, the high percentage of households served by the services stands out.

The coverage of water supply in DF, by general network, is 97.82%. Virtually all households have an urban garbage collection service. With a lower percentage, but still considered high in terms of care, 85.95% of households have a general sewage network with treatment. Some regions of more recent creation, notably high income, are generally served by septic tanks due to the low density. As for urban infrastructure served by a rainwater network, 85.71% of the urban population has this service. As a complementary information, the electricity network is present in 99.66% of the households.

With regard to solid waste, there is currently a great concern with the Landfill of the Jockey, because environmental impacts caused by the inadequate disposal of waste, potentiate alterations in the quality of the soil, air, and surface and groundwater, with effects on the environment fauna and flora, and on public health (disease proliferation).

The problem of urban households having the rainwater network infrastructure is that an inefficient rainwater drainage system can cause flooding and the superficial transport of waste, thus contributing to the proliferation of diseases. Another aspect is that there is no rain network, the population erroneously releases rainwater into the sewer pipe, causing serious risks of clogging and return of sewage to the homes.

## Water supply

Public water supply services in the Federal District are provided by CAESB.

According to SNIS data, in 2015, the urban water service index in the Federal District reached 98.98%



Most occupied households, 78.25%, consume filtered drinking water and 8.85% consume mineral water. In addition, it is worth noting that 12.90% of households still did not have a filter, a situation notably verified in lower income places such as Varjão and SCIA / Structural. The data is worrying due to the consequences for the health of the population.

Administrative regions whose locations do not have a filter for drinking water, may be ingesting contaminated water, which can lead to various health problems, such as diseases ranging from repeated diarrhea to cholera, hepatitis and leptospirosis.

### **Sewerage**

CAESB is responsible for sewage services in the Federal District. According to SNIS data, in 2015 the urban sewage service index for municipalities served with water reached approximately 84.51%.

Among the 31 Administrative Regions (RAs), Cruzeiro and Sudoeste / Octogonal stand out with 100% sewage by general network. However, most recently created RAs, notably high-income, are mostly served by septic tanks such as Vicente Pires (82.55%), Jardim Botânico (78.20%) and Park Way (73.09%). RA Fercal, notably low-income, is served by a septic tank (45.11%) and a rudimentary tank (47.78%).

In other places, septic tanks or rudimentary cesspits are used, often without inspection control. There is also a percentage with open sewage.

The percentage not attended is related to households in regions subject to regularization and irregular, low density regions (such as Park Way), remote areas and regions with network implantation works (such as Vicente Pires).

Urban cleaning and solid waste management in the Federal District are coordinated by the Urban Cleaning Service of the Federal District, subordinated to the State Secretariat of Infrastructure and Public Services of the Federal District, covering collection, treatment activities and final destination of household, commercial and hospital waste.

The collection service and proper disposal of waste has grown considerably in recent decades and, consequently, practices such as burning of waste (incineration) have been decreasing.

According to SNIS (2018), the coverage rate for the collection of Household Solid Waste in relation to the urban population is 100%.

The Jóquei Landfill has been used as an area for the final disposal of waste on the ground, which currently receives 100% of the waste collected in the Federal District.

The non-existent and adequate infrastructure for the final disposal of solid waste in the soil can cause several impacts on water, which is of concern, especially in view of the possibility of contamination of groundwater by leachate through infiltration into the soil.

Since the region's water sources are frequently used by local inhabitants and are part of an important hydrographic basin in the Federal District (the Lago Paranoá Basin), this situation ends up becoming increasingly critical.

The Jóquei Landfill has become a major focus of environmental degradation and a center of social conflict motivated by occupation in its surroundings by precarious housing inhabited by recyclable material collectors, homeless people and invaders.

Occupying an area of about 200 hectares, one of the most discussed issues is regarding its location bordering the Brasília National Park and the environmental impacts triggered by the percolated waters. We also observe the presence of recyclable material collectors who work without a formal relationship with the municipality, in a degrading way, being victims of numerous accidents, including fatal ones.

It can be said that the situation of Jóquei Landfill is still very precarious and incompatible with the pattern and importance of the Federal District in the national context.

Currently, it is planned to implement a new landfill in the Federal District, called Aterro Sanitário de Brasília.

In addition, clandestine waste disposal points have been identified, which require intervention, and their removal and final disposal in an appropriate location is recommended whenever possible.

### Sanitary conditions

#### *General information on pollution conditions of water resources in the Federal District*

According to ADASA (2016a, b, c) the main causes of pollution of water resources are correlated to the polluting loads resulting from the deficit in sanitary sewage and rain, urban and rural drainage. Data on land use and occupation of hydrographic basins, indicate that there is also contamination of water by diffuse pollution, mainly by agricultural activities, such as pesticides and fertilizers.

#### *Occurrence of waterborne diseases*

WHO (2015) data indicate that about 85% of known diseases are waterborne.

The Table 1 below presents data referring to the number of registered cases of epidemiological diseases over the years 2008 to 2016. Documents published by SES / DF were consulted.

**TABLE 1. History of cases by type of epidemiological diseases. Source: SES/DF 2018.**

Type of diseases	Year (number of cases)								
	2008	2009	2010	2011	2012	2013	2014	2015	2016
<b>Venomous animals</b>	412	482	549	681	787	1.204	1373	-	-
<b>Cholera</b>	0	0	0	0	0	0	0	1	-
<b>Dengue</b>	3.411	1.982	20.332	6.985	3.669	18.016	17.772	11.009	18.187
<b>Exathematic</b>	723	321	204	186	127	99	133	-	-
<b>Schistosomiasis</b>	9	9	3	6	3	-	-	-	-
<b><u>Yellow Fever</u></b>	72	20	27	19	10	-	-	-	-
<b>Chikungunya Fever</b>	-	-	-	-	-	-	-	153	703
<b><u>Hepatitis B</u></b>	-	199	155	138	132	168	151	-	-
<b>Hepatitis C</b>	-	239	210	213	198	146	156	-	-
<b>Leptospirosis</b>	59	-	29	10	16	26	17	23	-
<b><u>Malaria</u></b>	-	-	-	-	36	-	-	-	-
<b><u>Meningitis</u></b>	30	60	42	20	18	20	14	9	-
<b><u>Accidental Tetanus</u></b>	0	1	0	2	0	0	1	1	-
<b>Zika virus</b>	-	-	-	-	-	-	-	3	732



Another relevant issue, becoming detrimental to the health of the population, is the consumption of unfiltered water, as the population may be ingesting contaminated water, which can lead to various health problems, such as diseases ranging from recurrent diarrhea to cholera, hepatitis and leptospirosis.

Water-borne diseases belong to the group of Infectious and Parasitic Diseases (IPD). Contaminated water usually causes infectious intestinal diseases characterized by diarrhea.

Contact with untreated sewage can cause diseases such as typhoid fever, paratyphoid fever, cholera, hepatitis A, amebiasis, giardiasis, leptospirosis, polio, virus diarrhea, among other diseases.

With regard to the urban cleaning and solid waste management system, disposal to the environment can cause damage, especially to public health, since it may constitute a breeding ground for *aedes aegypti* mosquitoes, which transmit the dengue, Chikungunya and Zika, when contaminated.

As for rain drainage, in times of rain, it is common flooding that can bring adverse consequences to the population. This fact can be aggravated by the drainage system if there are sizing problems related to it. Runoff waters can often be contaminated, since they leach the soil and can come into direct contact with poorly managed solid waste and irregular sewage system networks. That is, these conditions can drag oocysts and contaminate people, as for example in the case of toxoplasmosis.

In the period 2008-2014, the main causes of mortality from IPD in the population of children under 5 years of age in the Federal District, were bacterial diseases, infectious intestinal diseases, diarrhea and gastroenteritis.

The Federal District occupied the 1st position, in 2010, in relation to the 27 Brazilian federative units according to the Municipal Human Development Index (MHDI). Besides, the Federal District stands out with respect to economic aspects, as it has the highest Human Development Index (HDI) in the country. However, it is important to note that there is a great socioeconomic inequality between the inhabitants. Another negative aspect is the disorderly urban expansion.

One of the biggest problems found in the Federal District is the disorderly occupation of land, that is, non-regularized households. Thus, the parameters of land use and occupation are essential factors for adequate management for sustainable development.

The accelerated population growth and its high concentration contributed to the aggravation of the problems faced in the Federal District with the occupation in areas of environmental protection (APP) (water courses such as rivers banks, lakes, streams, springs, etc.). In such a way, the main environmental problems resulting from large-scale urban development in the Federal District, are correlated with the process of population growth and urban expansion and are well deserved, as well as in several other Brazilian cities, as they did not adequately follow the demand basic services of the population, such as housing, basic sanitation and public leisure areas.

These problems were intensified by the lack of implementation and planning of basic sanitation services that includes the collection, treatment and final destination for the sanitary sewage system, stormwater drainage and management, and solid waste management in an integrated manner, thus preventing degradation of water courses caused mainly by pollution and erosion with silting of the bed of water courses, one of the main socioenvironmental problems today.

It is important to highlight that in the question of the environmental issue, with the objective of solving or at least minimizing the problems caused by anthropic intervention to the natural environment. Due to the

lack of awareness of the population and the absence of urban planning, must, at present, be emphasized by means of public policies, specific legislation and mainly to put environmental education into practice, as mentioned in art. 225o, § 1, item VI of the Brazilian Federal Constitution of 1998 “to promote environmental education at all levels of education and public awareness for the preservation of the environment” (JACOBI, 2003).

As for the units with deficits in basic sanitation, it basically involves demands for lack of infrastructure. The District Housing Plan of Social Interest (PLANDHIS) considers inadequate housing “because it presents excessive density, inadequate coverage, lack of health facilities or other characteristics that point to the need to qualify the Housing Unit”.

According to data from CODEPLAN and analyzing the data obtained from PLANDHIS (DF, 2012), it can be seen that there was a decrease by number of households without bathrooms in the Federal District, in which only 560 (0, 07%) households do not have a bathroom and 53.24% have a bathroom, 29.25% two bathrooms and 17.44% three or more bathrooms.

## **Health**

The diagnosis of the population's health situation addresses the perspective of basic sanitation and the integrated management of solid waste as a promotion and prevention of diseases. For that, the following information was raised.

Morbidity is the state of being symptomatic or unhealthy for a disease or condition (Hernandez and Kim, 2020).

Within epidemiology, the relative rate of patients with a specific disease is called morbidity or morbidity compared to the number of non-sick inhabitants at any given time, collecting statistical data on individuals who fall ill of the same disease at defined intervals of time and in determined areas, whether regional, municipal, state or national. With this, data are obtained regarding the behavior of diseases and their implications for the health of a population as a whole.

With emphasis on the morbidity of diseases related to the lack of basic sanitation, more specifically, infectious and parasitic diseases, the occurrence of 4.33% of the total hospital morbidity by the Unified Health System (Sistema Unico de Saúde - SUS) is verified, highlighting the percentage of 16.33% for children under 1 year old and 15.79% from 01 to 04 years old. Source: Ministry of Health - SUS Hospital Information System (SIH / SUS), 2016.

From the data on hospital morbidity due to DIP in the Federal District, according to the second year of occurrence, in the period 2008-2016, it can be seen that bacterial diseases have an increasing trend since in 2008 there were 132 hospitalizations and in 2016, there were 163 cases reported.

Among the diseases with some DIP with 62.75% are related to intestinal infectious diseases (22.00% - diarrhea and gastroenteritis of presumable infectious origin), followed by other bacterial diseases (20.92%) and other fevers due to arboviruses and fevers hemorrhagic by virus (19.83%).

It appears that infectious intestinal diseases (diarrhea and gastroenteritis of presumable infectious origin) are found mainly in children under 1 year old (36.36%) and from 01 to 04 years old (48.72%) these diseases are related to the lack of adequate basic sanitation.

## **DISCUSSION**

Basic sanitation in Brazil is defined by Law 11,445, of January 5, 2007 “as the set of services, infrastructures and operational facilities for the supply of drinking water, sanitary sewage, urban cleaning and solid waste management, rainwater management and urban drainage”.

Understanding this concept is possible due to the relationship that these factors have among themselves. It is common that floods spread pollution and transmit diseases through dirty water, in addition to interrupting the supply of drinking water to certain regions, for example. On the other hand, deposits of solid waste in improper conditions and locations contaminate several areas, be it soil or water, impairing the future use of these components and causing even greater complications by obstructing drainage networks and proliferating vectors. There are also cases where the sanitary sewage without proper treatment and maintenance ends up contaminating rivers, lakes and others.

Thus, the quality of life and health of citizens is directly linked to better conditions of basic sanitation. Under expected conditions, sanitation contributes to social, cultural and economic development. In the same way urbanization and the growth of cities impact on the health conditions of a region requires that its infrastructure keep pace with developments and new scenarios.

However, most cities are being occupied without following regulations and growing in a disorderly manner, also deteriorating the conditions of basic sanitation in that region. For this reason, public policies regarding basic sanitation have the duty to regulate the management of all processes related to this area.

Still following this north, according to the National Basic Sanitation Law of 2007, sanitation policies must “be linked to other policies to promote sustainable urban development, achieve adequate levels of health, reduce poverty, improve the quality of housing and live together in harmony with water resources and the environment”.

According to Instituto Trata Brasil (2020), “basic sanitation is one of the necessary conditions for the quality of life of a population and its absence compromises people's health and well-being”.

Data from the World Health Organization (WHO, 2008), indicate that the lack of basic sanitation is one of the main causes of infant mortality in Brazil, caused by parasitic and / or infectious diseases.

Since the Ottawa Conference in 1986, the concept of Health Promotion proposed by WHO, is seen as the guiding principle of health actions worldwide. Thus, it is assumed that one of the most important determinants of health is environmental conditions.

According to studies carried out by the World Bank, it is estimated that approximately 30% of the occurrence of diseases in developing countries is responsible for the inadequate domestic environment. Diarrhea, Tropical Diseases and Worms: Lack of sanitation, water supply, hygiene.

Water-related diseases can be grouped as follows:

Transmitted via the fecal-oral route (food contaminated by faeces): Leptospirosis Amebiasis, Infectious hepatitis, Diarrhea and dysentery, such as cholera and giardiasis. Associated with water (part of the life cycle of the infectious agent occurs in an aquatic animal: Schistosomiasis.

Transmitted by vectors that relate to water: Malaria, Yellow Fever, Dengue and Elephantiasis.

Diseases Related to the Absence of Sewer:

Fecal-oral (non-bacterial): Poliomyelitis, Hepatitis type A, Giardiasis, Amoebic dysentery, Diarrhea due to viruses.

Fecal-oral (bacterial): Typhoid fever, Paratyphoid fever, Diarrhea bacterial dysentery, such as cholera. Helminths transmitted by soil Ascariasis (roundworm), Trichuriasis, Hookworm (yellowing), Tapeworms (solitary) in beef and pork: Teniasis, Cysticercosis. Helminths associated with water: Schistosomiasis. Insect vectors related to feces: Filariasis (elephantiasis).

With regard to the urban cleaning and solid waste management system, disposal to the environment can cause damage, especially to public health, since it may constitute a breeding ground for *Aedes aegypti* mosquitoes, which transmit the dengue, Chikungunya and Zika, when contaminated.

There are many diseases related to the accumulation of waste and its lack of treatment, such as Rats and Fleas: Bubonic plague; Little typhus; Leptospirosis. Flies: Typhoid fever; Cholera; Amoebiasis; Dysentery; Giardiasis; Ascariasis. Mosquitoes: Malaria; Leishmaniasis; Yellow fever; Dengue. Cockroaches: Typhoid fever; Cholera; Giardiasis. Pigs: Cysticercosis; Teniasis. Felines: (through urine and feces) Toxoplasmosis. It appears that most of these diseases are relatively related to the lack of adequate basic sanitation.

In order to minimize the problems, mainly of the DIP, due to the lack of basic sanitation, the national environmental education policy is applied, walking together with health education.

SUS was created by the Brazilian Federal Constitution of 1988. The main objective of such a project was to change the national scenario of the time, in which the services provided by the different health sectors were differentiated for each social class. With SUS, public service to all Brazilian citizens has become mandatory, regardless of economic level. According to art. 196 ° of the Constitution of 1988, “health is the right of all and the duty of the State, guaranteed through social and economic policies that aim to reduce the risk of disease and other diseases and universal and equal access to actions and services for their promotion, protection and recovery”.

As provided for in item IV, of art. 200o of the Federal Constitution, of 1988, “the single health system is responsible, in addition to other attributions, under the terms of the law: to participate in the formulation of the policy and in the execution of basic sanitation actions” (BRASIL, 1988). And, by health, it is understood not only the scenario of people already sick or in recovery, but also all aspects of possible prevention.

Thus, the precariousness of basic sanitation services with its four components: drinking water supply, sanitary sewage, urban cleaning and solid waste management, rainwater management and urban drainage, have proved to be determining and conditioning factors in quality of life of the city population.

As is known, the improvement of sanitation services is directly related to the promotion of health and the quality of life of the population, when related to waterborne diseases. Studies released by WHO (2014) show that for each US \$ 1.00 invested in sanitation there is a corresponding reduction of US \$ 4.30 in public health expenses. It is undeniable that sanitation will always result in health protection.

For WHO, “all people, at any stage of development and socioeconomic conditions, have the right to access an adequate supply of safe and safe water”, which places even more emphasis on the need for extra care with quality programs of water, its supply and sewage.

## CONCLUSION

Brazil presents alarming data on access to basic sanitation services, with challenges to guarantee service to all and on an uninterrupted basis. Coverage by the water supply network is relatively high, although there are still about 35 million Brazilians without access to drinking water. The sewage collection and treatment service still presents worrying rates, revealing the harmful potential to the environment, especially due to the contamination of water bodies, which indicate how much the country still needs to move towards universal service.

Public health is listed as a fundamental and essential guarantee for the well-being of human beings. The extreme importance of basic sanitation services is evident, both in the prevention of diseases and in the preservation of the environment.

Public Basic Sanitation Policies are requirements to obtain quality of life and appropriate public health. This policy must be developed in partnership with organized civil society, observing the reality of each region and listening to its residents. It plays a crucial role in the projection of basic sanitation actions to be taken. Its execution is not immediate. The objectives are long-term and can still be changed along the way by the government, which makes it a State Public Policy and not a Government Policy.

According to the Trata Brazil Institute (2020), the Federal District in the sanitation ranking is ranked 27th among Brazilian capitals based on SNIS data (2018).

In order to reduce regional inequalities motivated by the lack of urban concentration resulting from the migratory flow between the Federal District and neighboring municipalities and seek solutions to the problems arising from the disorderly growth of Brasília / Plano Piloto and its surroundings, increasingly populated by migrants in search of better living conditions that ended up putting pressure on public services in the country's capital, the administrative action of the Union, the states of Goiás and Minas Gerais and the Federal District (RIDE) was promoted.

It is noted the importance that RIDE has in the Federal District and its surroundings, in order to plan the set of public services, mainly infrastructure and job creation.

The Public Consortium for the Management of Solid Waste and Rainwater in the Integrated Region of the Federal District and Goiás, is an example of implementation, composed of the Federal District, State of Goiás and 20 municipalities in Goiás constituting RIDE/DF, "whose proposal is to promote the associated and environmentally adequate management of solid waste and rainwater in the region, in addition to enabling the selective collection, recycling and final disposal of non-recycled waste".

The path to universal access and quality of basic sanitation services, as set out in Law No. 11,445 / 2007, will promote public health and environment and, consequently, improve the quality of life of the population.

Access to quality drinking water is a fundamental right indispensable to the health and well-being of the human person. In Brazil, the universalization of sanitation services and, consequently, the viability of drinking water is still a problem to be solved. It is important to emphasize that one of the causes of this problem is the management of water resources, which require treatment and protection of water, based on an adequate management policy that takes into account environmental protection and human needs.



A solution for water protection, for example, is the massive investment in sanitation and sewage treatment. The new Basic Sanitation Legal Framework signed on July 15, 2020 has as its main objective to universalize and qualify the provision of services in the sector. The Federal Government's goal is to achieve universal access by 2033, ensuring that 99% of the Brazilian population has access to drinking water and 90% to sewage treatment and collection. The expectation is that the universalization of water and sewage services will reduce annual health costs by up to US \$ 290 million. In addition, for every US \$ 1 invested in sanitation, savings of US \$ 4 should be generated by preventing diseases caused by the lack of service, according to the World Health Organization (WHO). Let's follow.

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