DIGITAL TRANSFORMATION IN A (POST-)PANDEMIC WORLD

PROCEEDINGS OF THE 2021 CONF-IRM CONFERENCE

Editors:
- **Lech Janczewski**
- **Iris Groher**
- **Cesar Alexandre de Souza**

Hosted by Institute of Business Informatics – Information Engineering, Johannes Kepler University Linz, Austria

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Welcome messages

Welcome Message from the Conference Co-Chairs

The ongoing COVID-19 pandemic has presented both challenges and opportunities for conferences such as the International Conference on Information Resources Management (Conf-IRM). The fact that we are not able to meet in person this year is still disappointing. Conf-IRM, an affiliated conference of the Association for Information Systems (AIS), is known to be an inclusive, collaborative, and friendly environment where colleagues from around the world meet each other to share research ideas as well as build personal relationships. That face-to-face dynamic will be missing this year again. As with everything COVID-19, we have had to pivot to new ways of doing conferences. Thanks to available technology, we can deliver an abbreviated conference online. As we have found with teaching, new opportunities for connecting and communicating are available in the online environment. So, while we cannot all be in Linz this year, we are afforded the opportunity to visit each participant in their own setting.

Conf-IRM is a venue for developing emerging scholars from every region of the world. We take great pride in seeing scholars who began their journey at one of our conferences go on to excel in the many ways they have. This is the 14th year for the conference. It builds on the traditions (with a twist) of previous conferences held in Canada, United Arab Emirates, Jamaica, South Korea, Austria, Brazil, Vietnam, Canada, South Africa, Chile, China, New Zealand, and the USA. While this year's conference will be in an online format, we have endeavored to put together a program that is substantive and meaningful. We therefore developed a program that reflects the different times zone, combining in the sessions people from the same region but also having interest in similar topics. We are very proud that the regional track again found a lot of attention; hence, people speaking Portuguese will find a large community. In addition, we will have a special meeting – we call it "The lobby" being available in parallel to the sessions where you can meet the chairs of the conference. We wish that the social time spent in the lobby or the social space together will be both inspiring and rewarding for each participant.

Conf-IRM always was and always will be a conference with a specific bunch of people. So be nice to each other, respect the work of others but do not hesitate to give friendly feedback. This is the best way to build a stable community that endures pandemics and other catastrophes. Although we will not have the usual opportunity to socialize in person, we hope you will be able to make beneficial and lasting contacts in our virtual meetups.

Have a great time!

Barbara Krumay & Gerald Grant

Welcome Message from the Program Co-Chairs

Welcome to the 2021 International Conference on Information Resources Management (Conf-IRM). Although many things have changed with COVID-19, we are pleased to have the opportunity through Conf-IRM 2021 to bring to you a programme featuring a range of technical, managerial, social and behavioural aspects of Information Systems, and a forum in which we can still meet and share with our colleagues around the world.

In keeping with the international reach of Conf-IRM, we received submissions from across 9 countries this year. Each submission underwent a rigorous double-blind review process that included peer-evaluation by at least two reviewers, assessment by the conference track chairs, and quality assurance of the revised submissions. The final programme covers a range of Information Systems research topics and problems. In total, 28 papers have been accepted with 22 research papers and 6 research-in-progress papers.

Conf-IRM 2021 involved 74 authors and 59 reviewers, alongside a dedicated conference committee. On behalf of the 2021 Conference Committee we thank all our authors for their submissions. We also extend our sincere thanks and appreciation to the track chairs and other colleagues who served as reviewers, and especially for the time they have spent and the valuable contributions, they have made to ensure the success of the conference. Indeed, our sincere thanks to everyone involved and especially at this time given the challenges, many are facing both personally and professionally – thank you!

Finally, we welcome you to our online symposium. We hope that you will enjoy Conf-IRM 2021 and we look forward to the opportunity meeting you during the conference.

Iris Groher & Cesar Alexandre de Souza
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Track 02 – Enterprise Systems & Knowledge Management
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Track 03 -Digital Services, Management & Governance
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Keynotes

Can Pre-Pandemic IS Research Help in a Pandemic and a Post-Pandemic World?

This keynote will explore how IS research conducted before the Coronavirus Pandemic on a variety of topics including online learning, virtual teams, work-family conflict, gender inequality and the digital divide can be applied in the pandemic and in a post-pandemic world. And further, have the findings from IS research been applied?

Carol Saunders is Professor Emerita at the University of Central Florida. She has received two lifetime accomplishment awards: the LEO award in the Information Systems (IS) discipline and the Lifetime Achievement Award from the OCIS Division of the Academy of Management. She also is an Association for Information Systems (AIS) Fellow and a Schoeller Senior Fellow. She served on a number of editorial boards, including a three-year term as Editor-in-Chief of *MIS Quarterly*. She served as General Conference Chair of the premier Information Systems conference, ICIS, and Program Co-chair of AMCIS 2015. She helped found the Organization Communication and Information Systems (OCIS) division of the Academy of Management and served in a variety of positions including its program chair and division chair. She was the AIS Vice President of Publications from 2016-2019. She was the Distinguished Fulbright Scholar at the Wirtschaftsuniversität – Wien (WU) in Austria and earlier held a Professional Fulbright with the Malaysian Agricultural Research and Development Institute. She has held research chairs in Germany, New Zealand, Singapore, and the Netherlands. Her current research interests include business models, coopetition, interorganizational systems, overload, sourcing, and time. She has published in top-ranked Management, IS, Computer Science and Communication journals.

How information & communication technology (IT) affects organizational resilience during the pandemic and enables the path to recovery and renewal for the future?

Resilience means the capability of being robust under conditions of enormous stress and change, that currently affects many organizations around the globe during the covid-19 pandemic. It suddenly became a new "buzzword", especially in the context of digital transformation. Let's find out why these terms are often used together in one sentence and if it can lead to recovery or even renewal of organizations for a post-pandemic future.

Roland Karlsböck, Information Management & Digitalization, voestalpine Steel Division. Robert Karlsböck studied Business Informatics at the Johannes Kepler University, Linz. In his function at voestalpine Steel Division, he focuses on digitalization, and with it the targeted application of new digital technologies as a cornerstone of continued value growth and technological leadership for voestalpine.
(see https://www.voestalpine.com/group/en/group/innovation/digitalization/).

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Conference Papers

1. A Preliminary Analysis of Communication Methods in Agile IS Development for Controlling Information Asymmetry

Peter Virag
Vienna University of Economics and Business
peter.virag@wu.ac.at

Edward W. N. Bernroider
Vienna University of Economics and Business
edward.bernroider@wu.ac.at

Ulrich Remus
University of Innsbruck
ulrich.remus@uibk.ac.at

Abstract

Agile information system development (ISD) projects are often characterized by high levels of information asymmetry, a condition when one party has imperfect information about the other. This condition can negatively affect IS development, especially in the agile context, which promises fast development cycles and the ability to cope with frequently changing requirements. The party with imperfect information is likely to develop concerns due to the uncertain or unobservable capabilities of actors or the assumed opportunistic behavior of those with private information. While communication methods in agile ISD have been well documented, extant research has neglected to address which of these are best at controlling information asymmetry in different circumstances. This research-in-progress draws on qualitative data to explore information asymmetry concerns and offer guidance to managers in selecting the appropriate communication methods under given conditions. Preliminary findings also suggest that information asymmetry may not always be harmful, which promises important theoretical and practical implications.

Keywords: Information Systems Development, Information Asymmetry, Communication, Agile, Scrum

1. Introduction

On the twentieth anniversary of the Agile Manifesto one might find it surprising that roughly every second agile project manager complains about insufficient leadership participation, organizational resistance to change and inadequate management support and sponsorship (Digital.ai, 2020). We know little about the underlying causes of these issues but what we know is that the success of an agile information system development (ISD) project is contingent on frequent interactions between numerous stakeholders in various job roles, whose expertise areas are often diverse (Dingsøyr *et al.*, 2012). It is also known that imperfect communication methods can hardly decrease information asymmetry (IA) among parties, that is a common reason of agile ISD project failure (Pikkarainen *et al.*, 2008). IA occurs when a party has private, different, hidden or a shortage of perfect information compared to another party (Bergh *et al.*, 2019) and can take place e.g. between agile project managers and their subordinates.

IA is a common target of control activities in agile ISD projects (Virag, 2020). It has been considered as an antecedent of project escalations and as a cause of goal incongruences, i.e. that subordinates pursue personal goals instead of organizational goals (e.g. Keil, Mann and Rai, 2000; Tuunanen and Kataja, 2006; Wachnik, 2015; Mallampalli and Karahanna, 2017; Waguespack, Babb and Yates, 2018). Therefore, these studies – although without focusing specifically on agile settings – emphasize the importance of decreasing IA between managers and subordinates. While IA may lead to subordinates building behavioral barriers to share private information in order to benefit themselves (Connelly *et al.*, 2011), IA can also raise concerns about the capabilities of actors that are either unobservable or uncertain (Bergh *et al.*, 2019). These situations may occur in agile projects because agile roles, such as the product owner have diverse competency requirements that others in the team with different job roles may not possess (Thouin and Hefley, 2020). Moreover, IA may also make managers anxious about the structural barriers in the organization that impede information sharing (Bergh *et al.*, 2019). Since about 80% of agile teams work in a distributed manner with large geographical distances among team members (VersionOne, 2015) and many of these projects are outsourced to external vendors (Gartner, 2014), structural barriers can be common in agile ISD projects.

While the different communication methods in both regular and distributed agile ISD projects are known (e.g. Pikkarainen et al, 2008; Dreesen et al., 2016), research has so far missed to address how these can help controlling IA under different circumstances. For example, daily stand-up meetings, a usual communication method in the scrum method (Schwaber and Sutherland, 2020), may not be useful in reducing IA in case of distributed teams with asynchronous working hours. Likewise, decreasing IA by evaluating developers' performance based on completed user story points (another typical agile communication technique) might be impossible if the project manager cannot estimate the amount of work needed to complete the various points. Therefore, choosing optimal methods to control IA depends on contextual factors, and research is needed to guide agile project managers setting up communication methods that fit the conditions. Expanding our knowledge in this area is also important form a theoretical perspective as the agile approach to ISD has unique communication rituals that are quite different in traditional ISD projects (Dreesen et al, 2016). Moreover, maintaining or even increasing IA may have a better benefit-cost ratio than reducing it: knowledge transfers are expensive and may not always be worth it (Jacobides and Croson, 2001). In addition, the agile worldview assumes intrinsically motivated team members, hence goal incongruences may be less likely (De O. Melo, Santana and Kon, 2012). Consequently, in agile settings IA may not always be considered harmful and communication methods can be implemented with different aims, such as for social reasons or for expressing needs (Paasivaara, Durasiewicz and Lassenius, 2009). Thus, the following research question guides this research-in-progress study: *Which concerns related to IA do project managers of agile ISD have and which communication methods are applied to mitigate these concerns?* While our research seeks to investigate numerous contextual factors that may determine the chosen communication method, at this stage of the research, we present preliminary findings related to project managers' perceived primary concerns resulting from IA. Our investigation took place in the IT department of a Danish multinational company that runs several scrum ISD projects in parallel.

2. Short summary of related literature

2.1 Information asymmetry in ISD projects
IA is an important issue in ISD projects due to the intangible character of software development, and the often complex and dynamic and nature of projects (Goldfinch, 2007). Typical sources of IA include ineffective communication (Thompson, Estabrooks and Degner,

2006), the lack of common domain knowledge and unclear requirements (Wang *et al.*, 2007), These can occur, for instance, between developers and product owners and between product owners and business representatives (Nuwangi *et al.*, 2014). In addition, it can also take place between product owners and project managers, which role is still present in the majority of agile projects and who, unlike scrum masters, are responsible for creating and managing the project plan and the project organization (Nuwangi *et al.*, 2014; Shastri, Hoda and Amor, 2016). IA has various negative consequences in ISD projects. It is a key antecedent of requirements volatility, conflicting requirements, and in outsourced projects IA leads to higher financial costs to be paid to vendors (Shan, Jiang and Huang, 2010). Reducing IA also makes performance evaluations and incentive schemes of ISD projects more accurate (Banker and Kemerer, 1992). Last but not least, according to agency theory, IA facilitates pursuing private interests too (Bosse and Phillips, 2016).

2.2. Agile ISD and communication in agile teams
The agile method for software development detailed in the Agile Manifesto (AgileAlliance, 2001) was created primarily with the purpose to enable quicker responses to changes in requirements and to shorten the development lifecycles (Highsmith and Cockburn, 2001). Agile is an iterative approach that relies on continuous interaction and communication among various stakeholders (Pikkarainen *et al.*, 2008). Scrum, a popular choice of agile methods, puts the customer in focus and emphasizes the importance of project management by continuously tracking project status. Scrum events (e.g. sprint planning, daily scrum) as well as scrum artefacts (e.g. product backlog, sprint backlog) are designed to enable transparency of key information (Schwaber and Sutherland, 2020). One of the main differences between agile and traditional software development is that agile puts emphasis on frequent communication both within the development team and with e.g. business representatives (Dingsøyr *et al.*, 2012). In scrum projects regular scrum events give opportunities to periodic interactions within the team (sprint planning, daily scrum and sprint retrospectives) while at sprint reviews the development team presents the results of the last sprint to other key stakeholders. Scrum artifacts, such as the product backlog also provides communication opportunities within the team. The product backlog is an emerging list that contains the necessary steps to improve the product (Schwaber and Sutherland, 2020). In addition to scrum-specific means of communication, there are more generic communication procedures in agile projects, such as *community of practice, user stories, customer presence, story board, monthly meetings, creation of open environment* – for definitions and a complete list see, for example, the study of Dreesen et al. (2016).

3. Research context and methods
Our work follows a single-case study design where agile team members are the units of analysis. The case context was the IT department of a Danish multinational container shipping company where several ISD projects took place simultaneously related to building customer-facing websites, back-end systems and mobile applications. All projects followed the scrum approach to a large degree, although, for instance, Kanban-boards were in use instead of Scrum-boards because Kanban-boards could be more easily adapted to tasks that continuously arrived. Project teams worked in two-week-long sprints that began with a sprint planning meeting, where participants chose items from the product backlog to be included in the sprint. During the sprint, daily scrums were organized to report status and to identify impediments. At the end of a sprint project teams held demonstrations to business stakeholders, at retrospectives, team members discussed what went well and possible improvement areas for the next sprint. Scrum teams were led by project managers, their subordinates included developers, product owners and scrum masters, sometimes borrowed from consultancies.

This case study relies on the theory elaboration method, which builds on empirical research using pre-existing conceptual ideas by contrasting, specifying or structuring them to develop or extend theories (Fisher and Aguinis, 2017). We adhere to "soft positivist" epistemology (Madill, Jordan and Shirley, 2000) to reveal pre-existing phenomena that objectively exists (positivist view, described in e.g. Miles and Huberman (1994)). However, we attempt to explore new phenomena too, maintaining that knowledge is local, provisional, and situation dependent (contextual constructionism, described in e.g. Madill, Jordan and Shirley (2000)). This hybrid approach has already been used in ISD research, for example by Kirsch (2004). We obtained primary data through 21 interviews: 12 with agile project managers and 9 with their team participants, the latter group was used as proxy subjects (Nederhof, 1985) to eliminate potential social desirability bias of answers related to goal incongruences. In the interviews we had open ended questions about situations where IA and communication methods were involved, about how communication affected IA, and about the contextual factors that influenced the choice of communication techniques. For data analysis we used descriptive coding (Saldana, 2013), for which we used existing codes for communication methods in agile ISD projects (Dreesen et al. 2016) and for IA (Bergh et al, 2019).

4. Preliminary findings

As shown in Table 1, our interview participants reported altogether eighteen communication methods, out of which sixteen were initiated with the intention to decrease and two to increase IA between the project manager and the subordinate. We found that only two kinds of communication methods were in place primarily due to the concern that IA may cause opportunistic behavior, namely Kanban-boards and status tracking software. We discovered four communication methods – rotation of on-site vendor employees, personal visit of vendor premises, open office space and synchronization of work hours – that were enacted when project managers had issues with structural barriers of information sharing and associated IA. Strong decrease of IA was observable when new vendor employees were placed on-site and when internal employees personally visited vendor premises. Most kinds of communication methods were, however, initiated due IA related to the uncertain capabilities of subordinates. Mostly in this category, we found situations where the project manager wanted to use communication to enhance collaboration with subordinates, to get to know the status of tasks, to allocate resources in an optimal manner and to remove potential impediments blocking the advancement of the project. Project managers also organized leisure activities after working hours, where they observed how well team members got along with each other. Last but not least, we found evidence that in some cases project managers did not mind IA increasing between them and subordinates and encouraged team members to participate in trainings and in communities of practices.

5. Contributions and next steps

The research question that led our study was *Which concerns related to IA do project managers of agile ISD have and which communication methods are applied to mitigate these concerns?* In the previous section we highlighted eighteen communication methods in scrum ISD projects and presented three perceived primary concerns with IA. At this stage of the research we see two main contributions to ISD literature. First, although much research dealt with communication in agile ISD projects (Pikkarainen *et al.*, 2008) and about IA in ISD projects (e.g. Tuunanen and Kataja, 2006), these research streams were decoupled as IA has only been examined in traditional waterfall ISD projects so far. Our results imply that while IA is present in agile settings as well, project managers mostly do not believe that subordinates would like to intentionally increase it for private purposes. Interestingly, we discovered that when project managers are still concerned about behavioral barriers to information sharing, Kanban-board

is a powerful choice to reduce IA that is not part of the regular list of scrum artefacts (Schwaber and Sutherland, 2020). This suggest that the case organization pays little attention to methodological pureness and rather employs a "mix and match" approach to agile adoption.

Perceived primary concern	Communication method	Perceived IA effect	Mentioned
Opportunistic behavior	Kanban-board	Strong decrease	Most projects
	Task, issue and status tracking software	Strong decrease	Every project
	Rotation of on-site vendor employees	Strong decrease	Most projects
Structural barriers	Personal visit of vendor premises	Strong decrease	Most projects
	Open office space	Weak decrease	Every project
	Synchronization of work hours	Weak decrease	Few projects
	Daily scrum	Strong decrease	Every project
	Product demo	Strong decrease	Every project
	Creation of a communication plan	Weak decrease	Every project
	Continuous communication (e-mail, IM, VoIP calls, screen-sharing)	Weak decrease	Every project
	Sprint planning	Weak decrease	Every project
Capabilities of subordinates	Retrospective	Weak decrease	Every project
	User story	Weak decrease	Every project
	Leisure activities	Weak decrease	Most projects
	Product backlog	Weak decrease	Most projects
	Documentation of new IS features	Weak decrease	Few projects
	Community of practice	Strong increase	Few projects
	External trainings	Strong increase	Most projects

Table 1: Preliminary findings

Second, we found that the majority of communication methods were enacted either because of concerns with structural barriers to information sharing or due to the uncertain capabilities of subordinates. For example, outsourced job roles required many personal visits to the vendors' premises and the synchronization of working hours as they often worked at remote locations. Similarly, the uncertain capabilities of subordinates were seen as the consequence of specialized job roles. For example, product owners collected user stories from business representatives and "translated" them to more technical requirements so that developers could understand them. This confirms previous findings that IA can simply be the outcome of having experts in the team (Thouin and Hefley, 2020) and that IA can be natural consequence of task delegation (Sivaramakrishnan, 1994). This is also in line with the finding that scrum events were not organized with the purpose to prevent self-interested behavior – the agile philosophy assumes intrinsically motivated, pro-organizational employees (De O. Melo, Santana and Kon, 2012). Furthermore, we observed that project managers encouraged subordinates to attend external trainings that even increased IA between them. This has important theoretical implications: it seems that an increase of IA can be desired under certain conditions and this can hardly be explained with agency theory (Bosse and Phillips, 2016). This calls for new theories to explain project managers' attitudes to IA agile ISD projects.

We plan to continue this research by exploring other contextual factors that affect how control is configured and enacted in agile ISD projects. For instance, personal characteristics, such as the level of technical knowledge of project managers can influence how well certain communication methods help controlling IA. Another promising path can be to examine how the chosen communication methods affect project control configurations (Wiener *et al.*, 2016). At this point, we intend to describe distinctive control scenarios attached with control configurations that fit the given contextual requirements, which may need to be explained with different theoretical frameworks. Our preliminary results given here not only demonstrate that agile project managers are relying on very different communication methods given certain

conditions, but also that decreasing IA is not always the intention of project managers, despite the common notion that high levels of IA have negative effects on IS development.

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2. An assessment of the role of agency among semi-skilled workers: Challenges in the attainment of developmental outcomes from the use of ICT

Ivonia Liebenberg
Department of Information Systems,
University of the Western Cape, South
Africa
3166458@myuwc.ac.za

Shaun Pather
Department of Information Systems,
University of the Western Cape, South
Africa
spather@uwc.ac.za

Abstract

There has been a widespread consensus for some time that Information and Communication Technology (ICT) can play an important role in the lives of individuals in poor and under resourced contexts as it enables them to engage in economic and social activities through access to information. The Covid-19 global pandemic has highlighted the need to re-intensify efforts to ensure participation in the digital era to all people regardless of social and economic status. As such, there are increasing programmatic interventions to provide ICT and internet access to individuals in communities. However, evidence to date indicates that there is a low uptake among older and working-class individuals. As such there are several aspects of the underlying digital inequality in society that must be understood. In light of this, this paper draws on the Choice Framework to investigate individuals' agency in navigating the ICT-opportunities that could lead to developmental outcomes. The findings show that there is a deficiency in the resource-set of semi-skilled workers which in turn make it difficult to navigate relevant structures in society to achieve both social and economic outcomes in their lives. Moreover, even though some semi-skilled workers have free access to the internet at their workplace or at government funded community centres, they are unable to make effective use of the internet. Consequently, they are denied potential developmental outcomes that they otherwise could have realized.

Keywords: ICT, Choice Framework, agency, choice, developmental outcomes, digital divide, effective use, ICT4D

1. Introduction

Since the turn of the century and the first World Summit on the Information Society (WSIS) Governments and various stakeholders have given serious attention to the role of Information and Communication Technology (ICT) in addressing societal and economic ills. ICT which in its simplest form, refers to technologies that are used to receive information and aid communication (Ponge, 2016) and has held the promise to enable poverty alleviation (Kauffman & Riggins, 2012). There is widespread consensus that access to ICT can benefit those who use it well with a better quality of life, increased income, and cultural and political advantages (Bridges.org, 2005; Pather, 2012). On the contrary, those who do not adopt and use it are left behind and as a result, the ICT gap or digital divide prevails. The persistence of the digital divide has exacerbated the gross inequalities that face the average poor person.

Selwyn (2003) argues that the ability to use ICT is a necessity to living and working in the information society. Having access to ICT will improve people's lives and enable them to become *effective users* of technology. Effective use is defined as the opportunity to successfully use ICT to attain self-identified goals (Gurstein, 2003). To make effective use of the

opportunities in communities, citizens are required to be ICT literate, skilled, and have access to a functional and connected device (Attwood, Diga, Braathen & May, 2013). Therefore, access to, and consequent *effective use* of devices and networks are critical to attain *developmental outcomes* such as reduction of poverty, increased social inclusion and the creation of a better life for an individual. It is commonly agreed that ICT does have a pivotal role to play in human development by improving the lives of people, since access and adoption opens the door to knowledge, financial and employment opportunities for many people worldwide (ITU, 2019).

However, a significant digital divide exists (ITU, 2017), which is threatening to become the new face of inequality, reinforcing the social and economic disadvantages suffered by women and girls, people with disabilities and minorities of all kinds (United Nations, 2020). At the end of 2018, only 80.9% of the world's population, in developed countries, were using the Internet and only 45.3% in developing countries (ITU, 2019). Some people are more privileged to have access to and use technology while others do not have and have more restricted access (Cohron, 2015). As a result, many countries seek to create a society where all citizens can reach and share information by forming policies to narrow the digital divide.

Recently, the global Covid-19 pandemic has heightened the call to eradicate the digital divide. The global crisis, including multiple lockdowns of communities, has heightened the digital inequality in that those afflicted by the digital divide were not able to engage in education activities, undertake online shopping or even access the latest news on the state of the pandemic, as well as a plethora of survivalist activities. In South Africa, like many other countries the provision of access to ICT through public access centres (PACs) has been widely commended as one of the initiatives to enable communities to participate in today's information led economy (Lebele, 2016). However, there is evidence that even though public access interventions may exist, they do not in itself diminish the digital divide. There is evidence of challenges that face the average citizen in respect of ICT access and adoption, e.g. Mapeshoane and Pather (2016) and through our observations in ongoing research efforts in poor Cape Town communities. While the plight of the unemployed person is well understood, we have also observed that even those who are in employ are in the digital divide. In light of the foregoing, this paper seeks to investigate the underlying problems that might be faced by semi-skilled employed workers in poor communities in respect of adopting and using the internet.

2. Context and Motivation

Even as technology becomes more affordable and internet access seem to increase globally, a digital divide between developed and developing countries and the rich and poor still remains (Ayanso, Cho & Lertwachara, 2010). The government's most acclaimed strategies were to provide the public with access to technology and the internet through PACs (Davison, Vogel, Harris & Jones, 2000; Uys & Pather, 2016)). In the following sections the context of the problem identified is expanded through an overview of the digital divide, the initiatives to address the digital divide as well as the challenges in relation to ICT adoption.

2.1 From digital divide to digital inequality

The notion of digital divide is not a new phenomenon, as the concept was initially coined during the mid-1990s (Connolly, Lee & Tan, 2017). Digital divide is a wide-ranging concept and it usually exists between those living in cities and in rural areas (Várallyai, Herdon & Botos, 2015). As such the Digital divide normally refers to the gaps in access to and use of technology across households (in urban and rural areas) and on socio-economic differences across households (Connolly, Lee & Tan, 2017).

With the advent of broadband internet, the divide has become more pronounced. Over recent years the divide is far more than the geographical divide that prevails between urban and rural. The digital divide now also mirrors the prevailing socio-economic inequalities that perpetuate across society. According to Kleine (2010) the digital divide also occurs due to the lack the availability, affordability and skills required to use ICT. This notion of the divide is reflected in the South African White paper on ICTs which sets forth the principles that guide the achievement of universal access to ICTs, including:

- "Availability of networks and coverage;
- Affordability including the ability to pay for access to infrastructure, networks, devices and services;
- Accessibility and the ability of all people to use and access services regardless of education, disability, age, gender etc.
- Awareness by users and potential users of what is available and the benefits of these;
- Ability of different groups of people and individuals to not only access services and acquire information and data but also to use the information and data to enhance the quality of their lives (i.e. digital literacy)."

<div align="right">(South Africa, 2016: 32).</div>

Based purely on access indicators, the South African digital divide remains prevalent, especially with regards to access to the internet. In the South African context, only 64,7% of households had at least one member who had access to the internet, or used the Internet either at home, work, Internet cafés or educational facilities and an astoundingly low 10,4% of households had access to the internet at home (Statistics SA, 2018). In light of this the government has made, and continues to make, extensive efforts towards addressing the digital divide such as through public access centres (PACs). Having access to PACs empowers people, of which there are many individuals who has not been exposed or able to gain the benefits of these centres (Castells, Gelernter, Vazquez & Morozov, 2014:14) However even in urban areas there are individuals who might be in proximity to government facilitated free internet access, but who not adopting and making effective use of such access. Studies have found that the role of motivational determinants and material determinants (Scheerder, 2017), are also factors in relation to the divide.

This points to the underlying complexity of the situation. As such the prevailing inequalities must be investigated further in order to understand what other factors, beyond that of access are associated with the perpetuation of the digital divide.

2.2   Challenges in relation to ICT adoption

Adoption of ICT refers to the use of computers and the Internet. Straub (2009:626) avers that ICT adoption involves an individual to make a choice to either accept or reject a specific innovation. The choice an individual makes to adopt and use ICT, has an impact on their everyday lives (Barron, Kemker, Harmes & Kalaydijian, 2003). Therefore, an individual needs to understand and know the consequences of choosing to (or not to choose) adopt and be aware of the factors within the social context in order to adopt (Straub, 2009:625). For several decades, the South African government has dedicated itself to achieve universal access to ICT, especially in underserved communities (Parkinson, 2005). However a challenge is that individuals in communities remain unaware of the benefits that ICT can bring to them (Uys & Pather, 2016). Another challenge is that of affordability, and the hashtag #DataMustFall is a well-known slogan in South Africa that has been used in protest against the high price of access

to the broadband network. Notwithstanding, even where free access prevails, there is evidence that especially older persons in poor communities struggle to make effective use of the internet.

2.3 Objective of the paper

The main aim of this study is to investigate the role of an agency among semi-skilled workers in navigating the opportunities that are presented by ICTs and access to the internet to make choices that could lead to ICT-facilitated developmental outcomes. The next section outlines methods used to collect and analyse data. Thereafter the paper presents the results.

3. Research Methodology

3.1 Theoretical Framework

The underlying policy goal of ICT public access programs is to catalyse economic and social development among citizens. The South African ICT White Paper sets out its purpose as to ensure that "everyone in South Africa, regardless of who they are, where they live or their socio-economic status can improve the quality of their lives through accessing the benefits of participating in the digital society" (South Africa, 2016:1). As such , the point of departure for this study was to assess why individuals who had access to the internet were not adopting or making effective use of the internet, given that all persons, regardless of status, does seek social and economic improvement. In this regard, the Choice Framework (Kleine, 2010), was deemed appropriate given that it serves to systematically analyze the underlying problems that might be faced by individuals in poor communities in respect of adopting and using the internet (Figure 1). In addition, the Choice Framework was also used in other studies e.g. Horn and Rennie (2018) which also set out to investigate why users do not participate equally in online practices. Kleine (2010) explains that the primary development outcome for an individual is that of choice, a development concept which she draws on from Amartya Sen (Sen, 1999). The primary argument is that *choice* is both the aim and the means of development.
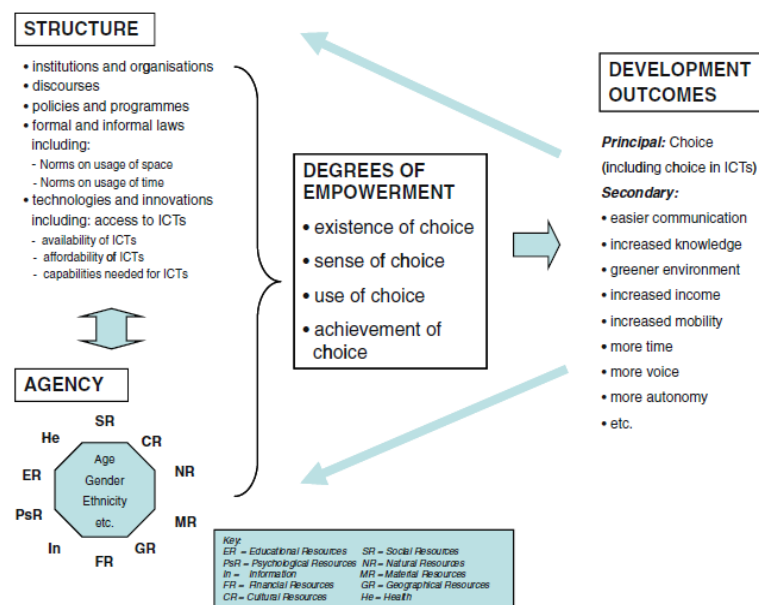

Figure 1: The Choice Framework
(Source: Kleine, 2010)

Primary developmental outcomes refer to the choice itself. In the case of this study choice refers to a choice which individuals make to adopt and use the internet to achieve secondary developmental outcomes. Secondary developmental outcomes, according to the choice framework refer to what individuals' value in life, including, for example, easier communication, increased knowledge, job creation and more autonomy (Kleine, 2010). Developmental outcomes are all about the kind of life people choose to live. *Agency* refers to an individual's resource portfolio and includes ten tangible resources such as educational, psychological, information, financial, cultural, social, natural, material, geographical resources and health (Kleine, 2010). The *structure* component of the choice framework includes rules, laws, formal and informal norms and policies which an individual navigates through their *agency* (Kleine, 2010). The *degrees of empowerment* are dependent on the individual's agency and the structures within which they operate. Agency, together with structure help the individual's agency to determine how resources can be adapted into capacities (Kleine, 2010).

3.2   Methods

The study explored the experiences and perceptions of working-class individuals who have access to the internet, but who are not making effective use of it. The effective use of the respondents was not measured, hence we asked them before the interview if they were frequent users of the internet or not. The interview schedule was designed to extract elements of the Choice Framework to gain a broader perception of how individuals make a choice to use the internet and if they have resources available to them to navigate the applicable structures in society to attain developmental outcomes.

We engaged in purposive and snowball sampling to identify the appropriate unit of analysis (UoA) to collect the data. As per the primary research aim, our sampling objective was to identify twenty-five semi-skilled employees at an organization located in Bellville within the Cape Metro in the Western Cape Province of South Africa. After initial negotiations with the organisation, we identified security guards and cleaners as worker categories that were aligned to the UoA. Snowball sampling was used as initially we found a reluctance among our UoA to be interviewed. However, upon knowing that they were recommended by a fellow colleague, they were more amenable to grant an interview.

The researchers undertook the fieldwork between September and October 2019 to perform the interviews. The interviews were recorded with an audio recorder. During the interviews, records of observation and field notes were used as part of the data collection strategy. Using the Choice Framework as a lens, the data was coded and categorised until several high-level themes emerged. This study used thematic analysis as the main analytical strategy and the process involved identifying themes within qualitative data (Maguire & Delahunt, 2017:3352). ATLAS.ti, a tool for qualitative data analysis, was used to support the researchers during the data analysis process for coding of transcripts and associated textual analysis (Smit, 2002:65).

Details of the demographics of the respondents are displayed in Table 1. The majority of the respondents consisted of security guards, whose highest level of education was less than a high school certificate.

4.   Results

The findings demonstrate how respondent's agency is used (or not used) to navigate structures around them to use the internet and associated devices. As a starting point, we acknowledge that the reasons for people to make use of the internet is a combination of socio-economic, motivational and psychological factors that have an impact on whether people use the internet

or not (Helsper & Reisdorf, 2013). The reasons for not using the internet are manifold amongst users. Those who do not use the internet are offline because of choice, interest and disposition, or other issues such as access and skills (Groselj, Reisdorf & Petrovcic (2019: 214). In addition, respondents identified the following resources as predominant in terms of their restrictions to attain developmental outcomes: material, educational, psychological and geographical resources; and other factors.

		Frequency	Percentage
Monthly income	Below R5000 ($341.37)	2	8%
	R5000 - R10 000 ($341.37 - $682.73)	21	84%
	R11 000 - R15 000 ($751.10 - $1024.23)	1	4%
	R16 000 - R20 000 ($1107.73 - $1365.46)	1	4%
	Total	**25**	**100%**
Occupation	Security guards	21	84%
	Cleaners	4	16%
	Total	**25**	**100%**
Highest level of education	Less than Grade 12	15	60%
	Grade 12	7	28%
	Diploma	2	8%
	Advanced Diploma	1	4%
	Total	**25**	**100%**

Table 1: Demographics of respondents

4.1 Material Resources

Material resources are defined as items owned such as machinery, computer hardware and other equipment to access the internet (Kleine, 2011). In this study, 80% of the respondents own a mobile device that is capable of connecting to the internet. It is evident that they do not make use of other devices, such as computers or laptops, which are one of the biggest problems these respondents face. One of the respondents said that: *"I use my sister's device. I then use her data. She would come from work and I just want to see some pictures. I do my own thing and download. I just want to check something for example google a celebrity. But she complains and yells because I use her data".* As a result, this is a cause of their lack of knowledge, lack of motivation and support, lack of ICT skills and lack of awareness and understanding of ICT. One of the respondents said that: *"I only use mobile phone, I don't have a laptop, and not here at work, because I can't use a computer here at work".* This supports the data that indicates that the respondents are not allowed to use computers at their workplace, as it is not part of their work function. Due to the lack of material resources, it is evident that there is a gap in the ownership of associated devices which inevitably results in lack of ICT skills and knowledge, and confidence to access and use the internet.

4.2 Educational Resources

Educational resources refer to having the skills to use both devices and the internet itself. It is evident that respondents have access to free Wi-Fi at their workplace. However, they are unable to use the internet to attain developmental outcomes due to a lack of ICT skills and knowledge. It was found that 60% of the respondents lack higher education, and whose level of education was below that of a high school certificate (referred to as a Matric Certificate in South Africa).

Low levels of education and lack of ICT skills are barriers which influence the adoption and use of the internet. The lack of knowledge and ICT skills in this regard also led some respondents to abandon other software applications and platforms, because they do not know how to use the application properly. When they were asked: *"Do you have an idea of what the Internet is?",* most of them could not give an explanation without the researcher trying to probe additional questions for more clarity. One of the respondents' answer was: *"No, I don't, just know what it used for but don't know what it is".* This is supported by Peng, Kanthawala, Yuan & Hussain (2016) who suggest that the lack of ICT skills is one of the educational barriers resulting from users not knowing how to use applications. Therefore, educational resources impacted the perceived ease of use negatively.

4.3 Psychological Resources

Psychological resources include self-confidence, tenacity, optimism, creativity and resilience (Alsop & Heinsohn, 2005). Several respondents encountered, in general, a lack of confidence. One of the respondents said that: *"I am scared when it comes to banking information or scared clicking the wrong button".* Technology anxiety is described as a person's apprehension when challenged with the likelihood of using a computer or the internet. Byers et al. (2016) mention that fear can also be a barrier. The lack of confidence and technology anxiety is caused by a lack of ICT skills and knowledge. It was found that most of the respondents in this study, at the surface, appeared to exhibit confidence to use the internet, should they need to undertake a simple task for general information search. For example, several respondents described how they simply just type anything into a search engine and that they are able to obtain information. However, this notwithstanding, what the data does demonstrate is that there is an innate lack of confidence to use the internet for more clearly defined social or economic related gains.

4.4 Geographical Resources

Geographical resources concern the practical implications of location and relative distances to access ICTs. Cybercafés plays an important role as the starting point for first-time users in order to build their confidence and skills with computer literacy (Gomez, Pather & Dosono, 2012:14). In the case of this study, although respondents are making use of the free Wi-Fi when they are at work, both PACs and Cybercafés are not in close proximity to their homes. So, despite their autonomy of use (Hargittai, Piper & Morris, 2019), which refers to the freedom to use the internet when and where one wants, they do indeed face restrictions to internet access when they are at home. Therefore the notion of autonomy is compromised. For example, one of the respondents explained that: *"In Manenburg[1] there are no internet café's nearby, you must travel to Bellville for one due to the area and crime".* Another respondent lamented the distance and said that: *"Distance to these accessions* [sic]*, you have to use transport".* The physical proximity to PACs and Cybercafés is associated with the crime and safety in the area and is in agreement to the findings of Gomez & Pather (2012) and Uys & Pather (2016) that the location of PACs is seen as one of the barriers to access the Internet, thus their autonomy of use is restricted. Therefore, geography related constraints are a challenge to respondents.

4.5 Affordability and the constraint of time

Another factor that was identified which prevent individuals to attain developmental outcomes is affordability, low level of income, and time constraints. Affordability was a key issue for those who are not yet connected to the internet, either by mobile phone or computer, due to their low level of income. 84% of the respondents earn an income between 341.37 USD and 682.73 USD per month (5000 – R10 000 ZAR). With this low level of income, respondents

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[1] Manenburg and Belville are communities in the Cape Town metropole

reported that the average cost of data was beyond their reach. Despite many efforts to reduce price, affordability remains a significant constraint for many people not using the internet.

Time was also a hindrance. Respondents work a 12-hour shift and are only allowed to use the Wi-Fi at work during their lunch or when it is quiet at night. If they were able to use PACs in their community, they find that their shift work makes it prohibitive. One of the respondents pointed out: *"I don't have more time because I'm always here at work, don't have time to go to Internet Café"*. The findings are supported by Groselj, Reisdorf & Petrovcic (2019:215) who identified four dimensions that are critical for users to access and use the internet: attitudes and interest; access; cost and absence of digital skills.

4.6 The interaction between agency and structure to reach degrees of empowerment
The interaction between agency and structure to achieve developmental outcomes are explained by the Choice Framework (Figure 1). In this study context, the organization that served as the site of study, does avail adequate resources in the form of free Wi-Fi. As such all respondents, are presented with an *existence of choice*, and even a *sense of choice*. However, at this point their ability to move to the next degree of empowerment, viz. *use of choice* is a challenge, due to deficiencies in the agency. Therefore, respondents are not able to transcend from being aware of the existence of choice, to ultimately realizing choice. At the same time respondents did sense certain developmental outcomes that they aspired to and which they value in life. These included personal growth, better job opportunities and becoming more adept at technology use.

For the achievement of developmental outcomes, a choice must exist (the availability of the Internet), the sense of choice (considering the Internet is something one can access and use), the use of choice (one choose to act), and the achievement of choice (one was able to make the choice he or she had reason to value). The existence of choice refers to whether an opportunity to make a choice exists (Alsop & Heinsohn, 2005). The use of choice involves evaluating whether or not a person takes advantage of an opportunity to choose (Alsop & Heinsohn, 2005). It is evident that the respondents make a choice to use the free Wi-Fi. The achievement of choice is evaluating how far a person is able to achieve their desired outcome. One of the participants responded: *"Sometimes I use my daughter's laptop, but she shows me stuff"*. This indicates that he has a sense of choice, but has to rely on someone else to assist him to achieve the choice. Therefore, an individual's choice can be explored by analyzing the association between their agency and structure.

5. Conclusion
This paper reports on research that was conducted to better understand the nature of the digital divide, and the low uptake among working adults from poor communities, in light of the recent global pandemic. Although the data was not collected during the pandemic, it highlighted the importance of ensuring to narrow the digital divide. The research investigated the underlying problems that might be faced by individuals in poor communities in respect of adopting and using the internet. The underlying theoretical framework was the Choice Framework which provided a conceptual lens to investigate the effect of an individual's agency in navigating the opportunities that are presented by ICTs and access to the internet to make choices that could lead to ICT-facilitated developmental outcomes. The empirical data was used to understand the resources that comprise the *agency* of semi-skilled workers and the factors preventing individuals to not realise the benefits presented by the Internet. From the analyses, the paper draws conclusions regarding the agency of semi-skilled workers in terms of the resource constraints that prevent individuals from navigating the ICT related structures.

The findings show that there is a deficiency in the resources of semi-skilled workers. As a result, material, educational, psychological and geographical resources, and other factors are preventing this demographic to attain developmental outcomes. The main deficiency in agency relates to the following: the lack of ICT skills and knowledge, lack of awareness and understanding of ICT, and low level of education and income. Furthermore, barriers such as not owning a device and time constraints are a deficiency in terms of resources. However, while these appear to be prevalent, they can be overcome. The findings further note, that long working hours makes it difficult for this group of internet users to navigate the relevant structures to access ICTs and free internet access.

A firm recommendation that emanates from the findings is for more active digital skills training in the form of workshops and short courses are critical in enhancing computer usage and use of the internet. In this study, all of the participants indicated that they would attend workshops and short courses to help them gain more knowledge and skills on how to use the internet and computers. There is a need as such for both employers and government to make computer literacy training available to this demographic as it will increase awareness and effective use of ICT. To date much attention has been on the youth. Consequently the middle-age demographic especially from the working class remains on the wrong side of the digital divide as they are unable to navigate the appropriate structures to realize benefits from the internet. Therefore, it is extremely important that this be taken into consideration if ICT policy objectives in respect of attaining social and economic developmental outcomes are to be fulfilled for the entire population. The design of such programmes must take into account the diverse characteristics of the target population, from both a design and implementation considerations. Future studies should look into modalities of providing such training.

Additionally, the findings of the study found that even though semi-skilled workers have free access to the internet at the workplace, but due to the deficiencies in their agency they are unable to make effective use of the Internet, thereby denying themselves of the potential development outcomes that they could potentially realise. This is the question probed by this research, and as such we conclude that the lack of agency has hindered the achievement of choice, and therefore the attainment of social and development outcomes amongst the respondents.

Finally, the paper contributes to the ICT4D field in two ways. Firstly the study adds to the existing body of evidence in respect of the application of the Choice Framework as a lens that is suitable to analyse to the underlying problems that are faced by individuals in relation to ICT adoption and the consequent effective use that must follow to achieve development outcomes. Secondly the paper advances our thinking in respect of ICT4D related public policy. This paper confirms that supply side interventions such as free access to the internet is not sufficient to achieve development. The findings lend support to the need for integrated interventions in which affordability, awareness and skills are also critical factors to enhance the agency of individuals thereby enabling the conversion of choice to use ICTs into much needed social and economic outcomes.

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3. An Extended Analysis of Risk Management Concepts in IT Management Frameworks

Maksim Goman
Johannes Kepler University Linz, Austria
maksim.goman@jku.at

Abstract

This paper analyzes risk concepts and risk assessment practices in modern IT management frameworks. We evaluate consistency and suitability of their methods for practical business decision-making using system analysis method. The objective is to determine fundamental logical flaws in regard to risk management in well-known IT control frameworks, and this can help to identify how to fix them. It turned out that examined frameworks can produce highly doubtful output of risk assessment in both substantial meaning and significance for decision-making.

Keywords: IT management, risk assessment, security risk, IT control framework

1. Introduction

IT risk management (RM) is a central topic of every IT control framework. For efficient management, any risk should have an exposed stakeholder and uncertainty about the circumstances of decision-making (DM) (Goman, 2018). The decisions aim at achieving specific predetermined goals. Uncertainty, i.e. lack of complete certainty or knowledge (Hubbard, 2014), is a natural feature of decision circumstance in management. Uncertainties can be different: imprecise information about threats or competitors, unclear perspectives of a technology, absence of certain technological skills, resources deficit, unstable business environment, inaccurate estimations and foundational models in general, lack of internal control (may not be recognized), improper organization structure, etc.

It seems that an intuitive course of action for a practitioner in respect of IT RM is to adhere to existing IT risk control methodologies from known IT management frameworks. Such frameworks are also called "best practices", meaning "a proven activity or process that has been successfully used by multiple enterprises and has been shown to produce reliable results" (ISACA, 2012). Existence of multiple "good practices" means that their user is self-accountable for proper choice of the "best practice" and proper realization of its lower level techniques.

An interested reader grasps that the most known frameworks like IT Infrastructure Library (ITIL) (TSO, 2011) or Control Objectives for Information and related Technology (COBIT) (ISACA, 2012), consider IT RM as an important issue. However, their methods of risk analysis for IT function or enterprise level control are limited. An apparent question is whether they have a feedback control? That is, is there a measure of how well a "best practice" that works well "most of the time" behaves in a given company with specific environment "most of the time"? Hubbard (2009) formulated it as a risk paradox: The higher abstraction level of management, the less risk analysis is employed on regular basis and the simpler methods are used. Moreover, it is routinely taken for granted to evaluate business and technical risks with qualitative methods and scales. Quantitative methods of risk analysis are not even well referenced in frameworks COBIT and ISO 27000.

The primary goal of the paper is to highlight fundamental problems with reference to RM that popular IT related frameworks have. That can enable to propose directions for improvement to risk control practices in the future. Systems approach, observation and generalization are used to decide on consistency and validity of framework's vision towards IT RM. As a secondary objective, we call for debate on the modern problems of risk analysis in IT and business control. We analyze four aspects of IT RM in each framework. As the frameworks support specific parts of business management (projects, security, higher benefits through better services, strategic competitiveness, etc.), these four aspects should be coherent within each framework and serve the goal of risk control in a company. The four aspects were chosen following Goman (2019):

- Concept of risk, i.e. the very definition of the subject of control;
- Methods of risk measurement and assessment. Wherever possible, methods or algorithms should be provided for measurement;
- Relation between IT and business risk. Each framework promotes IT to business connection. Therefore, risk analysts and managers on the lower IT level should understand the connectivity of IT risk to the higher level business risks; and
- Criteria of IT RM effectiveness (related to overall corporate risk change) and special aspects of its evaluation in the risk control process or higher-level management processes. This is interesting because all standards under review consider RM as a stabilized process with a feedback.

The paper is organized as follows: A review of conditions of today's high-level IT RM principles is given in Section 2. Risk terminology and classification issues are considered in Section 3. Analysis of frameworks in the context of the four aspects is carried out in Section 4. The final section concludes the paper.

2. Background of RM in IT Control Frameworks

Our focus in frameworks for this paper is on their concept of risk and risk methodology. Publications on IT management usually employ a single pattern regarding RM. They provide a system of practical advice or heuristics based on common sense or practical experience including certain assumptions. Customarily, no proofs of effectiveness or empirical success rate is provided, including effectiveness of risk analysis practices. IT management frameworks aggregate the information from the relevant body of knowledge, so we consider them as an established source of RM guidance for IT management.

As a brief summary, the definitions of IT risk concepts are not critically reevaluated; methodology is considered completed, proven, and unanimously understood; and any referred methods as reliable. The main goal of the books and frameworks in the area is to give solutions to certain typical problematic IT control scenarios or situations, and to perform exploratory and empirical risk analysis. IT risk is considered as mainly operational risk: only losses from inadequate or failed internal processes and systems, and human errors are assumed under operational risk. Accordingly, IT risk is referred to in a typical information security (IS) interpretation as "any threat to the integrity, confidentiality, or availability of data or IT assets" (Betz, 2011), i.e., a threat to IT assets, not to business. Nevertheless, impact to business presents in frameworks to some extent starting from purely IS objectives (e.g. prevention of unauthorized enterprise information access or its loss, etc.) (ISO, 2011) up to the goal of full-scale business support in the IT governance domain (ISACA, 2012).

There is no need to cite papers and books that agree on rules from frameworks like COBIT. Our objective is to analyze the underlying rules. The reader is referred to the couple of

examples of independent analysis, namely Betz (2011) reveals problems with process approach in ITIL (TSO, 2011), and Hubbard (2009) that criticizes modern management practices towards risk management. The latter author devoted another book to problems of IS risk analysis (Hubbard, 2016).

Insufficient data about the scale of practical application of any IT RM methodology may indicate that its effectiveness for IT risk evaluation was not proven. On the other hand, there is no proof in the IT frameworks that their methods shall produce accurate and repeatable result. They give no references to external sources with such information. Besides, the reviewed frameworks do not consider validation of its methods of risk assessment as well as verification of results obtained with the analysis.

3. Importance of Risk Concept and Classification

Definition of risk drastically differs in frameworks. Sometimes it is derived from one another (e.g. in (ISO, 2011; ISACA, 2012)). Each framework has risk treatment measures and control metrics. However, no evaluation of effectiveness of proposed measures or references to it are supplied. But the problem of measurement of risk level change after risk treatment as per framework's guidance is important in accordance with system approach. This is a feedback control in the RM activity. This control depends on risk definition and helps to assure RM effectiveness. Should frameworks have very different risk definitions, how can we assure that the feedback controls are compatible and appropriate?

We found that papers (Holton, 2004) (about philosophical basics) and (Goman, 2018) (about generic IT risk definition) are vital for understanding the nature of the risk concept. We believe that a consistent risk definition for IT RM is Goman (2018): "Risk is a state of uncertainty, such that there is a possibility that involves loss or other undesirable outcome for an exposed actor". Put it otherwise, risk is a *condition* when an actor is exposed to a problem and uncertain about its consequences.

Risk is usually categorized. Most of classifications include market, business, operational, strategic, reputation risks. Each framework applies a different approach to risk categorization and classification. This classification is subjective (i.e., performed by an expert) and not unique. Risks may belong to several classes. We found neither comprehensive database nor uniform scheme for such a database of IT risk classes and their business effects.

Some frameworks, e.g. COBIT, assume that IT risks are connected to non-operational business risks. But in most cases, the regulations and frameworks suppose that technology is a source of only operational risk. Legal regulations, like Sarbanes-Oxley Act and Basel Advanced measurement approach, include minor statements on IT risk control in their scope. Nevertheless, some IT great failures that originate from errors in business DM, in IT governance or failures in strategic technology implementation, mean strategic business risk (see example in (Goldstein et al., 2008; Nelson, 2005; Nelson, 2007; Widman, 2008)).

System approach tells us that legal and other non-operational risks can emerge from IT risk realizations together with them or following them as a consequence of a common mode failure. IT project failures can be spectacular too (Nelson, 2005; Nelson, 2007). While the losses can originate from operational failures, they can have eventually strategic outcomes. Such cases were revealed during our own work in IT audit and risk analysis. Because a company is a large system of sub-systems, even seemingly operational decisions on technology change may reveal

strategic influence due to its high importance for business change. Such decisions can fall into several risk categories. For instance, in (Goldstein et al., 2008), operational IT faults were not only IT concern, but were cases of business risk. Likewise, the mean loss seems large for any type of risk event classes in (Goldstein et al., 2008).

Furthermore, according to popular frameworks, threats, assets, vulnerabilities, impacts, existing controls, actors, scenarios, etc. are classified and documented. Risk registers should be maintained. For example, risk classification is a part of risk assessment task of repeatable Deming's IS RM process (ISO, 2011): Context establishment, Risk assessment, Risk treatment, Risk acceptance. This is applied for every known risk and is well documented. Someone should do that continuously. Analyst's imagination can conceive an almost infinite number of risk scenarios taking into consideration operational risk, IT complexity, and human actors in a business or IT process. An addition of a single change in asset or threat registers produces exponential growth of analysis overhead and the need of register maintenance. What resources does a large corporation having business in highly volatile business environment need for that? Some frameworks (e.g. COBIT (ISACA, 2014)) admit that, and recommend to restrict the number of artifacts in registers and the number of scenarios for them, but without details of how to differentiate between a critical scenario and one that is not worth consideration.

RM based on risk classification requires resources and creates management overhead. It helps to understand the firm, its problems, details of risky decisions, actors, ambiance, etc. How can we make it effectively? Which constraints should one apply to threats, assets, vulnerabilities, and their myriad combinations to have manageable registers? Frameworks do not provide a single answer.

4. Analysis
The following frameworks were studied: COBIT 5 (ISACA, 2012, 2013, 2014;), COBIT 2019 (ISACA, 2018a, 2018b), ITIL v.3 (TSO, 2011), ITIL v.4 (AXELOS, 2019), PMBOK 5th ed. (PMI, 2013), PMBOK 6th ed. (PMI, 2017), ISO 31000 (ISO, 2009a, 2009b), ISO 27005 (ISO, 2011), and NIST Special Publication 800-30 Revision 1 (NIST) (NIST, 2012). These frameworks were available to us.

Concepts of risk are very different in the frameworks (some have several distinct definitions). Results of risk concept analysis are summarized below:
1. COBIT: Risk is
    a) "the combination of the probability of an event and its consequence" (ISACA, 2012);
    b) "the potential that a given threat will exploit vulnerabilities of an asset or group of assets to cause loss of/or damage to the assets" (ISACA, 2013);
    c) "the potential of business objectives not being met" (ISACA, 2013);
    d) Business risk is "a probable situation with uncertain frequency and magnitude of loss (or gain)" (ISACA, 2012);
    e) IT risk is "a business risk associated with the use, ownership, operation, involvement, influence and adoption of IT within an enterprise" (Goldstein et al., 2008).
2. ITIL: Risk is
    a) "a possible event that could cause harm or loss, or affect the ability to achieve objectives. A risk is measured by the probability of a threat, the vulnerability of the asset to that threat, and the impact it would have if it occurred" (TSO, 2011);
    b) "a possible event that could cause harm or loss, or make it more difficult to achieve objectives. Can also be defined as uncertainty of outcome, and can be used in the

context of measuring the probability of positive outcomes as well as negative outcomes" (AXELOS, 2019).

3. PMBOK:
   a) "Project risk is an uncertain event or condition that, if it occurs, has a positive or negative effect on one or more project objectives such as scope, schedule, cost, and quality" (PMI, 2013);
   b) "Individual project risk is an uncertain event or condition that, if it occurs, has a positive or negative effect on one or more project objectives." (PMI, 2017) (this is also a definition of risk in the PMI glossary);
   c) "Overall project risk is the effect of uncertainty on the project as a whole, arising from all sources of uncertainty including individual risks, representing the exposure of stakeholders to the implications of variations in project outcome, both positive and negative" (PMI, 2017);
   d) "Secondary Risk. A risk that arises as a direct result of implementing a risk response" (PMI, 2017).

4. ISO 27005:2011 (ISO, 2011), ISO 31000:2009 (ISO, 2009a): Risk is:
   a) "an effect of uncertainty on objectives";
   b) "a combination of the probability of an event ... and its consequence";
   c) Information security risk is "potential that a threat will exploit a vulnerability of an asset or group of assets and thereby cause harm to the organization".

5. NIST (NIST, 2012): "Risk is a measure of the extent to which an entity is threatened by a potential circumstance or event, and is typically a function of: (i) the adverse impacts that would arise if the circumstance or event occurs; and (ii) the likelihood of occurrence." "Information security risks are those risks that arise from the loss of confidentiality, integrity, or availability of information or information systems and reflect the potential adverse impacts ...".

Each framework connects IT risk to business risk in some way. Proposed measures of RM effectiveness always presume analysis by some external party to RM or DM process with certain time delay. In this way, RM problems would be revealed with latency and their communication can be delayed. The measures can be as vague as "maturity levels" in COBIT, post-analysis of risk methodology by audit or "lessons learned" activity in PMBOK. ITIL has no explicit position in this regard and refers to other frameworks.

All the frameworks considered advise application of subjective ordinal scores as *numerical scales* for risk analysis and give examples. Methods of risk measurement and assessment in the frameworks are the following:
- COBIT 5 (ISACA, 2012): qualitative risk analysis using heat maps, ordinal scales for risk (low, med., high, very high), risk frequency and risk impact (0 to 5).
- ITIL v3 (TSO, 2011): refers to other frameworks on this matter.
- PMBOK (PMI, 2013): qualitative risk analysis as in item 1, quantitative risk analysis.
- ISO 27005:2011 (ISO, 2011), ISO 31000:2009 (ISO, 2009a): qualitative risk analysis, quantitative risk analysis, but with examples of qualitative analysis.
- NIST (NIST, 2012): qualitative risk analysis using heat maps, ordinal scales for risk, impact, likelihood, etc. (very low,..., very high), (0 to 10), or (0 to 100).

An important controversial point is a "positive" meaning of risk in all frameworks. The meaning of "positive" risk is confusing because it includes a desired outcome beyond unwanted ones. A usual meaning of the term "risk" is something negative, undesired, inadmissible, or inappropriate. A failure or loss suits this meaning in many languages (Holton, 2004; Hubbard,

2009, 2016), and this is the case of practical usage of the term "risk". Some other related issues of the "positive risk" are discussed in Goman (2019).

The positive quality of any risk is dispelled with the typical questions of RM: What is risk treatment for a "good" risk? What is the residual risk after the treatment measures? Finally, what is risk tolerance to this kind of risk? Consequently, the term "risk" is meaningful in only negative context.

Risks are classified by diverse properties and this is a resource demanding activity. All frameworks refer to risk registers, but give no advice on classification overhead reduction. Simple qualitative assessment methods based on subjective ordinal scores like "high", "medium", "low" or ordinal scales such as {0, 1, 2, 3, 4, 5} are recommended in each framework directly or indirectly (sometimes with respective examples). Existence of quantitative methods of analysis is only mentioned in passing. Instead, "heat maps" are promoted for management DM. Nevertheless, it is known that mathematical calculus for scores does not exist and application of such scores is problematic (Hubbard, 2009, ch. 7, 2014; Thomas, et al., 2013). The result of arithmetical operations on these subjective scores and any other ordinal values is not defined and meaningless.

Relevant findings will be shown in the following subsections. The descriptions of the selected frameworks add evidence to our discussion of problems in the IT risk control domain and generalizations in the conclusion.

4.1. COBIT

COBIT promises to be the most objective convolution of IT control practices that ensures achievement of the best possible business benefits while treating risks and optimizing use of resources. It calls success factors "enablers", namely "factors that, individually and collectively, influence whether something will work" (ISACA, 2012). COBIT classifies many goals, risks, success factors, etc. Then it defines finite sets of predefined IT processes, sets of IT goals with relations between them, and relations from IT goals to a set of business (enterprise) goals (Betz, 2011, ISACA, 2012). COBIT's concept is that IT processes ensure IT goals and IT goals support business goals realization. The processes "Manage risk" and "Ensure risk optimization" are among them.

COBIT 5 and COBIT 2019 are very close in relation to RM. According to them, risk should be managed through its identification, assessment, and design of an appropriate "enabler" to mitigate the risk. Risk optimization has become a major part of governance and management objectives in the COBIT core model. In the areas "Evaluate, Direct and Monitor" (EDM) and "Align, Plan and Organize" (APO), there are dedicated sub processes EDM03 – Ensured Risk Optimization (risk governance process), and APO12 – Managed risk (risk management process) for risk management (ISACA, 2012; ISACA, 2013; ISACA, 2018a; ISACA, 2018b). IT RM also presents in enterprise goals. Moreover, COBIT 5 has a special book devoted to risk management (ISACA, 2013). Risk is regarded from two different points: Risk function and Risk management perspectives (ISACA, 2013). The former describes *what* is needed to establish efficient risk governance *and* management activities. The latter relates, *how* the core risk management processes are assisted by COBIT enablers. COBIT refers a user to ISO 27000 and ISO 31000 for guidelines on RM and risk control. COBIT 2019 further integrates overall business risk governance and management with IT governance and management.

There is a clear vision in COBIT that IT risk may refer not only to operational risk, but to any component of enterprise risk, including market, credit, and even strategic risk where IT component exists (e.g. IT is required for a new strategic business initiative). In addition to generic risk concept, COBIT defines business and IT risks. Regrettably, these two definitions are too different. Moreover, both of them allow "positive" risk that is unfortunate as well. However, they recognize IT risk as a subset of business risks. COBIT 2019 refines: "The management of IT-related risk should be integrated within the enterprise risk management approach..." (ISACA, 2018b). COBIT 2019 also specifies a term "Risk optimization" that splits value creation and value preservation. The latter is a designated objective of RM. COBIT itself "Helps to ensure the identification and management of all IT-related risk" (ISACA, 2018b) for risk management stakeholders.

COBIT 5 for risk (ISACA, 2014) gives an example of IT risk assessment. It suggests further IT risk classification: Primary (of high degree) and Secondary (of low degree) risks. This is an oversimplification. To decision-makers, does it mean that primary risks should be considered now, and secondary may be resolved later? Furthermore, it suggests aggregation of risks on a plot to cluster similar risks, e.g. a cluster contains risks that may cause a prohibitive impact and must be prevented at all cost. From engineering and mathematical points of view, aggregating two scored ordinal values for risks of completely different nature and measures is not as trivial as COBIT supposes. COBIT 2019 suggests further ways of risk and risk factors classification.

Basic example risk scenarios are shown in (ISACA, 2013). More than 100 sample risk scenarios are given in a special COBIT issue (ISACA, 2014). Without any doubt, the examples represent the view of COBIT on a good risk assessment practice. The major downside is usage of ordinal scales. For instance, is a certain enabler's "Low" effect on frequency enough for a case where combination of the frequency of risk is 3 and the impact is 2 (on a scale from 0 to 5)? Problems of such scales were analyzed in (Hubbard, 2009, 2014), and further references can be found in the books.

COBIT regards qualitative methods to be better for the initial risk assessment, but admits "high level of subjectivity, great variance in human judgments and lack of standardized approach" (ISACA, 2012). Problems of subjective qualitative estimations were well described by Hubbard (2009, 2014). COBIT suggests, that risk assessment methodology should be chosen by every company according to their needs, but does not tell anything about the principles of how to do it properly.

COBIT insists that organizational controls, well-built IT processes with defined and understood roles, inputs and outputs, company culture and so on will produce good RM. But after that, they propose to measure RM effectiveness as maturity levels, which are a kind of subjective ordinal scale. Taking into consideration information from this section, COBIT can not assist effective RM.

4.2. ITIL
The framework aims at organizing an optimized set of processes for a service provider. Risk is considered mainly in the context of risk for the supplier, not for the client. An exception is a service provider inside the company – IT function. It is implicated that, with adherence to process approach, risks are minimized. Metrics showing benefit for business, such as total cost of ownership and return on investment are supported. ITIL (TSO, 2011) advises, that processes should be measurable and performance-driven. Measurement methods and metrics are strongly propagated and proposed metrics are more reasonable for their objectives, than those in

COBIT. Unfortunately, examples in ITIL books show, that its authors prefer simplified trivial techniques for risk assessment and evaluation.

Although IT risk is mostly considered as technical and technological operational risk, ITIL allows not only operational but any other kind of risk classes for both service provider and a customer, including strategic risk. Attention is paid to project risks too. Importance of understanding complexity of IT and processes is traced through all ITIL books.

ITIL introduces ambiguity to the risk concept: It is hard to conceive a risk (measured by probability, vulnerability, and impact) as an undesired event, and sometimes, as only an uncertainty about success or failure (measured by probability only) (TSO, 2011; AXELOS, 2019). Usage of the term "risk" either crosses with the meaning of "threat" or presumes that there exists imminent risk for intangible information assets, e.g. "...understanding and managing risks to the confidentiality, integrity, and availability of information..." (AXELOS, 2019, p. 114).

As risk is not a trivial topic, ITIL does not give any considerations on good methods of risk analysis and key factors or measuring techniques for both IT service provider and a client. Any details about RM are advised to see in other standards. Considering all above, ITIL does not incorporate RM well into its process paradigm.

4.3. PMBOK

The subject area of the framework is project management. The objectives of project RM are to increase the likelihood and impact of good events, and decrease the same characteristics for bad events in a project (PMI, 2013). In the 6th edition, project RM process has become even more complex, for it should address both levels of risk: individual risks and the overall risk (PMI, 2017). However, there is a discrepancy in the objective of the process, because at the same time "Project Risk Management aims to identify and manage risks that are not covered by other project management processes" (PMI, 2017, p. 677).

Ambiguity between terms "uncertainty" and "risk" increased in the latest edition with introduction of "non-event risks" (variability risk, ambiguity risk) (PMI, 2017, ch. 11). Multiple definitions of risk make the risk ontology complex and interrelations between the terms unclear. Moreover, the definition of a threat does mean another risk "event": "**Threat**. A risk that would have a negative effect on one or more project objectives" (emphasis in original) (PMI, 2017, p. 724).

Definition of risk assumes that a risk can be a "positive thing", e.g. individual and overall risks (if they occur) can have a positive or negative effect on project objectives (PMI, 2017, p. 677). Another innovation is "positive and negative risks are commonly referred to as opportunities and threats" (PMI, 2013). It is true for an opportunity, but a risk and a threat are hardly the same entity. Note, that these terms *are different* in ITIL, which considers PMBOK a framework supporting projects for ITIL processes.

The framework mentions the idea of simulation and modeling techniques. Regrettably, examples of probability and impact definitions show, that PMBOK prefers ordinal scales to mathematical numbers and conceals its mathematical rules for ordinal scoring values (see examples in (Snyder, 2013; Snyder, 2018)). There is no example of quantitative risk analysis for PM purposes in PMBOK. However, we know at least the book (Grey, 1995) that explained simple modeling for PM and had existed for more than a decade before the 5th PMBOK edition.

A good thing in the framework is lessons learned process, which aims at identifying things that fail and that should be improved in future projects. In spite of its retrospectives, this simple concept is very important in practice of RM, but the framework does not introduce it comprehensively.

4.4. Standards ISO 31000 and ISO 27000
Both standards are close in their terms. Standard ISO 31000 (ISO, 2009a) aims at managing any type of risk, and, for any decision-making activity. It is very abstract. ISO 27005 (ISO, 2011) targets on IS risks in the context of the organization's business risks. An essential idea through the standards is relation of risk to DM.

ISO 31000 standard defines principles for effective RM including extensive discussion of the human aspect, such as corporate culture. Recommendation is given to use quantitative methods whenever possible (ISO, 2009a). Both standards presume use of modeling techniques. At the same time, plenty of different methods are only shortly explained in the ISO book of risk assessment techniques (ISO, 2009b).

IS risk definition is defined with negative meaning, but introduces another ambiguous term "potential". These definition misses the decision-maker's involvement. According to ISO 27000 standard, a company should work out specific RM approach, then specific risk assessment methodology, and, in particular, assess the business impact. It is also suggested that analytical models and simulations should give meaningful results (ISO, 2011), and it is the only framework that mentions *refinement* of risk likelihood as a way of risk control.

These standards are the only frameworks (among all studied) that define terms "measure" and "measurement". It is important to admit that ISO 27005 warns: "Users of these methods should be aware that it might be invalid to perform further mathematical operations using the numbers that are qualitative results produced by qualitative risk assessment methods" (ISO, 2011). And in spite of that, several vague examples full of qualitative estimations follow. Unfortunately, in spite of some positive concepts, these standards repeat all ineffective approaches with subjective ordinal scores that we have seen above.

4.5. NIST
The framework defines risk principles and IS RM process for organizations and managers at all levels in the USA. The link between business and IT risk is clearly declared: "IS risk is associated with the operation and use of information systems that support the missions and business functions of their organizations" (NIST, 2012). It seems that risk basics are better developed in NIST than in other considered frameworks.

Although IT risk is mostly considered as technical and technological operational risk, its strategic influence is well defined in the text of the framework. Risk has only adverse meaning in the framework, and as in ITIL, risk is imminent for intangible information assets. An explanation of multiple risk interaction between different levels of an organization is provided. A generic risk model is given where risk to organizational operations or assets, individuals, and the Nation is a combination of impact and likelihood caused by interaction of threat sources, events, vulnerabilities, and actual conditions (including risk controls). However, subjective aspect of risk is missing.

There is a large effort to explain and illustrate importance to conceive IT and organizational complexity, and classification of threats and vulnerabilities in the framework. Uncertainty is well explained in relation to risk evaluation, but not as an inherent origin of risk. The framework introduces risk aggregation for a number of lower-level risks into a higher-level risk, and claims that risk is expressed better in the qualitative form or using ranges of values rather than single values. Quantitative analysis is well mentioned as well as difficulties of qualitative and semi-quantitative methods (methods using subjective qualitative range scores or scales akin (1-10)). As regards impact, the following statement is practically important and has no analogous in other frameworks: "In general, the risk level is typically not higher than the impact level, and likelihood can serve to reduce risk below that impact level. However, when addressing organization-wide ... impact as an upper bound on risk may not hold".

The risk management process includes risk assessment, result communication, and maintenance of risk assessment. The process should be applied on three main tiers of an organization and thoroughly communicated between the tiers. Nevertheless, as follows from Appendices D (threat sources), F (vulnerability severity), G (likelihoods), H (impacts), and I (level of risk as a combination of likelihood and impact), risk analysis is presumably should be based on usage of qualitative (semi-quantitative) values, and heat maps without theoretical background of their algebra and advised rules of their aggregation, combination, etc. Risk management process lacks measures of risk control effectiveness, except a single mentioning of "lessons learned" technique.

5. Conclusion

We considered today's IT management frameworks regarding their concepts of risk and methods of RM in the paper. We believe that there is an explicit criterion of effectiveness for any method: It should yield expected results in practical application. COBIT 2019 restates this explicitly: "It should also be measured in a way that shows the impact and contributions of optimizing IT-related business risk on preserving value" (ISACA, 2018a). Unfortunately, there is lack of empirical evidence that the application of "best practices" from the frameworks improves risk assessment, enhances related estimations and risk evaluations, reduce losses, and increases firms' efficiency and profits. However, we show that the frameworks contain so many serious problems that one needs a lot of consideration in order to effectively use RM methods in these frameworks.

Considering IT risk as a part of business risks, one needs to see IT RM effectiveness in the company's overall performance metrics and financial result. Current IT management frameworks have no means for that. Common metrics for that are still missing and practical validation of existing metrics is required. Feedback control systems for processes in frameworks leave to be better specified using unified concepts and notations from respective branches of science and engineering.

No objective evaluation were discovered about practical effectiveness of frameworks' risk control practices in companies and no tracks of post-analysis of popular frameworks' application were found. It means, that no systematic work is performed to link changes in IT function according to IT management frameworks and subsequently to overall change of business risk of companies.

To sum up, RM should be a proactive activity, not a reactive one: One needs better information about future bad events and their impact, not a "risk process" itself. Clear terminology is the basement: What is the decision, who is the decision-maker and what is risk for him. Next,

proven methods of analysis, probabilistic view and stochastic modeling are required. To manage IT risks efficiently, it is vital to understand systemically all relevant processes, projects and IT systems, maintain this knowledge, and constantly discover new insights from analysis of available data and history of events. Efficient RM is not possible without consideration of people in models and assigning responsibility to them. Meaningful KPI/KRI, reports and documentation in business and IT processes should help employees, but not produce overhead.

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4. Analysis of literature on accessibility of e-government websites with respect to Persons with Disabilities (PWDs)

Saleem Abdurahman
University of Cape Town
abdsal004@myuct.ac.za

Salah Kabanda
University of Cape Town
salah.kabanda@uct.ac.za

Abstract

E-Government is perceived to be a vehicle for transforming how governments deliver public services and interact with each other and with their citizens as well as businesses. It is therefore paramount that e-Government services are accessible and well-designed to allow all those who use the services the ability to use them. Yet, accessibility of e-Government websites continues to remain a challenge to people with disability (PWDs) worldwide and more so in low to middle income countries where the majority of PWDs reside. This descriptive study examines the current literature on the accessibility of e-Government services to PWDs using a literature synthesis approach. Four themes on the accessibility of E-Government literature are identified through the analysis: successful factors for adopting e-government, designing for accessibility, assistive technologies, and the evaluation of the accessibility and usability of websites. These findings can guide future work and practitioners in the provision of online services for PWDs.

Keywords: E-Government, Accessibility, Assistive Technology, Universal Design, Person with Disability (PWDs)

1. Introduction

Investment and growth within the information communication and technology (ICT) sector in South Africa is increasing and technology plays an important role in improving the standards of living of its citizens (Naidoo, 2012). ICT is now being used in government, in what is termed as e-Government, as a catalyst in enabling government to offer more efficient ways of delivering information and making services accessible to both citizens as well as to businesses, and the process transparent (Kariuki et al., 2019).The ability to access e-Government services 'promotes democracy through inclusive participation' and this is ultimately what e-Government is trying to achieve (Agangiba et al., 2018, p2). Despite these benefits, e-Government has the potential to exclude persons with disability (PWDs) – these are the 15% of the world's population that lives with a physical, sensory, intellectual, or mental health impairment significant enough to affect their daily activities (Groce, 2018). These forms of disability make it difficult to participate fully in consuming e-Government services. PWDs usually receive limited support from the community, and consequently live "without equal access to health care and rehabilitation, education, and employment, and marginalised or excluded from the socioeconomic, religious, and political lives of their communities (Groce 2018, e724). This is concerning especially for lower to middle income countries that have higher populations of PWD's than developed economies (Flaxman et al., 2017); and have a low level of digital literacy required to navigate and use technological systems, such as e-Government systems. Adding to these challenges is the lack of clarity on the web content accessibility guidelines which fail to guide developers during implementation and the cost associated with meeting these guidelines (İşeri et al., 2017). Although several studies have documented how inaccessible online government services are to PWDs and how this alienates them from enjoying the e-Government benefits; there remains limited studies exploring how best to address the challenges PWDs face; specifically, the barriers within the context of lower to middle income countries where the majority of PWDs reside. Part of the problem is that

there remains limited studies done in low to middle income countries on this phenomenon; and when done, these studies take place in silos, thereby making it difficult to see the big picture. This study seeks to contribute towards addressing this challenge because "people with disabilities have routinely been overlooked by global health and international development efforts" Groce (2018, e724), despite the "strong correlation between digital exclusion and social exclusion" (Othman et al 2020, p2567). Specifically, this study provides a descriptive analysis of the literature on accessibility of e-Government websites with respect to PWDs.

2. Related work

2.1 Related work on e-government

E-Government can be conceptualized as the usage of information and communication technologies (ICT) to provide services, improve efficiencies, and improve the operations of government (Vidmar et al.,2019; Twizeyimana & Andrersson,2019). It is widely cited that e-Government emphasizes technology and how it can be harnessed to address issues relating to access to information as well as interaction between citizens, businesses, and government (Agangiba et al. 2018; Choi & Chandler, 2020; Harder and Begnum, 2016). Several benefits have been associated with e-Government, and yet e-Government, although developed with good intentions, can also act as a tool of exclusion for PWDs when not implemented with their needs in mind.

Although Web Content Accessibility Guidelines (WCAG 2.0) have been proposed to ensure that all online resources/services are accessible to PWDs; several researchers have noted that most remain inaccessible. For example, Salvio (2020) found at least 77% of the 12 e-Government websites in the Philippines were not accessible. In India, Paul and Das (2020) examined 65 Indian e-Government websites for their accessibility and usability. Their findings of the accessibility tests highlight the existence of accessibility issues and the usability tests also showed that e-Government websites give low priority to such aspects during website design and development. Similar findings are reported in Sub Saharan Africa (SSA) where most government websites remain inaccessible (Verkijika and De Wet 2017). Specific instances are noted, like Uganda which show that all the websites not do not satisfy the level AA accessibility guidelines (Nakatumba-Nabende et al, 2019); Ethiopia where the current status of e-Government websites are seen to violate most of usability heuristics rules (Zeleke, 2020); and Libya whose government websites had significant number of usability problems ranging from visibility of system status, user control and freedom, and the ability to recover from errors (Karaim and Inal 2019). According to Verkijika and De Wet (2017), factors influencing e-Government accessibility in SSA, include the Human Development Index (HDI), Corruption Perception Index (CPI), and percentage of the active population (15-64 years). They show that countries with high HDI levels and low CPI levels tend to have websites with fewer accessibility errors, while those for countries with high percentage of the active population have more accessibility errors.

2.2 Related work on Accessibility

The Web content accessibility guidelines (WCAG 2.1) define web accessibility to include tools as well as technology that are developed and designed so that people with disabilities can understand, interact as well as navigate and contribute with the website. WCAG 2.1 caters for all disabilities accessing the web including physical, cognitive, auditory, speech as well as neurology. Although the web accessibility guidelines are well established studies have shown the lack of compliance to these guidelines specifically relating to e-Government websites (Boussarhan and Daoudi 2014; Fuglerud & Sloan 2013). For e-Government websites to be

accessible they need to adhere to these guidelines to ensure equal access for all citizens. In addition to providing information and e-services that cannot be granted privately, government websites need to ensure compatibility with tools and technologies which may be required by persons with disabilities (Kamoun & Almourad, 2014). Kamoun and Almourad (2014) highlights reasons for placing emphasis on accessibility for e-Government services: Firstly, there are a significant number of citizens with disabilities, citizens globally with some forms of disability are thought to be the world's greatest minority, and according to the world health organization 80% of those are living in developing countries (Bundoc et al., 2019). Secondly e-Government services have allowed citizens previously unable to access certain information to do so from the comfort of their own homes. Thirdly, the government needs to ensure that they provide equal access of services and information to all citizens and not to discriminate against a minority due to their disability as this is considered a human right. The WCAG guidelines on accessing e-Government websites remain the most respected standard for designing, developing, and assessing websites as mentioned by most research.

3. Methodology

This paper is descriptive in nature and followed a literature review synthesis approach. Research articles on the phenomenon of e-Government and accessibility were collected via desktop search published between 2010 and 2020. Specifically, keywords used were e-Government and accessibilities, e-Government and person with disabilities. These keywords are consistent with the goal of the study. The search on Google scholar using the keywords produced 9028 articles. This comprised of 8872 articles on e-Government and person with disability and 156 articles on e-Government and accessibilities. Given the high return value, these papers were firstly looked at and analyzed based on the title and in some cases the abstract. Papers that did not focus on PWD and or focused on another phenomenon other than e-Government were removed. For example, papers such as Ruijer et al. (2020) or Moon (2020) that focused solely on open government and services without consideration of e-Government services and PWDs were removed. This exercise significantly narrowed down the number of articles to 42. These remaining articles were then examined as follows: first, each article was read by the primary reviewer who wrote a synopsis on the article. The rationale of the synopsis was to provide a summary of the article as well as the points surrounding it validity to this study. The analysis of the articles began by reading each one to understand the relevance to the study as well as the objective the article aimed to achieve. Articles which included e-Government accessibility as well as e-Government focusing on persons with disabilities were then included for the next phase of analysis.

Once all the articles that met the criteria were read, summarized sections of the text that were perceived to be relevant were highlighted and assigned to a theme which described the concept. The text was then collated and condensed into the main points. Patterns were identified and for example the economic, organisational, technological, and socio-cultural barriers to e-Government were highlighted by multiple authors as points for consideration for e-Government services to be more accessible. These were then grouped as success factors for e-Government. The aim of this was to create potential themes to create a useful collation of the data for the purpose of this research. The themes were then reviewed to ascertain whether these themes represented the articles analyzed as well as to ensure no potential important themes were missed. The naming of the themes was intended to create an understandable succinct name for each theme. For example, designing for accessibility as a major theme is simple and broad, but the theme encompasses the sub themes such as universal and inclusive design, design intention, design team demographics and co-operation of e-Government actors and reflective practices.

Theme	Subthemes
Success factors for adopting e-e-Government	Economic
	Organizational
	Technological
	Socio-cultural and End user
	Industry support
Designing for accessibility	Universal design principles
	Co-operation of E-government actors
	Design team demographics
	Design intentions
	Practitioners' reflective practices
Assistive technologies	Cost
	Availability
	Usage
	Accessibility automated tools
Evaluation of the accessibility and usability of website	Web content accessibility law and guidelines
	Periodically monitor sites for accessibility

Table 1: Emergent themes

4. Findings and discussion

Four emergent themes as shown in Table 1, were identified during the analysis of the literature: successful factors for adopting e-government; designing for accessibility, assistive technologies, and the evaluation of the accessibility and usability of website. These are discussed below.

4.1 Success factors for adopting e-government

Most studies focused on identifying successful factors or barriers to e-Government adoption (see Table 2). Five factors were identified as key to successful adoption of e-Government. These factors are economic, technological, organizational, socio-cultural and end-user, as well as policy and strategy. Several studies have noted the need for readily available resources for the implementation of an accessible e-Government system (Zhenbin et al., 2019). Yet, many e-Government systems lack adequate resources. For example, although access to information technology experts as well as knowledge workers involved in the designing and implementation of e-Government services is important; this remains as one of the consistent organizational challenge most public institutions face (Kurt 2018). Another consistent organizational challenge is financial resource, mismanagement and inadequate financial and human resources contribute towards poor service delivery of government services (Antwerpen & Ferreira 2016). In South Africa, implementation of e-Government faces challenges due to the decentralization of e-Government funding (RSA Government gazette, 2017). Access to financial resources is seen to be limited for public actors (Wynen et al., 2014) and there is a perception that designing for accessibility is cost intensive and therefore not given a priority during design and implementation (Rossvoll & Fuglerud, 2013).

Success factor dimension (number of papers)	Examples of papers addressing the dimension
Economic (11)	(Agangiba et al., 2018; Almarabeh and Abu Ali, 2010; Ashaye & Irani, 2019; Choi et al., 2016; Flaxman et al., 2017; Glyptis et al., 2020; Kariuki et al., 2019)
Organisational (11)	(Almarabeh and Abu Ali, 2010; Ashaye and Irani, 2019; Choi et al., 2016; Choi and Chandler, 2020; Glyptis et al., 2020; Naidoo, 2012
Technological(10)	(Ashaye and Irani, 2019; Choi et al., 2016; Choi & Chandler, 2020; Fogli and Provenza,2012; Glyptis et al., 2020; Harder and Begnum, 2016; Kariuki et al., 2019)
Socio-cultural and end user (14)	(Agangiba et al., 2018; Almarabeh and Abu Ali, 2010; Choi & Chandler, 2020; Dawar et al., 2017; Glyptis et al., 2020; Groce, 2018; Johnson et al., 2017)
Policy and strategy (14)	(Agangiba et al., 2018; Almarabeh and Abu Ali, 2010; Choi & Chandler, 2020; Dawar et al., 2017; Glyptis et al., 2020; Groce, 2018; Johnson et al, 2017)
Industry support (6)	(Agangiba et al., 2018; Choi et al., 2016; Choi & Chandler, 2020; Naidoo, 2012)

Table 2: Success factors for adopting e-Government

4.2 Designing for accessibility
4.2.1 Universal and inclusive design
Buchdid et al (2015) asserted that for ICT products to be accessible and usable to all, researchers need to identify the barriers in the design of information systems. Several researchers now advocate for universal design (UD) and inclusive design (ID) as potential means of addressing accessibility challenges during design. This is based on the premise that UD begins with considering all users, to develop products that are accessible to and usable by all people regardless of their abilities (Liu et al 2015); and ID focuses on providing the 'full range of human diversity' and intends to provide access to as many citizens as possible (Dosis, 2014, p8). Seen in this manner, UD and ID presents an approach for exploring the barriers in the design of e-Government systems, with the intent of understanding how these services can be made accessible and usable to PWDs.

Universal Design is guided by some key principles of equitability, flexibility, ease of use, access, and tolerance of error. With these principles, it is envisaged that designers and developers as practitioners would be well guided in developing inclusive solutions for consumers regardless of any impairment. For example, with equitability, UD seeks to avoid disadvantaging and stigmatizing users and ensuring that one provides the same means of use, privacy, security, and safety for all users (Skuse 2020). The design should accommodate a wide range of individual preferences and abilities; and also make it easier to understand and use. These principles are echoed by Dosis (2014) who calls designers to meet two additional requirements when creating online solutions that meet the wide range of human diversity: sociability and hospitality. According to Dosis (2014) inclusive design begins when designers understand that online users are social beings who engage in social actions. As social beings, engaged in online activities, designers should develop online solutions that give users a social space of belonging, instead of a space that makes it difficult for them to participate and feel included. User experience becomes optimal when applications are designed with sociability and with people-oriented focus (Dawar et al (2017). People-oriented focus speaks to the aspect of hospitality that requires designers to "consider what the needs and desired outcomes of the users are and mirror those in the design" (Dosis 2014, 19).

4.2.2 Co-operation of E-government actors
E-Government systems are very complex and require participation of several agents to arrive at a successfully implemented accessible system. Rowley (2011) proposed a typology of e-Government stakeholder agents which compromises of, among others: e-Government project managers, technology practitioners (software designers, developers and human–computer interaction specialists (Fogli & Provenza, 2012); the people as service users and as citizens; businesses and trading partners; public administrators (employees) and other government agencies, non-profit organizations. Close co-ordination and collaboration between these agents are important for having a successful e-Government implementation project (Choi et al., 2016) because user's voices become incorporated and taken on board.

However, Al-Rawahna et al. (2019) notes that this collaboration is very minimal during the initial design and implementation process of an e-Government project and could be the source for projects not meeting their intended goals and objectives. Gunawong and Gao (2017, p168) sees the key challenge in e-Government system implementation as the lack of top management as "focal actors to support the other actors in the network in their efforts both to play their roles properly". Harder and Begnum (2016) calls for top level management to collaborate with all stakeholders, specifically the design team and the PWD interest groups to ensure focus is on developing systems that are accessible to all users. Agbozo (2019) also calls for e-Government

authorities to create the necessary environment for the private sector to support government in achieving a formidable e-Government system. Ashaye and Irani (2019, p253) have "recommended that public organisations would need to strategise their relationships with stakeholders in order to achieve a collective interest for successful e-Government implementation". The number of people involved in decision-making could potentially lead to the achievement of a successful implementation of an accessible e-Government and ultimately achieve the sustainable development goals (Othman et al 2020).

4.2.3 Design team demographics

Part of developing systems which have successful inclusive design (ID) requires having the ability to be sensitive to different user capabilities and needs (Lim, 2010). To reduce the exclusion nature of e-Government service, it becomes important for designers and developers to be able to understand user's limitations in interacting with technology. Olbrich et al. (2015) pointed out that it is important to note the demographics of the design team as this may have an influence on the usability and accessibility of products and services created. A diverse group of people will generally have more members who are sensitive to at least some design accessibility issues. As stated by Olbrich et al. (2015) there is a likelihood that there will be an improvement in providing inclusivity in design if a wider array of design team members are working together. For example, it is reported that from a gender perspective, men and women assess web-based interfaces differently (Watling, 2011). Keeping gender in mind when designing a user interface is important, as the outcome of the solution may affect the user's ability in engaging on the online platform (Reinecke and Gajos, 2014).

Designers of web interfaces can create an engagement between the interface and users. Far too often the design decisions taken have negatively impacted on PWD in their use of web and mobile interfaces (Watling, 2011). Biased design of interfaces negatively affects users of lower socio-economic backgrounds (Johnson et al, 2017). To avoid exclusion therefore, when designing for accessibility, diversity must be assumed to be the norm (Rieber & Estes, 2017) because without diversity there may be 'knowledge redundancy' within the team (Mahr et al., 2014). Knowledge and information diversity amongst information systems project team members can contribute towards to the success of the project (Liang et al., 2012).

4.2.4 Design intentions

Design intent "is the reflection of the design idea in designers' brain. …is the reflection of product function in design process, and designers can express design intent by expressing target function" (Wang et al 2016,p1758). It is important that design intentions of the team are communicated throughout the team to ensure a shared vision. Without this shared vision, there could be a "fragmented understanding of the different elements of the design requirements and how they are connected", across the design team (Laursen and Mriller 2016,p3). Given the multifaceted nature of the design intentions Otey et al (2018), and the need for inclusivity, it is important that the design team includes the voice of PWDs who will champion accessibility and inclusivity issues.

4.2.5 Practitioners' reflective practices

Scholars such as Samuels (2018) have indicated the need for practitioners to be reflective of their work for them to be aware of their potential biases and inequitable practices. Highlighted benefits of reflection include "better education, improved design processes, and increased self-knowledge" (Baumer et al 2014,p99). These benefits of reflective practices are significant when designing for inclusion lest practitioners adopt certain values and norms unconsciously that could lead to PWD barriers (Stumpf et al 2020). Thus, simply following universal design

principles is inadequate without reflective practices. Yet, most scholars agree that reflection is a challenge because reflective practices are usually seen as "uncomfortable… as it may reveal characteristics" practitioners do not want to see (Samuels 2018,p26). Further, there have been few studies exploring what reflection should be about in systems design; and this has created some sense of vagueness to what reflection involves (Baumer et al 2014). To ensure the focus remains on inclusive design, practitioners need to establish a working definition of reflection in the context of systems design, development, and testing; and most importantly, actively involve PWDs participants in the entire process of design, development and testing to evaluate barriers.

4.3 Assistive technologies

The Third theme pointed to the need for readily available, cost effective assistive technologies that are easy to use and compatible to the activities PWDs engage in. Assistive technologies such as screen readers that read web pages aloud for the blind, screen magnifiers for people with low vision, and selection switches for people who cannot use a keyboard or mouse (Moreno et al., 2018), should be accessible to PWD as a support mechanism when performing tasks. The challenge as Agangiba et al (2018) points, is the cost associated with acquiring assistive technologies. Most PWDs in developing countries see the cost to be high and this hinders them to utilize online services. The findings of Rohwerder (2018,p2) show that the 'assistive technology industry is limited and mostly serves the requirements of high-income settings…. and the small scale local assistive technology producers and providers in low-income countries cannot meet the needs of all those who need assistive devices.

Assistive technology services are also often in short supply and available, PWDs may require third party assistance when navigating and using technological systems; such as e-Government systems and in some cases, use these assistive technologies (Almarabeh and Abu Ali, 2010) that tend to be developed not within the context of lower to middle income country users. Adding to these challenges is the lack of clarity on the web content accessibility guidelines which fail to guide developers during implementation and the cost associated with meeting these guidelines (İşeri et al. 2017). Along with affordability there are several researchers who have raised the lack of awareness of the different types of assistive technologies available and the benefits thereof as a barrier to accessibility (Dollie et al. 2017, Agangiba et al. 2017, Borg and Östergren 2015, Oliveira et al., 2017, Rohwerder, 2018). Another aspect surrounding accessibility was a lack of training and intervention from government surrounding the usage of e-Government (Agangiba et al, 2018). Whilst some e-Government websites might integrate assistive technologies during design, the challenge remains, that most websites are not adapted to or compatible with the assistive technologies used by PWDs (Boussarhan and Daoudi 2014). To combat this challenge, periodic expert and end user testing is recommended to allow for assessment for compatibility with a wide range of assistive technologies and verify programming flaws in the interface that can cause confusion to assistive technology users.

4.4 Evaluation of the accessibility and usability of website

The final theme was on the evaluation of the accessibility and usability websites. The findings show that both usability as well as accessibility is a quality assurance regarding development of information systems (Quintal & Macías, 2018). However, the quality regarding user-centered processes is less emphasized than that of the quality of the usability and accessibility of the product itself (Lacerda & von Wangenheim, 2018). According to Quintal & Macías (2018) there is a lack of proposals which focus on identifying way to improve usability as well as accessibility, as this may lead to reduced errors, and implementation time. Some organizations have adopted the accessibility maturity model (AMM) which serves as a tool to

guide the planning accessibility in the workplace. However, this approach to assess accessibility uses online automatic tools such as Achecker,Taw, Wave, SortSite; but does not have the sufficient methods and techniques in place to execute an assessment that relates to both usability and accessibility (Lacerda & von Wangenheim, 2018; Quintal & Macías, 2018). Other tools and resources available for ensuring accessibility include the developed web content accessibility guidelines (WCAG). However, several studies have noted that these guidelines lack clarity and they only accommodate for the remediation of around thirty-five to fifty percent of PWD accessibility issues (Power et al, 2012; Romen & Svanæs, 2011). Focusing purely on the WCAG 2.0 compliance guidelines can cause developed solutions that are not holistically accessible and may lead to missed opportunities to include certain PWD (Fuglerud & Sloan 2013). To address this missed opportunity, one solution is to have periodic monitoring of e-Government websites for accessibility.

5. Conclusion

The purpose of this study was to document the current literature on accessibility of e-government website with respect to PWDs. The study followed a descriptive literature synthesis on the phenomenon. From the analysis, four themes were identified. Firstly, a significant number of studies focused on identifying the successful factors influencing e-Government adoption. These studies paid attention to user's access to e-Government services from the following front: economic, organizational, technological, socio-cultural and end user, policy and strategy, and industry support. Whilst these studies present the foundational basis of what to consider when implementing e-Government services; these studies fail to engage and consider PWDs specific needs of accessibility. Studies in the second theme, sought to address this gap by putting the focus on the design process. It is envisaged that when all stakeholders are engaged during the design and work collaboratively in the design and implementation process, whilst being reflective of their practices to identify their biases in their design; the product would be accessible and meet PWDs needs. The third strand of research had a focus on the readily availability of cost-effective assistive technologies that are easy to use and compatible to the activities PWDs engage in. The final theme was on research that focuses on developing evaluation tools for evaluating websites to assess their accessibility and usability for PWDs. Although these studies help practitioners identify accessibility issues in several websites, the evaluation in most cases, tend to be after the fact, with most not involving end users' (PWDs) in the evaluation process. These findings show that the design and implementation of accessible e-Government websites are done in a fragmented manner with limited co-operation amongst researchers and the numerous stakeholders involved. By tackling issues around the design of e-government systems collectively, we can contribute towards a better understanding of how these systems can be better designed and implemented for inclusivity purposes.

The study has a limitation on the sampling. Keywords that were used for data collection can be expanded on beyond the keywords e-Government and accessibilities, e-Government and person with disabilities, which might not reveal all papers related to people with disabilities. Further, focusing on a specific disability because each disability has its own specificity, and should be studied individually.

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5. Avaliação do Impacto das Fintechs no Índice de Inclusão Financeira Brasileira

Elisa Lais Alves da Silva
University of Sao Paulo
elisa.lais@usp.br

Daielly Melina Nassif Mantovani
University of Sao Paulo
daielly@usp.br

Abstract

Brazilian financial system has banking concentration and high costs, however, the fintechs provided accessible financial products and services to the population. This paper aims to evaluate the impact of the fintechs on the financial inclusion of the Brazilian population. We collected data from governmental and non-governmental sources about fintechs and other financial institutions in Brazil between 2014-2017 to compose the financial inclusion index proposed by the Central Bank. We applied a regression tree model to identify variables that could explain the index. The descriptive analysis pointed out that some fintech variables have a moderate correlation with the index. Also, most of the variables related to the traditional financial system presented a high correlation with the index, which can indicate that today the traditional model predominates as the first option to enter the financial system to a great number of Brazilians. The decision tree selected seven variables with high explanatory potential, two of them were related to fintechs. There was a clear division in the decision tree, the left side represented the North, Northeast, Central-West, and the right represented the South and Southeast regions. Fintechs variables selected were on the right of the tree, indicating their prevalence in South and Southeast.

Keywords: Financial Inclusion Index. Fintechs. InformationTechnology. National Financial System. Banking Sector.

1. Introdução

As novas tecnologias têm impactado de forma impressionante em como nos relacionamos e os serviços que utilizamos diariamente. O sistema financeiro foi um dos setores impactados por estas transformações e vislumbra um novo momento de revolução com a introdução de novas tecnologias, como: mobile-banking, contas digitais e contas de pagamento. Nos últimos anos, o Brasil tem vivenciado uma ruptura no seu sistema tradicional, com a ascensão de novas tecnologias que estão contribuindo para que um maior número de adultos tenha acesso aos serviços financeiros (PwC, 2018). De acordo com o Relatório de Cidadania Financeira (2018), realizado pelo Banco Central, o Brasil tem um nível estável de pessoas com relacionamento bancário de 2015 a 2017. Neste último ano da amostra eram 140 milhões (86.5%) de brasileiros "bancarizados", ou seja, que mantinham contas para depósito, poupança ou investimento. O cenário do sistema financeiro brasileiro é caracterizado pela alta concentração bancária, grandes spreads e altas tarifas (PwC Brazil Fintech Deep Dive, 2018). Este conjunto de características põe sem acesso a serviços financeiros uma grande parte da população, cerca de 45 milhões de brasileiros, de acordo com a pesquisa do Instituto Locomotiva, realizada em 2019. Esta conjuntura cria oportunidades para novas empresas atuarem no mercado, com o objetivo de atender a esta nova demanda.

Diante desse novo cenário, empresas denominadas fintechs estão aplicando a tecnologia como forma de criar serviços e produtos mais inovadores no mercado financeiro. De acordo com a PwC (2018,p.8), fintechs são "um segmento de companhias que está na intersecção entre a

tecnologia e os serviços financeiros, que adotam um modelo de negócio escalável com o objetivo de alcançar as necessidades de consumidores através da inovação em produtos e serviços". Para Dapp (2015), um ponto de diferenciação entre fintechs e os bancos tradicionais está no domínio de novas tecnologias, como algoritmos de análise de dados e tecnologias web. Neste sentido, as fintechs estão na vanguarda deste novo movimento de construção de um ecossistema digital. Os novos tipos de produtos e serviços oferecidos pelas fintechs possuem, no geral, um custo menor do que o oferecido pelos bancos tradicionais, e acesso facilitado aos serviços, já que muitas fintechs permitem cadastramento e operações completamente digitais sem envio de nenhum documento físico ou visita a uma agência física. Por esta razão, estas empresas têm alcançado o público que antes não conseguia ter acesso a uma conta bancária em bancos de grande porte.

Nos últimos anos, a abertura de contas digitais tem crescido no Brasil e muitas pessoas estão optando por esta nova modalidade de conta pela maior acessibilidade e menores custos. Esta nova modalidade está substituindo contas correntes e contas poupanças presentes no mercado e a população antes "desbancarizada" conseguiu inserir-se no sistema financeiro através dessas soluções inovadoras. Desta forma, o objetivo da pesquisa é avaliar se as fintechs possuem efeito positivo ou negativo no nível de inclusão financeira dos brasileiros, a partir do Índice de Inclusão Financeira (IIF), proposto pelo Banco Central. Pretende-se como contribuição da pesquisa elucidar o impacto das fintechs na inclusão financeira no Brasil, de forma a se trazer insights que podem ajudar fintechs e instituições bancárias a redefinirem seu posicionamento e produtos e serviços.

2. Referencial teórico

2.1 Uso de tecnologia no setor bancário brasileiro

De acordo com Levy (1983), o setor bancário iniciou seu processo de digitalização no Brasil na década de 60. Este processo, primeiramente, foi desencadeado pela expansão da atividade bancária em território nacional, a partir deste momento, muitos problemas de ordem administrativa surgiram, como, inconsistências nos dados e alto volume de documentações e papéis em geral nas agências. Estes impasses poderiam, em longo prazo, prejudicar as atividades bancárias. Neste sentido, houve a necessidade de automatizar algumas atividades relacionadas ao back-office do sistema, garantindo uma melhor eficiência e coerência ao longo dos anos. Assim, muitos dados processados diariamente passaram a ser destinados a centrais de informação que armazenavam e protegiam essas informações para o dia seguinte.

A década de 80 foi responsável pela automação de atividades relacionadas ao atendimento do público. O objetivo era aumentar a eficiência dos serviços prestados, diminuir custos operacionais e ganhar competitividade. Os caixas automáticos, ou ainda, ATMs (Automed Teller Machines) representaram um grande avanço na forma de atendimento, porque a partir dessas máquinas era possível realizar uma grande variedade de operações sem a necessidade de um atendimento presencial. Também neste período, foi criada a primeira iniciativa de home banking no Brasil, este novo serviço permitiu que os clientes pudessem ter acesso a suas contas bancárias e fazer movimentações a partir de um computador de sua casa que estava diretamente conectado com o sistema central do banco (Levy, 1983).

Na década de 90, o processo de automação bancária iniciou-se com a criação do Plano Real em 1994 - o que permitiu maior estabilidade do sistema financeiro e controle da inflação - além disso, programas como PROER (Programa de Reestruturação e Fortalecimento do Sistema Financeiro) e PROES (Programa de Estímulo do Setor Público no Sistema Financeiro), foram

responsáveis por concentrar o sistema modificando sua estrutura. Entre os anos de 1999 e 2001 observa-se um aumento de investimentos em hardware e software pelos bancos, fato que acarretou em um crescimento proeminente de canais automatizados para atendimento de clientes. Este processo de investimento tecnológico se fez necessário por conta da crescente competição no setor e normas mais rigorosas (Teixeira, 2005).

No século XXI os canais digitais estão em expansão promovendo maior rapidez e qualidade nos serviços prestados, seguindo, dessa forma, a mudança de perfil de seus clientes, que estão mais conectados nas redes sociais e prezam pela qualidade do serviço. As transações bancárias feitas por meio do mobile banking apresentam crescimento acelerado desde 2014, para a Febraran (2019) "seis em cada dez transações bancárias já são realizadas pelo cliente pelo celular ou pelo computador". O número de contas bancárias abertas pelos meios digitais também sinaliza este novo cenário. Segundo a Pesquisa de Tecnologia Bancária da Febraban 2019, as contas de mobile banking (70 milhões) ultrapassaram o número de contas de internet banking (53 milhões) em 2018. Para a fundação, a facilidade no uso de novas tecnologias foi responsável por aumentar a adesão dos clientes nestes novos meios digitais. Para Viana (2018), novos produtos e serviços que entraram no mercado, a partir dos denominados bancos digitais e startups, estão modificando a maneira como os usuários entram em contato com o sistema financeiro e realizam operações financeiras.

2.2 Fintechs

O setor bancário está sob constante pressão para se reinventar por conta da entrada de novos competidores que oferecem serviços financeiros similares, mas não são considerados bancos como as fintechs (Dapp, 2015). Para tanto, o sistema financeiro torna-se mais digital e modifica sua interação com os clientes. Compreendem-se por fintechs empresas que utilizam tecnologia aplicada ao setor financeiro. Estes novos negócios começaram a surgir após a crise econômica de 2008 e, atualmente, eles atuam em conjunto com bancos tradicionais oferecendo produtos e serviços financeiros (Cortina & Schmukler, 2018). Uma melhor definição para o termo é apresentada por Dhar e Stein (2016, p. 2),

Financial sector innovations involving technology-enabled business models that can facilitate disintermediation, revolutionize how existing firms create and deliver products and services, address privacy, regulatory and law-enforcement challenges, provide new gateways for entrepreneurship, and seed opportunities for inclusive growth.

Segundo Dapp (2015), uma das vantagens que as fintechs apresentam é o domínio de novas tecnologias, em contrapartida, os bancos tradicionais vieram de um sistema analógico e iniciaram seu processo de digitalização de forma mais lenta. Neste sentido, as fintechs teriam maiores vantagens no estabelecimento de um sistema digital pois se posicionam na vanguarda das novas tecnologias.

No território nacional, a grande massa de empresas neste segmento está localizada na região Sul e Sudeste, além disso, três quartos das empresas que participaram do estudo possuem menos de quatro anos de existência. A maioria das fintechs brasileiras surgiram depois de 2016 e se concentram em atividades, como: meios de pagamentos e concessão de crédito. Com seu modelo digital e acesso simplificado, aliado ao baixo custo de operação, essas empresas estão numa posição vantajosa para promover a inclusão de grande massa de pessoas que vive à margem do sistema financeiro ou que está insatisfeita com as instituições tradicionais (PwC, 2018).

2.3 Relação entre fintechs, bancarização e inclusão financeira

De acordo com o relatório do Banco Mundial Global Findex 2017 aproximadamente 30% da população brasileira com mais de 15 anos não possui acesso a uma conta bancária. Dentre as barreiras mais comuns para não ter uma conta bancária estão: falta de dinheiro, não precisar de uma conta e o alto valor das contas bancárias. No Brasil, aproximadamente 60% dos adultos desbancarizados possuem acesso a aparelhos celulares e a internet (Global Findex, 2017). O Bacen aponta que a utilização de iniciativas digitais no segmento financeiro é uma alternativa que pode ser adotada como forma de tornar o acesso aos serviços financeiros mais democrático a essa parcela da população (RCF, 2018).

Ainda de acordo com o Banco Central do Brasil, é importante destacar que a bancarização é uma variável crítica para a avaliação da inclusão financeira. Contudo, a inclusão financeira da população representa muito mais do que somente a posse de uma conta bancária, é importante avaliar também outras necessidades deste público como o acesso ao crédito, investimentos e dentre outras variáveis. Dentro da metodologia adotada pelo Banco Central, a bancarização é parte integrante da inclusão financeira, que unida a outros conceitos origina a cidadania financeira de todo brasileiro (RCF, 2018). De acordo com Furche et al. (2017), é comum que nos países em desenvolvimento o mercado financeiro seja, na maioria das vezes "fragmentado, instável e custoso". Para os autores as fintechs conseguem trazer grandes benefícios para que o mercado seja mais estável. Nestes países elas podem contribuir, por exemplo, garantindo o acesso universal aos serviços financeiros. Contudo, é possível que o foco de outras fintechs que estão no mercado não seja essencialmente a bancarização. Como evidenciado na pesquisa de Bueno (2019), na qual todos os clientes pesquisados já possuíam contas em bancos tradicionais antes de serem clientes de fintechs. Apesar de seu impacto incerto na bancarização, as fintechs estão de fato transformando o mercado financeiro, como é apontado por (Brêtas, 2019; Katori, 2017; Maino, 2016).

3. Método

Um dos desafios apontados no Relatório de Cidadania Financeira (2018) é elaborar um índice de inclusão que de fato possa refletir a situação atual do país e de suas regiões administrativas. Neste sentido, entende-se que as fintechs representam um novo momento no sistema financeiro brasileiro que, provavelmente, possa ter implicações na forma como a população se relaciona com essas instituições, desta forma, resultando em efeitos em sua inclusão financeira. Portanto, parte-se do objetivo de compreender o impacto das fintechs no Índice de Inclusão Financeira (IIF), que mede o nível de acesso e uso dos brasileiros aos serviços bancários.

O Relatório de Inclusão Financeira (RIF, 2011) propõe as dimensões que compõe o IIF, são elas: acesso e uso do sistema financeiro. Além disso, o relatório explora a construção em detalhes do índice, apontando indicadores para as dimensões adotadas. Contudo, não é de domínio público as variáveis que são utilizadas para composição do índice. Neste sentido, será utilizado como base para o presente trabalho o Indicador de Inclusão Financeira para as Regiões Brasileiras (IFRBr) proposto por Timotio, Theóphilo, Gonçalves e Filho (2018) em uma perspectiva também regional. Ademais, o período de análise escolhido compreenderá os anos de 2014-2017 (Regiões Administrativas) e 2014-2019 (Brasil).

O presente estudo contou com o auxílio de bases de dados governamentais e não-governamentais para o cálculo do Índice de Inclusão Financeira (IIF). A seguir, detalha-se o processo de coleta e preparação dos dados que serão utilizados para compor as diferentes dimensões adotadas para o IIF.

I.   Dimensão acesso: os dados utilizados para a composição desta dimensão foram retirados do Sistema Gerenciador de Séries Temporais (SGS) administrado pelo Banco Central do Brasil. Todas séries estão disponíveis no item Inclusão Financeira do SGS e foram extraídas diretamente da ferramenta em formato CSV. Os dados de cada região administrativa foram agrupados de forma a compor uma base de dados única, as variáveis Território Total em Km2 e Total de Pessoas Adultas por região administrativa foram obtidas pela plataforma de estatísticas do Instituto Brasileiro de Geografia e Estatística (IBGE).

II.   Dimensão uso: os dados referentes à dimensão uso foram extraídos de três bases de dados distintas. A variável bancarização foi extraída do Sistema Gerenciador de Séries Temporais (SGS) e está disponível no item Inclusão Financeira, série Relacionamento com o Sistema Financeiro Nacional (SFN). A variável crédito bancário total também foi retirada do SGS e está disponível no item Economia Regional. Para os dados de depósitos bancários totais a base de dados utilizada será a de Estatística Bancária Mensal por Município (ESTBAN), esta base apresenta os saldos de balancetes de bancos comerciais e múltiplos atuantes no Brasil por município. Por fim, as variáveis auxiliares Total de Adultos e Produto Interno Bruto (PIB) foram retiradas a partir da plataforma de estatísticas do Instituto Brasileiro de Geografia e Estatística (IBGE). Assim como aplicado no estudo de Timotio et al. (2018), as variáveis que se apresentam em valores monetários serão deflacionadas utilizando o Índice de Preços ao Consumidor Amplo (IPCA) do ano de 2019, último ano do período escolhido para análise. Após este ajuste inicial, todos os dados mencionados foram agrupados em um único arquivo base.

III.   Fintechs: os dados relacionados à atividade das fintechs foram extraídos do relatório Inside Fintech 2019 (Distrito Dataminer) e The Pulse of Fintech 2019 (KPMG) conforme apresentado no quadro 4. Os dados referentes a investimentos em fintechs foram deflacionados de acordo com o índice de preços ao consumidor americano (CPI, na sigla em inglês) de 2019 obtido por meio da plataforma US Inflation Calculator. Ambas as séries encontradas apresentam um consolidado geral de todo território nacional, neste sentido, houve a necessidade de realizar um dimensionamento dessas variáveis de acordo com as regiões administrativas e país. Para tanto, dado que as operações via smartphones se expandiram nos últimos anos como aponta o RCF (2018) e que o modelo digital de negócio das fintechs apresentam uma grande vantagem para integração de usuários que ainda não foram integrados ao sistema financeiro como aponta PwC (2018), a porcentagem de adultos com posse de telefone celular por região foi escolhida para dimensionar as variáveis utilizadas no modelo, estes dados foram obtidos através do site do Instituto Brasileiro de Geografia e Estatística (IBGE). Após este processo, os dados foram colocados em uma tabela única e, posteriormente, agrupados a base de dados de dimensão de acesso.

A seguir apresenta-se na tabela 1 a descrição em detalhes dos dados da dimensão acesso que serão utilizados no presente estudo. Ressalta-se que as descrições apresentadas tiveram como base o estudo de Timotio et al. (2018) e o RIF (2011).

A seguir, são apresentadas as variáveis selecionadas para dimensão uso. Esta tabela foi composto com base no estudo desenvolvido por Timotio et al. (2018). A variável bancarização será obtida por meio do Sistema Gerador de Séries Temporais do Banco Central. Para as variáveis nível de crédito e depósito serão utilizados os dados presentes no sistema IBGE Cidades.

Variável	Descrição
Sedes	Centro administrativo das instituições financeiras.
Agências	Local pelo qual as instituições financeiras autorizadas pelo Banco Central prestam seus serviços à população em geral.
Postos	São dependências bancárias que podem ser instaladas em entidades da administração pública ou em empresas privadas com o objetivo de prestar serviços financeiros em geral.
Postos eletrônicos	São equipamentos de autoatendimento presentes em instituições bancárias. O conjunto de ATMs forma um Posto de Atendimento Eletrônico (PAE).
Correspondentes	São empresas contratadas pelas instituições financeiras autorizadas pelo BCB para realizar determinado conjunto de serviços em nome dessas instituições.
ATMs (*Autometed Teller Machines*)	São equipamentos eletrônicos de autoatendimento. Por meio de um ATM é possível realizar uma grande variedade de operações, como por exemplo: saques, pagamentos, transferências, consultas, entre outras operações.
POs (*Points of sale*)	São equipamentos eletrônicos menores, utilizado por comércios em geral para processar pagamentos por meio de cartões de crédito, débito e pré-pagos.
SCFI	São as sociedades de crédito, financiamento e investimento. Possuem como objetivo a realização de financiamentos para aquisição de bens, serviços e capital de giro.
Fintechs	São empresas que aplicam tecnologia e inovação ao sistema financeiro.

Tabela 1 - Descrição dos dados utilizados - Timotio et al. (2018) e no RIF (2011).

Variáveis	Equação
Adultos com relacionamento com o sistema bancário (bancarização)	Adultos com algum relacionamento bancário / Total de Adultos
Nível de crédito	Crédito bancário Total / PIB
Nível de depósito	Depósitos bancários / PIB

Tabela 3 - Variáveis determinadas para a dimensão uso - Timotio et al. (2018).

Após a normalização das variáveis, o índice é calculado de acordo com a equação 1, expressão esta que também é aplicada nos estudos de Sarma (2008) e Timotio et al. (2018).

$$IFF = 1 - \frac{\sqrt{(1 - d_1)^2 + (1 - d_2)^2 + \cdots + (1 - d_n)^2}}{\sqrt{n}} \qquad (1)$$

O numerador corresponde à distância euclidiana de di do ponto ideal, normalizada pelo denominador. A subtração de 1 é feita para obter a inversa da distância euclidiana. A normalização é feita para que o valor do IIF esteja entre 0 e 1 e o inverso da distância euclidiana é considerado porque quanto maior o valor de IIF isso corresponderá a uma maior inclusão financeira (Sarma, 2012).

4. Resultados

A análise de dados foi elaborada a partir da base de dados utilizada para a criação do Índice de Inclusão Financeira (IIF). A mesma apresenta um total de 50 colunas e 26 observações. Para o Índice de Inclusão Financeira (IIF) as medidas resumo denotam a diferença entre as regiões administrativas. As regiões Sul e Sudeste apresentam um maior IIF, regiões estas que de acordo

com o Relatório de Cidadania Financeira (Bacen, 2018) lideram também com os maiores níveis de população bancarizada no Brasil. Por outro lado, as regiões Norte, Nordeste e Centro-Oeste destacam-se como regiões com menor IIF, inclusive menor que a média brasileira, regiões estas que também apresentam menor nível de bancarização se comparadas ao Sul e Sudeste (RCF, 2018). Ademais, as amplitudes seguem o mesmo padrão em que para as regiões com maior IIF maior é a amplitude, enquanto que para os menores valores de IIF menor será a amplitude e também não há tendência de crescimento ao longo dos anos em todas as regiões.

Das associações entre as variáveis foram encontradas as seguintes correlações lineares de Pearson. Conforme a tabela de correlações para a dimensão uso e o gráfico de dispersão a bancarização apresenta o maior valor, isso pode ser explicado pelo fato de que a partir do momento que uma população consegue acesso a produtos e serviços financeiros através de bancos tradicionais, por exemplo, ela consegue se inserir no sistema financeiro de imediato e desta forma participar dele ativamente aumentando o Índice de Inclusão Financeira (IIF) na região onde reside. Por outro lado, as variáveis Nível de Crédito e Nível de Depósito apresentam uma correlação moderada com o IIF, indicando que ambas as variáveis atuariam como variáveis secundárias no aumento do IIF no Brasil. Para a dimensão acesso há alta correlação (Média = 0.782 e Desvio-Padrão = 0.146) da maioria das variáveis com o IIF, com destaque para variáveis que estão relacionadas com a prestação de serviços financeiros básicos à população: número de caixas eletrônicos, número de agências e número de correspondentes bancários. Em contrapartida, as variáveis com correlações moderadas ou baixas estão relacionadas a entidades do sistema financeiro mais secundárias: uniões de crédito, postos avançados de serviços financeiros e microempreendedores ou microempresas de crédito.

As variáveis geográficas de número e investimentos em fintechs apresentaram correlação moderada com IIF, o número de fintechs teve especial alta correlação com as regiões Sul e Sudeste o que pode ser explicado pela maior acessibilidade aos serviços de tecnologia oferecidos pelas fintechs nestas regiões, como é apontado pela PwC (2018). É possível observar que o IIF (eixo y) tem relação tanto com o número de fintechs racionalizado pelo número de pessoas com aparelho celular na região administrativa (eixo x) quanto com os investimentos racionalizados da mesma forma (tamanho dos pontos) dado o evidente agrupamento dos pontos. Assim, quanto maior o número de fintechs e os investimentos maior será o IIF.

Com essas associações destacadas foi elaborada uma árvore de decisão (Figura 1) com a estratégia de fazer feature selection, isto é, obter as variáveis com maior potencial explicativo do IIF. A métrica adotada foi o Mean Square Error (MSE) para que os erros maiores fossem priorizados dada a pequena amplitude ao longo dos anos do IIF para cada região administrativa. A variável geográfica Number of electronic service outposts of finance companies (Quantidade de correspondentes de sociedades de crédito, financiamento e investimento) apresenta alta correlação com o IIF e o MSE de 0.031, o que demonstra sua qualidade de separar amostras com índices de inclusão mais distantes, como, por exemplo, a separação de Sul e Sudeste das demais localidades do país.

Um segundo nível foi necessário para realizar uma separação em uma escala menor, como, por exemplo, entre regiões com IIF próximo. A primeira delas: a variável demográfica Number of credit unions correspondents (Quantidade de correspondentes de cooperativas) que divide o subconjunto em dois diferentes grupos com MSE de 0.01. A segunda é Number Fintechs Brazil (Número de Fintechs Brasil) que divide o subconjunto em outros dois diferentes grupos com MSE 0.001. A primeira delas divide as regiões Norte, Nordeste (média = 0.083, desvio-padrão = 0.029) do Centro-Oeste e Brasil (média = 0.275, desvio-padrão = 0.019) como é possível

observar pelo gráfico 5. A última divide as regiões Sul e Sudeste por ano 2014 e 2015 (média = 0.504, desvio-padrão =0.012) e 2016 e 2017 (média = 0.553, desvio-padrão = 0.019). Um terceiro e último nível ainda foi gerado pela árvore de decisão mas dado o número pequeno de amostras para evitar o overfitting foi realizada apenas uma análise qualitativa do impacto das features desse nível na determinação do IIF. Como pode ser observado pela figura 1 uma de quatro variáveis deste nível é relacionada às fintechs e apresentam um comportamento de corte espacial nos dados dividindo-os em dois grupos que não se interceptam de acordo com o IIF.

Abaixo temos as tabelas de regras de associação para a árvore de decisão criada. Como é possível observar o primeiro nó representado pela variável geográfica Number of electronic service outposts of finance companies (Quantidade de correspondentes de sociedades de crédito, financiamento e investimento) divide as amostras em dois diferentes ramos. Para valores maiores que 0.652 as amostras pertencerão ao ramo direito da árvore e estão sujeitas as regras de associação presentes na tabela 4. Por outro lado, se os valores forem menores ou iguais a 0.652 as amostras pertencerão ao ramo esquerdo da árvore e estarão sujeitas as regras de associação apresentadas na tabela 5. Como relatado anteriormente, o primeiro nó realiza a divisão das regiões Norte, Nordeste, Centro-Oeste e Brasil do Sul e Sudeste. Por fim, os nós do segundo nível dividem as regiões Norte, Nordeste do Centro-Oeste e Brasil (lado esquerdo) e Sul e Sudeste de acordo com os anos (lado direito).
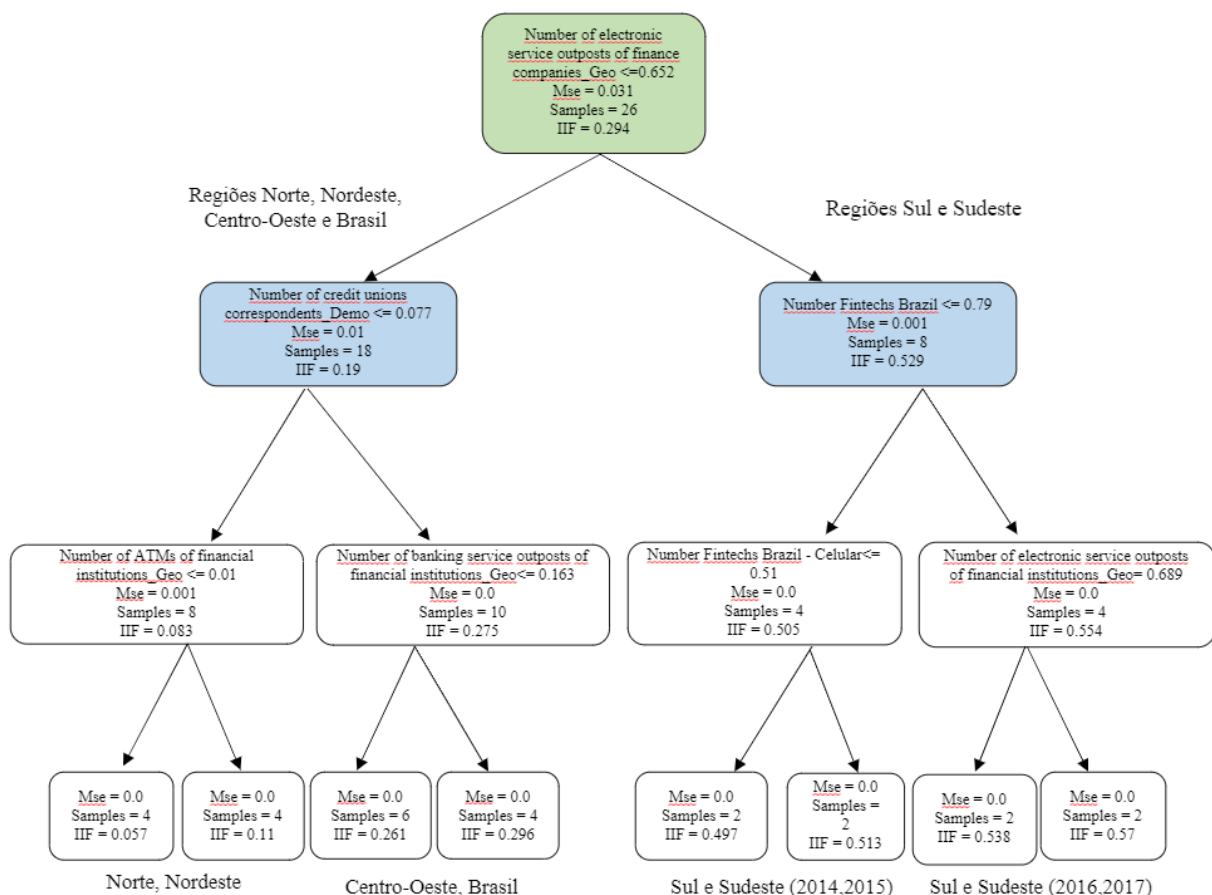

Figura 1 - Árvore de Decisão IIF

Number of electronic service outposts of finance companies_Geo	Number Fintechs Brazil	Number Fintechs Brazil - Celular	Number of electronic service outposts of financial institutions_Geo	Região
> 0.652	≤ 0.79	≤ 0.51	-	Sul e Sudeste
> 0.652	≤ 0.79	> 0.51	-	(2014, 2015)
> 0.652	> 0.79	-	≤ 0.689	Sul e Sudeste
> 0.652	> 0.79	-	> 0.689	(2016, 2017)

Tabela 4 - Regras de associação para o ramo direito da árvore

Number of electronic service outposts of finance companies_Geo	Number of credit unions correspondents_Demo	Number of ATMs of financial institutions_Geo	Number of banking service outposts of financial institutions_Geo	Região
≤ 0.652	≤ 0.077	≤ 0.01	-	Norte e
≤ 0.652	≤ 0.077	> 0.01	-	Nordeste
≤ 0.652	> 0.077	-	≤ 0.163	Brasil e Centro-
≤ 0.652	> 0.077	-	> 0.163	Oeste

Tabela 5 - Regras de associação para o ramo esquerdo da árvore

A construção da árvore utilizou o Erro Quadrático Médio (MSE, na sigla em inglês) para penalizar os erros individuais maiores afim de realizar a seleção de variáveis que fossem melhores para todo conjunto amostral de IIF, ao invés de priorizar apenas alguns subconjuntos com determinadas regiões administrativas ou em determinados anos que fossem bem explicados por algumas variáveis. Caso que pode ocorrer quando o erro utilizado é o Erro Absoluto Médio (MAE, na sigla em inglês). Pode verificar o ganho de informação a partir da adição de cada uma das três variáveis selecionadas pela árvore de decisão regressora. Respectivamente em relação ao MAE e MSE, a utilização das três variáveis diminuiu em 87.6% e 98.7% em relação ao erro que se apresenta utilizando somente a esperança do IIF.

Baseado na análise descritiva apresentada que verifica que a correlação das variáveis geográficas das fintechs com o Índice de Inclusão Financeira (IIF) é de valor significativo, inclusive maior que algumas variáveis de acesso e na construção do modelo de árvore de decisão que em sua escolha das 7 variáveis de maior importância escolheu 2 de fintechs é possível inferir a partir dos dados apresentados que as variáveis de fintechs podem ter influência no IIF. Ainda assim é de se destacar a tendência de crescimento do IIF de algumas regiões ao longo do tempo simultaneamente às variáveis de fintechs que também apresentaram essa tendência, o que impacta as conclusões sobre as fintechs já que não é possível verificar a direção de causalidade entre o passar dos anos e o número e investimentos em fintechs.

Diante do exposto, é possível observar que o fenômeno das fintechs não se apresenta de forma homogênea em todo Brasil. As regiões Sul e Sudeste destacam-se como pioneiras neste novo processo de modernização do sistema financeiro nacional, como é apontado pela PwC (2018) e confirmado pelo modelo elaborado que selecionou duas variáveis de fintechs para o ramo direito da árvore, sinalizando que as fintechs podem ser boas variáveis preditoras para o IIF nessas regiões. Em contrapartida, para as regiões Norte, Nordeste e Centro-Oeste nenhuma variável de fintechs foi selecionada pela árvore de decisão, confirmando também o que sinaliza

o relatório realizado pela PwC (2018) e a pesquisa Fintech Mining (2019) que pontua as regiões Sul e Sudeste com o maior percentual de fintechs no Brasil.

O crescimento no número relativo de fintechs e investimentos em fintechs observado por região é notável entre os anos da amostra e é acompanhado por um crescimento sutil no IIF como é possível observar pela tabela 6 abaixo. Este aumento no número relativo de fintechs nas regiões administrativas foi também acompanhado pelo aumento na posse de aparelhos. Este aumento pode indicar que a população brasileira está modificando a maneira como utiliza os serviços financeiros e tornando-se mais digital, como é apontado por Viana (2018). Esta mudança no comportamento dos consumidores brasileiros sinaliza que o sistema financeiro nacional está entrando em fase de transformação devido a introdução dessas novas tecnologias como é proposto por Cortina e Schmukler (2018).

Além disso, este aumento na posse de aparelhos celulares e no número fintechs e de investimentos em fintechs pode acelerar a transformação do sistema financeiro nacional principalmente em regiões em que a taxa de adultos bancarizados é menor, como as regiões Norte e Nordeste. Assim como é apontado pela PwC (2018) o modelo de negócio simples, digital e de menor custo das fintechs proporciona a este tipo de negócio uma vantagem frente às empresas tradicionais e pode alcançar assim como também é colocado pelo Inter-American Development Bank e Finnovista (2018) a população que não tem acesso ao sistema financeiro ou aqueles que estão descontentes com os serviços oferecidos pelas instituições tradicionais. A possibilidade de expansão das fintechs principalmente pelos meios digitais para as camadas da sociedade excluídas desse sistema é de fato uma possibilidade, visto que no Brasil de acordo com o Banco Mundial (2017) aproximadamente 60% dos adultos desbancarizados possuem acesso a aparelhos celulares e a internet. Este cenário cria a possibilidade de desenvolvimento de um mercado mais estável assim como proposto por Furche et al. (2017) e aumenta a inclusão financeira da população assim como sinaliza Katori (2017) e Brêtas (2017).

Por outro lado, a situação para as regiões Sul e Sudeste é similiar a da pesquisa feita por Bueno (2019), na qual a maior parte dos clientes deste estudo que detinha contas em fintechs possuíam contas também em bancos tradicionais. É possível que com a expansão das fintechs nessas regiões ocorra o que foi apontado na reportagem de Almeida et al. (2019), ou seja, a partir da maior disponibilidade de fintechs nessas regiões a bancarização passe a se tornar obsoleta, pois a maior parte dos adultos já possuirá algum vínculo com instituições financeiras tradicionais ou fintechs. Ademais, apesar de o IIF possuir alta correlação com algumas variáveis de fintechs, outras variáveis como a bancarização, número de agências, sedes e pontos de atendimentos eletrônicos estavam também altamente relacionadas com o índice, o que pode evidenciar que a população brasileira ainda tem como porta de entrada majoritária para o sistema financeiro os sistemas tradicionais como agências e correspondentes bancários como é apontado pelo RCF (2018).

A partir do exposto é possível indicar que as fintechs estão proporcionando modificações notáveis no sistema financeiro brasileiro. As variáveis relacionadas a fintechs utilizadas para a construção do modelo de árvore de decisão apontam que neste primeiro momento elas conseguem ser boas preditoras para o IIF nas regiões Sul e Sudeste, regiões estas mais desenvolvidas como já apontado anteriormente. Contudo, é importante pontuar que com o avanço da posse de aparelhos celulares , investimentos e número de fintechs, as fintechs possam também serem boas preditoras do IIF nas demais regiões brasileiras. Portanto, considerando o contexto de transformação do sistema financeiro nacional tal qual descrito por

(Brêtas, 2019; Katori, 2017; Maino, 2016) indica-se que a partir da utilização de variáveis relacionadas as fintechs será possível obter um IIF mais acurado.

5. Conclusão

Observou-se a inclusão digital da população brasileira pelo avanço do acesso à internet e planos de dados, bem como posse de aparelhos de telefone celular, smartphones, impulsionar e pode dar força à transformações do sistema financeiro no país. A flexibilidade, conveniência e custos reduzidos das fintech tem atraído clientes não-bancarizados e também os bancarizados. Há heterogeneidade entre as regiões geográficas brasileiras, sendo as fintechs boas preditoras do IFF nas regiões sul e sudeste, onde estão mais presentes. Contudo, uma expansão para as demais regiões é possível com eventuais adaptações aos mercados locais. É importante destacar o papel da cultura sobre a bancarização; embora a tecnologia venha substituindo serviços bancários, mesmo antes do surgimento das fintechs, há uma proporção de clientes resistentes à deixar os serviços tradicionais nas agências bancárias, fenômeno esse que bancos e fintechs deverão lidar no contexto de transformação digital. Como sugestão para novos estudos sugere-se avaliar o impacto das fintechs no IIF com uma série temporal maior, exemplo (2014-2019), ou ainda, avaliar os impactos que por ventura novas iniciativas como o Pix terão no IIF.

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6. Contrastes da implementação da infraestrutura tecnológica em 2020 para aulas remotas das escolas públicas brasileiras no período da pandemia da Covid-19

Edilaine de Azevedo Vieira
Federal University of Paraná
Curitiba, Brazil
edilaineazevedo@ufpr.br

Álvaro Maximiliano Pino Coviello
Federal University of Paraná
Curitiba, Brazil
alvaropino@ufpr.br

Taiane Ritta Coelho
Federal University of Paraná
Curitiba, Brazil
taianecoelho@ufpr.br

Rodrigo Eduardo Botelho Francisco
Federal University of Paraná
Curitiba, Brazil
rodrigobotelho@ufpr.br

Resumo

Este artigo visa investigar se as escolas públicas brasileiras terminaram o ano letivo de 2020 com a infraestrutura tecnológica adequada para as aulas remotas durante a pandemia da Covid-19. Especificamente, busca detectar a infraestrutura real utilizada e identificar introdutoriamente a preparação para o início das aulas do ano de 2021. A investigação baseou-se em uma estratégia de pesquisa qualitativa, de caráter exploratório. Os achados indicam que não existiu planejamento de infraestrutura tecnológica para essa emergência provocada pela Covid-19. Os professores e alunos utilizaram sua própria conexão e aparelhos tecnológicos para desenvolver o processo de ensino e aprendizagem. O panorama de início das aulas é diverso no calendário e em muitos casos apontam para a migração do formato remoto para o híbrido. Desta forma, a pesquisa contribui para mostrar um panorama de como as escolas lidam com a situação de adaptar-se às aulas com isolamento social, sem encontrar uma política educativa com metas claras em uma crise sanitária. Depois de quase um ano de pandemia, tampouco se tem um alinhamento geral para iniciar um novo ano letivo.

Palavras-chave: Covid-19, Infraestrutura tecnológica, aulas remotas, aulas híbridas, TICs.

1. Introdução

A pandemia da Covid-19 que afetou o mundo em 2020, fez com que as relações sociais fossem alteradas. Como medidas para combater a doença, uma das principais providências indicadas pela Organização Mundial da Saúde (OMS) foi o distanciamento social (Fioratti, 2020). O cenário da educação e o processo ensino e aprendizagem também passaram por transformações, tornando o processo ainda mais desafiador. Como medida para diminuir a propagação da doença, o sistema público brasileiro de ensino se viu obrigado a utilizar ferramentas tecnológicas para a estruturação das aulas remotas. Na educação, as medidas foram sendo tomadas de acordo com as indicações das autoridades de saúde. De acordo com publicação no Brasil de Fato (2020), no contexto de pandemia, a expansão do sistema de educação remota passou a ser uma realidade nacional. E, segundo um levantamento feito pelo Conselho Nacional dos Secretários de Educação (Consed), não houve um padrão específico. Alguns estados brasileiros passaram a utilizar apenas aulas pela televisão, outros lançando mão de plataformas virtuais e outros ainda mesclando os dois formatos, distribuindo os conteúdos por meio de

distintos canais. Ou seja, cada estado começou a procurar uma saída recriando as atividades, e, os docentes precisaram administrar problemas relacionados à falta de organização do trabalho.

Durante a implantação do sistema remoto de ensino surgiram dificuldades e desafios tanto para os docentes como para os discentes. Uma pesquisa de Vieira, Coviello & Coelho (2020) mostrou que as escolas públicas enfrentam falhas estruturais para a introdução de tecnologias e plataformas digitais. Inicialmente não se considerou que as escolas necessitavam de plataformas digitais e os docentes de formação em tecnologias para atuarem em situações adversas aos habituais. Além disso, muitos dos alunos não dispunham de tecnologias adequadas. Muitas pesquisas sobre as TICs na educação e no processo de ensino e aprendizagem estão sendo realizadas neste contexto de emergência sanitária (Dias e Pinto, 2020; Santos Junior e Monteiro, 2020a, 2020b; Joye, Moreira & Rocha, 2020). Os autores mencionados escrevem sobre efeitos pedagógicos e não sobre a estrutura tecnológica para ministrar as aulas. Ao abordarem a inserção das TICs na educação, Souza e Santos (2019) afirmam que seu uso não pode ser ignorado e tem exigido do sistema educacional e do profissional docente uma nova postura. As mudanças geradas no sistema educativo em geral, vieram para ficar. Sobre esta visão crítica, está sendo feito um registro das experiências educativas e das consequências futuras em nível mundial, liderado por Christopher Cheong do *Informing Science Institute*.

Em meio às respostas imediatas à crise de saúde e à crise econômica iminente, está o impacto simultâneo e global que a pandemia terá em toda uma geração de alunos e como os educadores administraram e ainda estão administrando a mudança repentina e inesperada para a educação online. Um aspecto fundamental da continuidade da educação em tais circunstâncias é entender como alunos e educadores administraram este feito, o papel crítico que a tecnologia desempenhou na educação online, as lições aprendidas e como seria uma educação "preparada para o futuro". (Informing Science Institute, 2021, tradução nossa).

Mas também há interesse em se identificar com que velocidade se deram respostas à infraestrutura necessária para continuar com as aulas no novo contexto. O presente artigo tem como foco a questão da infraestrutura das escolas públicas brasileiras em relação às tecnologias disponíveis para ministrar as aulas no cenário da pandemia. Segundo Alves e Xavier (2018) a definição de infraestrutura em educação é polissêmica, compreendendo desde a concepção arquitetônica das escolas, os seus ambientes educativos e administrativos, os recursos educacionais e os equipamentos, mas também as práticas, o currículo, os processos de ensino e aprendizagem e a capacitação dos professores para utilizar os recursos disponíveis. Diante do exposto, o que se questiona é: as escolas públicas brasileiras terminaram o ano letivo de 2020 com a infraestrutura tecnológica para as aulas remotas, e se estão preparadas para iniciar o ano letivo de 2021? Foram definidos três objetivos específicos. 1) analisar se as escolas públicas finalizaram o ano letivo com a infraestrutura necessária para as aulas remotas. 2) detectar a infraestrutura real utilizada. 3), identificar introdutoriamente a preparação para o início das aulas do ano de 2021.

2. O contexto do ensino remoto na pandemia da Covid-19

No imaginário social e para as autoridades de educação, a suspensão das aulas poderia ser por algumas semanas. Conforme a situação sanitária foi piorando, se estabeleceu a educação remota. O ensino remoto não deve ser entendido como educação à distância. Conforme definição pelo CIEB (2020), o ensino remoto visa dar subsídios ao gestor público para mobilizar e planejar ações pedagógicas frente ao contexto de isolamento social. Já a

Educação a Distância (EAD) é apoiada em trabalho sistematizado baseado em metodologias e processos de desenvolvimento de soluções para a aprendizagem.

Em 26 de março de 2020, a Unesco divulgou que mais de 1.5 bilhões de crianças, adolescentes e universitários de 165 países estavam sem aulas, e desde o fechamento de escolas para conter a pandemia da Covid-19, os governos têm implementado soluções e lidado com a complexidade para oferecer educação de forma remota, desde o fornecimento de conteúdo e apoio a professores, até orientar as famílias e a enfrentar os desafios da conectividade (UNESCO, 2020). Como registra o estudo preliminar Vieira, Coviello & Coelho (2020) no primeiro momento se pensou que o desafio da educação era dotar as escolas públicas de conectividade e infraestrutura adequada para poder levar uma educação remota. Parecia que as escolas deveriam se constituir em centros de produção de materiais didáticos e os professores auxiliarem a planejar, produzir e transmitir suas aulas. Por outro lado, os alunos tinham diversos contextos de infraestrutura tecnológica. Muitos não contaram com conectividade, internet nem com computador em suas residências para fazer as aulas.

A inclusão das TICs no sistema educativo não é um debate novo, mas a pandemia da COVID-19 exige uma integração mais célere, além de mudanças. Um estudo colaborativo de 39 pesquisadores narra a visão geral da interrupção da educação devido à pandemia em 31 países com uma representação de 62,7% de toda a população mundial. Fica claro que as práticas atuais de emergência são diferentes das práticas planejadas de educação a distância. "Este estudo aponta como a injustiça social, a desigualdade e a exclusão digital foram exacerbadas durante a pandemia e precisam de medidas específicas e direcionadas para serem abordadas" (Bozkurt *et al.*, 2020, tradução nossa), ademais identificam muitas arestas pedagógicas e problemas derivados como doenças psicológicas. Outros estudos (Ferrada-Bustamante *et al.*, 2021) se centram na pertinência das ferramentas digitais como redes sociais e sistemas de gestão de aprendizagem (*Google Classroom, Edmod*o e *Comunidad Tu Clase*). Mas para poder avançar sobre as ferramentas, primeiro tem que existir infraestrutura disponível, assunto da atual pesquisa. Zhang, Wang, Yang Chuanyi (2020) analisam a iniciativa do governo chinês chamada "Suspensão das aulas sem interromper o aprendizado". Identificam 5 etapas da política emergencial educativa: 1-Integração de recursos nacionais e planejamento da infraestrutura tecnológica. 2- Formação de professores em ensino on-line e designação de técnicos para auxiliar. 3- Habilitação às autoridades locais e escolas a ministrar ensino remoto de acordo com as condições locais. 4- Formulação de diretrizes para uma transição de volta à educação *off-line*. 5- Elaboração de um plano de reabertura de escola após a epidemia. Embora a implantação de salas de aula remotas tenha muitas arestas de análise, China priorizou etapas iniciando pela infraestrutura tecnológica. Os autores asseguram que o governo tomou medidas para garantir a oferta de recursos do serviço de rede juntamente com várias operadoras de telecomunicações o que permitiu o fornecimento de redes rápidas e estáveis para a educação *on-line* e garantiu o acesso. Além da primeira, na segunda etapa aparecem os técnicos de manutenção e na terceira, se outorga liberdade para que os governos locais e as escolas articulem melhor opção tendo em conta as diferenças geográficas, sociais e de serviços por região. Mas ao fazer a avaliação das dificuldades na implementação de políticas concluem que o ensino on-line é limitado pela infraestrutura devido às necessidades de ensino em grande escala que ficam sobrecarregadas e as diferenças na infraestrutura de tecnologia da informação entre as regiões. Mas além da infraestrutura reconhecem outros problemas na implantação das etapas como a eficiência do uso de recursos de ensino remoto, da falta de pedagogia específica dos professores, dos problemas domésticos que se devem enfrentar e a desorientação na didática adequada. Mas é pertinente a investigação porque diferença ações em etapas de prioridades que permite um melhor diálogo com a atual pesquisa que se centra na etapa 1 em

um país continental como Brasil que neste sentido é similar a China. Em igual nível de organização de prioridades, Lassoued; Alhendawi; & Bashitialshaaer (2020) estudam os obstáculos para o alcance da qualidade no ensino a distância durante a pandemia com professores e alunos de universidades do mundo árabe (argelina, egípcia, palestina e iraquiana). Embora não se trate educação básica, é válida, limitaram-se a quatro categorias de obstáculos: pessoais (autoimpostos), pedagógicos, técnicos e financeiros/organizacionais. E quanto aos problemas técnicos indicam que um dos obstáculos foi a velocidade fraca da internet em muitas áreas remotas e as consequentes interrupções na transmissão e o impedimento para as aulas seguintes, além da dificuldade de obtenção de computadores por alguns alunos. As duas últimas pesquisas citadas dialogam com o atual trabalho cujo foco é a infraestrutura tecnológica para as aulas no contexto de emergência sanitária com isolamento social.

3. Procedimentos metodológicos

Este estudo baseou-se em uma estratégia de pesquisa qualitativa, de caráter exploratório. Foi feita uma triangulação de dados das diferentes fontes utilizadas para cada objetivo. Para responder ao objetivo se as escolas públicas finalizaram o ano letivo com a infraestrutura necessária para aulas remotas foram feitas análises dos dados secundários de três fontes escolhidas pela magnitude de dados. A primeira fonte foi o CIEB que promove a cultura de inovação na educação pública brasileira. O site do CIEB tem uma página exclusiva denominada "Aprendizagem remota em tempos de pandemia", reunindo materiais e ferramentas criadas especialmente no contexto da Covid-19, com o objetivo de "apoiar as Secretarias de Educação e garantir o direito fundamental à aprendizagem (CIEB, 2021). A segunda fonte consultada foi o MEC/FNDE que é responsável pela execução de políticas educacionais do Ministério da Educação (MEC) para alcançar a melhoria e garantir uma educação de qualidade na educação básica da rede pública. A terceira fonte consultada foi o CETIC, que tem a missão de monitorar a adoção das TICs no Brasil e do FNDE, vinculado ao MEC. O CETIC publicou a "Pesquisa sobre o Uso das Tecnologias de Informação e Comunicação nas Escolas Brasileiras". Também foram selecionadas pesquisas que analisaram o desenvolvimento das aulas remotas, como as realizadas pelo Instituto Península, Instituto de Pesquisas Datafolha e Fundação Carlos Chagas. Para o terceiro objetivo e para responder a segunda questão da investigação foram feitas pesquisas em fontes oficiais e jornalísticas sobre a organização das escolas ao redor do Brasil para o início do ano letivo de 2021. As fontes selecionadas cobrem dados governamentais como da sociedade civil. Em relação às diretrizes para o início do novo ano letivo, algumas informações são até o mês de janeiro de 2021. Este estudo abrange o período compreendido entre a segunda quinzena de junho até dezembro de 2020, dando continuidade ao estudo preliminar, uma vez que busca identificar a infraestrutura tecnológica das escolas no período da pandemia de Covid-19.

4. Apresentação dos resultados

No Brasil existem 27 unidades federativas, sendo 5.570 municípios. Em relação ao quantitativo de escolas públicas, o Censo Escolar 2019 aponta que o país conta com 184,1 mil escolas de Educação Básica. De acordo com Estatísticas Sociais (2020) a rede pública de ensino é responsável por 74,7% dos alunos na creche e pré-escola, 82% dos estudantes do ensino fundamental e 87,4% do ensino médio. Há de se considerar que a pandemia do coronavírus poderá elevar estes índices, já que muitas famílias estão perdendo renda e transferindo os filhos para as escolas públicas.

4.1 Ano letivo 2020: Infraestrutura tecnológica para aulas na pandemia

O CIEB (2021) não se refere à infraestrutura tecnológica em si, mas aos aspectos relacionados à mesma e os desafios que as redes de ensino enfrentam. Desenvolveu ferramentas e materiais de aplicação prática e imediata, identificou as diferenças entre ensino a distância e aprendizagem remota; ofertou a seleção das estratégias remotas adequadas e a aquisição e implementação de tecnologias educacionais.

Não há dados específicos no site do MEC/FNDE, apenas a publicação de uma notícia da Assessoria de Comunicação Social do FNDE com data 27 de janeiro de 2021 que anuncia: "Escolas públicas têm até 1° de março para informar quantitativo de alunos matriculados em 2021 nos ensinos fundamental e médio" (BRASIL, 2021). Mas não faz referência ao contexto da Covid -19. O CETIC publicou a "Pesquisa sobre o Uso das Tecnologias de Informação e Comunicação nas Escolas Brasileiras" que tem uma atualização sobre as ações em 2020:

No Brasil, em julho de 2020, a Rede Nacional de Pesquisa e Ensino (RNP) divulgou uma chamada para operadoras de telefonia móvel, com o objetivo de apoiar o Ministério da Educação durante a pandemia na oferta de pacotes de dados móveis para alunos de baixa renda matriculados em universidades e institutos federais de educação profissional e tecnológica. Esse é um exemplo do que pode vir a se tornar parte de uma estratégia a ser implementada em outros contextos educacionais, como a Educação Básica, com a priorização de ações de oferta de recursos diretamente aos estudantes. (CETICa, 2020, p. 80).

As práticas pedagógicas remotas não estavam mediadas pelas tecnologias da escola, estavam mediadas pelas tecnologias particulares de cada docente. Na urgência por retomar o ritmo de estudo, se articularam diferentes opções (quase sempre de forma desordenada) e de acordo com as competências pessoais de cada professor.
No Brasil, as orientações para a continuidade das atividades educacionais ficaram a cargo das secretarias de Educação estaduais e municipais, de maneira descentralizada. Para além das medidas institucionais, as próprias instituições de ensino se articularam, cada uma à sua maneira, para dar continuidade à interação com os alunos e professores. (CETICa, 2020, p. 80).

Não existem dados atualizados referentes ao planejamento e execução da infraestrutura tecnológica, só uma projeção "da pesquisa TIC Domicílios 2019 (CGI.br, 2020a), que diz que 82% dos domicílios localizados em áreas rurais não possuíam computadores e 48% não contavam com acesso à Internet" (CETIC, 2020a, p. 105). Quanto à área urbana, cerca de 39% dos estudantes de escolas públicas não têm computador ou tablet em casa e 21% só acessam a internet pelo smartphone. Sobre as instituições educativas, apenas 14% das escolas públicas (estaduais e municipais) tinham ambiente ou plataforma virtual de aprendizagem antes da pandemia CETIC (2020a), o que dá uma projeção do impacto do período sem aulas presenciais. Isso leva a pesquisar sobre o segundo objetivo, identificar a infraestrutura real utilizada.

4.2 A Infraestrutura tecnológica utilizada

Identificou-se que para as aulas remotas foram utilizados recursos que estavam ao alcance dos professores e dos alunos. Pode-se perceber que inicialmente as escolas não forneceram equipamentos, o que leva a induzir que tanto os docentes, quanto os discentes, precisaram utilizar seus equipamentos de uso pessoal. No CETIC existe o Painel TIC COVID-19 "inclui indicadores definidos internacionalmente, adotando referenciais da iniciativa multissetorial Partnership on Measuring ICT for Development, liderada pela União Internacional de Telecomunicações (UIT)" (CETICb, 2020). A população-alvo da pesquisa são pessoas de 16 anos ou mais de idade que sejam usuários de internet no Brasil. Os dados misturam pessoas

que trabalham com as que estudam e não considera a população com menos de 16 anos que está no ensino fundamental e médio, o que impossibilita conhecer o que sucede na educação básica infantil. Os resultados estatísticos apresentados não mostram se a conectividade foi fornecida pelo Estado. A pesquisa do Instituto Península (2020) demonstra que em novembro de 2020 a forma de contato com os alunos foi 84% por whatsapp, 39% por grupo de sala de aula (*Google classroom*); 28% por ambientes virtuais de aprendizagem; 20% por redes sociais. Ou seja, predomina o contato pessoal não regulado por um marco institucional. Mas ante a possibilidade de estender as aulas remotas, aparece a importância da infraestrutura para os professores, sendo que 63% dos docentes falam da necessidade de infraestrutura adequada em casa como se apresenta na Figura 1. Percebe-se, também, a necessidade de formação pedagógica para que o docente possa se preparar para o ensino remoto, mas, o fator formação pedagógica não é o foco deste estudo.
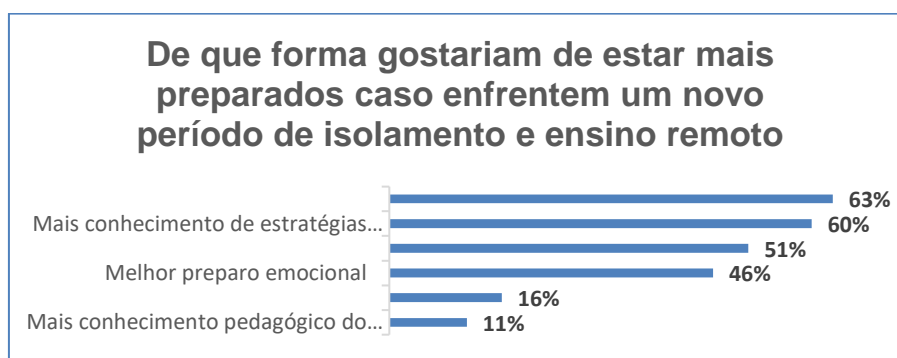

Figura 1 - Importância da infraestrutura
Fonte: Instituto Península, 2020, com adaptação dos autores

A Fundação Carlos Chagas (2020a) realiza uma pesquisa de 30 de abril a 10 de maio para verificar como os professores das redes públicas e privadas estão desenvolvendo suas atividades, como conciliam o trabalho profissional com a vida privada e quais suas expectativas para o período de retorno às aulas presenciais, mas não se investiga sobre infraestrutura ou sobre onde deve estar o foco na infraestrutura tecnológica. Tem uma segunda pesquisa realizada de 10 a 27 de julho (2020b) que procura identificar os desafios e as estratégias propostas pelas escolas e utilizadas pelos professores com vistas a garantir o direito dos alunos público-alvo da educação especial à educação na perspectiva inclusiva durante o período de suspensão das aulas presenciais.

Outra pesquisa realizada de 16 de setembro a 02 de outubro pelo Instituto Datafolha (2020) procurou identificar se os estudantes dos ciclos de ensino fundamental e médio estavam recebendo, acessando e realizando as atividades de aprendizado remoto. Mas a investigação esteve centrada na perspectiva do estudante e sua família sobre as dificuldades enfrentadas em relação ao acesso, rotinas e motivação. A tabela 1 mostra o percentual de equipamentos utilizados pelos estudantes de acordo com a pesquisa do Instituto Datafolha (2020):

Base: estudantes (1556/1553 entrevistas)	Julho 2020 %	Setembro 2020 %
Pelo smartphone	69	84
Pelo computador	49	59
Por material impresso	45	60
Pela TV	17	22

Tabela 1 - Meios utilizados, atividades por equipamentos
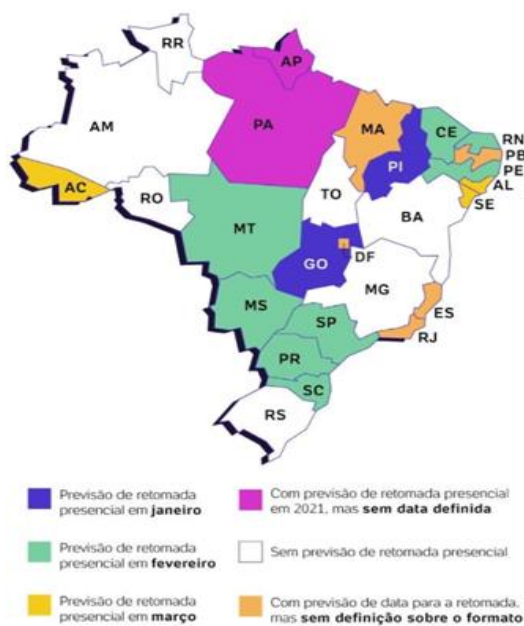Fonte: Os autores adaptado de Datafolha (2020, p.31)

A pesquisa do Datafolha (2020, p. 58) também se centra nos equipamentos presentes no domicílio, tudo indica que o foco são equipamentos presentes no domicílio dos estudantes e dos professores. Na prática, as escolas não foram centros de produção de conteúdos pedagógicos mediados pela tecnologia no contexto da pandemia. Os professores e alunos utilizaram a infraestrutura tecnológica particular (conexão de internet e equipamentos). Muitos professores prepararam e transmitiram suas aulas de suas casas e foram à escola apenas para algum trâmite que não pudesse ser de forma virtual. Na pesquisa do Instituto Península (2020, p. 27) se conclui que "44 % dos professores já enxergam o futuro da educação com um modelo híbrido de ensino, com aulas presenciais e online". Daí surge a pergunta que leva ao terceiro objetivo: existiram políticas públicas para investimentos na infraestrutura tecnológica nas escolas ou suporte para alunos e professores em suas residências? Como as escolas estão se preparando para o ano letivo de 2021?

4.3 O cenário previsto para o ano letivo de 2021

Se identificou introdutoriamente a preparação para o início das aulas de 2021, sendo consultadas fontes oficiais e jornalísticas. Em 09 de dezembro de 2020, foi homologado o parecer CNE/CP nº 19/2020, do Conselho Pleno do Conselho Nacional de Educação que definiu as Diretrizes Nacionais para a implementação dos dispositivos da Lei nº 14.040, de 18 de agosto de 2020, que estabelece normas educacionais excepcionais a serem adotadas durante o estado de calamidade pública reconhecido pelo Decreto Legislativo nº 6, de 20 de março de 2020. O parecer é válido para todas as redes de educação e permite que as aulas não presenciais continuem, do ensino fundamental ao superior, até dezembro de 2021 ou enquanto durar a pandemia de Covid-19. Inicialmente as escolas retornarão no formato híbrido, ou seja, um percentual dos estudantes terá aulas presenciais e os demais aulas remotas, sendo feito um revezamento semanal entre os alunos. Vale ressaltar que não é imperativo a participação do aluno no formato presencial, podendo optar pelo formato remoto enquanto durar a pandemia.

De acordo com Viegas (2020) se entende por ensino híbrido a combinação do uso da tecnologia digital com as interações presenciais, visando à personalização do ensino. É um modelo possível para facilitar a complementação do ensino online com o ensino presencial. Um exemplo disto é o Estado do Paraná, que de acordo com a Agência de notícias do Paraná (2020), o retorno das aulas neste Estado será em fevereiro, em formato híbrido, tendo preferência em assistir às aulas presenciais os alunos que não possuem smartphone ou computador em suas residências. Também será adotado um novo modelo de transmissão de aulas remotas, com transmissão das aulas presenciais via *Google Meet*. Cada sala de aula terá ainda ponto de acesso wi-fi e uma TV LED instalada em um suporte, conectada a um computador com acesso à internet e a uma câmera com microfone. Assim, o professor poderá dar aula aos alunos que estão na sala ao mesmo tempo em que poderá ver e interagir com os que estão em casa, transmitindo a todos o mesmo conteúdo.

Segundo um levantamento feito pelo site de notícias UOL junto às Secretarias de Educação, publicado em 04 de janeiro de 2021, ao menos 15 redes públicas de ensino estaduais já têm previsão de quando retornarão às aulas. Quase todos os estados planejam o retorno entre os meses de janeiro e março. Em relação ao formato utilizado, grande parte das Secretarias de Educação optaram pelo modelo híbrido de ensino, mesclando aulas presenciais e remotas. A figura 2 apresenta a previsão de retomada do calendário escolar para 2021. Os estados sem previsão para aulas presenciais são: Amazonas, Roraima, Rondônia, Tocantins, Bahia, Distrito Federal, Minas Gerais e Rio Grande do Sul. Já Maranhão, Paraíba, Alagoas, Sergipe, Espírito Santo e Rio de Janeiro têm previsão para retorno, mas sem definição do formato das aulas (presenciais, formato híbrido ou apenas remoto).

Figura 2 - Previsão da retomada das atividades escolares nas redes estaduais em 2021
Fonte: Bermúdez, 2021.

Note-se que até 04 de janeiro de 2021 alguns estados ainda não haviam definido data para as aulas presenciais, sendo Amazonas um deles. Conforme Agência do Senado (2020), a Câmara dos Deputados aprovou em 18 de dezembro de 2020 uma proposta que oferece acesso gratuito à internet para alunos e professores de escolas públicas do ensino básico. O texto destina R$ 3,5 bilhões (três bilhões e 500 milhões) de reais para estados e municípios aplicarem em ações para garantia do acesso à internet, em decorrência da pandemia de Covid-19. No entanto, a proposta ainda aguarda aprovação, a matéria ainda vai para análise do Senado. Se aprovado, pode beneficiar cerca de 18 (dezoito) milhões de estudantes de baixa renda e 1,5 milhão (um milhão e quinhentos mil) docentes durante a pandemia. Não foram encontrados indicadores explícitos entre os regulamentos consultados, que indiquem qual será o foco da infraestrutura tecnológica para a educação na modalidade híbrida. Os focos podem ser: 1- A escola física como centro de produção de conteúdos pedagógicos por meio das TICs. (Os professores e parte dos alunos estarão fisicamente nas escolas e a outra parte dos alunos acompanha as aulas em casa). 2- A infraestrutura e dispositivos tecnológicos que o professor possua de forma exclusiva para uso escolar para não utilizar os equipamentos de uso pessoal ou familiar. 3- A conectividade à internet e a tecnologia que o aluno dispõe para acompanhar as aulas nos diferentes formatos (híbrido ou remoto). 4- Os três focos ao mesmo tempo.

5. Conclusões e projeções

A pandemia obrigou o sistema de ensino brasileiro a utilizar ferramentas tecnológicas para que pudesse ofertar as aulas remotas, o que acabou evidenciando os problemas estruturais enfrentados pelas escolas públicas do país. Toda a rede pública de ensino conseguiu implementar algum tipo de atividade remota. No entanto, apesar da adoção de alguma forma de educação como plataformas virtuais, sites, aulas pela TV aberta, uso de redes sociais e até mesmo transmissão via rádio, os professores e alunos enfrentaram dificuldades para adaptação à nova realidade. As escolas públicas brasileiras não terminaram o ano letivo de 2020 com uma infraestrutura planejada para as aulas remotas. A heterogeneidade das propostas empregadas não demonstrou riqueza de diversidade, mas o que mostrou foi a falta de políticas concretas

para implementar nas escolas. Sem estrutura fornecida pelas escolas, os professores e alunos terminaram as aulas utilizando a estrutura particular que tinham em suas casas.

A situação evidenciou ainda mais as assimetrias educativas e a brecha tecnológica por falta de acesso às TICs e conectividade à internet. Não se localizaram dados sobre investimentos na infraestrutura das escolas públicas brasileiras pela pandemia durante o ano de 2020. As iniciativas encontradas são para o ano de 2021, conforme proposta para acesso gratuito à internet para alunos e professores, que ainda aguarda aprovação do Senado. Para o início do ciclo letivo 2021 se introduziu um processo de mudança do sistema remoto para o sistema híbrido, mas tampouco com um enfoque que evidencie uma política pública concreta. A pesquisa contribui para possuir uma descrição de como as escolas lidam com a situação de adaptar-se às aulas com isolamento social, sem encontrar uma política educativa com metas claras em uma crise sanitária. Depois de quase um ano de pandemia, tampouco se tem um alinhamento geral para continuar em um novo ano letivo.

O Brasil, por ser um país organizado em unidades federativas, muitas vezes as ações descentralizadas não beneficiam a infraestrutura das escolas. Cada estado atua de maneira independente, de acordo com seus próprios interesses e recursos. Uma possibilidade de colaborar com a análise da realidade do país e ao mesmo tempo ter estudos comparativos e que completem o panorama mundial, é utilizar as mesmas técnicas que outros investigadores.
Para uma nova fase da pesquisa, se pode dar continuidade com indicadores que sigam as cinco etapas identificadas por Zhang, Wang, Yang & Chuanyi (2020) na China e diagnosticá-las no Brasil. Para fazer a análise no ensino superior, poderia se utilizar a mesma técnica de questionário com similares perguntas empregadas por Lassoued; Alhendawi; Bashitialshaaer (2020). A política de infraestrutura educativa não se encontra coordenada em meio a pandemia, cuja perspectiva é continuar em 2021. A falta de políticas conjuntas colabora para aumentar a desigualdade educativa. A Covid -19 estimulou uma nova assimetria na inclusão digital.

Uma limitação da pesquisa é que o conceito de infraestrutura tecnológica é polissêmico, pelo qual as necessidades e o que se entende por infraestrutura é diferente de uma escola para outra, assim como de um estado para outro. Nesta pesquisa se limita a infraestrutura a aparelhos tecnológicos e conectividade que possui a escola, sem especificar se são para uso dentro da escola ou fora dela. Novas fontes de dados podem ser incorporadas em futuras pesquisas para identificar o panorama da infraestrutura tecnológica das escolas brasileiras.

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7. Covid-19 Emergency Aid: How the Brazilian Government used Social Big Data Analytics to give economic support and protect vulnerable citizens

Rafael Ronqui
FGV EAESP
rafaelmronqui@gmail.com

Thiago Oliveira
FGV EAESP
thisco@gmail.com

Alexandre Silva
FGV EAESP
alexandre.lbs@gmail.com

Carlos Brandão
FGV EAESP
brandao@intelliway.com.br

Rodrigo Silva
FGV EAESP
rodrigorubens@newroad.com.br

William Helouani
FGV EAESP
williamboscardini@gmail.com

Tiago Lara
FGV EAESP
tiago.a.lara@gmail.com

Eduardo Francisco
FGV EAESP
eduardo.francisco@fgv.br

Abstract

The digital transformation has been accountable for major socio-cultural and economic changes, requiring different management solutions from governments and corporations. Data have a fundamental role due to their contribution to the decision-making process. An unexpected accelerator of these changes was a virus that paralyzed Brazil and the world, generating social isolation and freezing the economy while all the attention turned on how to contain and mitigate it. The social and economic impacts, especially on the low-income Brazilian population, were immediate. In May 2020, Dataprev (Social Security Technology and Information Company)'s core capabilities were used to put in place in 14 days the Emergency Aid program, fundamental to prevent the impacts from being even greater for the Brazilian population. In this study, we present the role and relevance of using technology and big data analytics (BDA) as the basis for the implementation of the largest aid program ever developed in the country, in which the Government invested R$ 265 billion (50 billion USD) and benefited more than 65 million people.

Keywords: Big Data Analytics, Data Lake, Social Impact, Brazil, Covid-19

1. Introduction

As new technologies emerge and Internet access becomes widely available, the amount of generated data grows at an exponential ratio. In such a connected world, handling a high volume of data efficiently and turn it into a value is a major challenge for companies and governments. The Global StorageSphere report by International Data Corporation (IDC) appoints that the global data storage capacity has been doubling every four years and suggests that 2020 landing will be 6.8 zettabytes, 16.6% growth over 2019 (Reinsel et al., 2017).

While the availability of these data represents an unprecedented opportunity for businesses, processing and interpreting them is a computational challenge considering that the widely

assimilated relational database management systems (DBMS) were not designed for such concurrent record reading and writing competition. The term Big Data emerges to describe these huge data sets that, in contrast to traditional data sets, include masses of unstructured data and real-time analysis that generate opportunities for discoveries (Chen et al., 2014).

In the last decade, several systems were created to enable Big Data, providing horizontal scalability for simple reading and writing activities in databases distributed by many servers. These new-generation data storage systems are known by the acronym NoSQL, with no consensus between the definitions "Not Only SQL" and "Not Relational" (Cattell, 2010). A key feature that makes NoSQL systems stand out is the shared-nothing horizontal scale, which replicates and fragments data across multiple servers, allowing several read and write operations simultaneously.

The use of NoSQL and BDA databases was fundamental for the Brazilian Government through the state company Dataprev to manage and integrate a wide range of data for the distribution of the so-called "Emergency Aid", a financial help provided during the Covid-19 pandemic targeting the population without income sources or whose income was impacted due to the sanitary restrictions. This initiative allowed the Brazilian Government to technically specify the business rules, integrate databases, develop a mobile app, and release the payment for the affected population in 14 days, benefiting more than 65 million people. This initiative was the largest operation of resources transferring for the socially vulnerable population in Brazilian history (Cidadania, 2020).

2. Context

Due to the new Covid-19 pandemic, global poverty is expected to have the highest growth since 1990 (Sumner et al., 2020). According to World Bank Group, it is estimated that millions of people migrated to extreme poverty living on less than U$$ 1.90 a day due to the pandemic crisis (World Bank Group, 2020). Brazil was one of the most impacted countries by Covid-19, causing the death of 194.949 people by the end of 2020 (Cidadania, 2020).

With an estimated population of 211 million people, Brazil is the largest country in Latin America and the fifth most populous country in the world with an average per capita income of US$ 5.386,04 per year (IBGE, 2021). In addition to the humanitarian issue, the pandemic has accentuated other country issues such as political, health, social, and economic ones, paralyzing several important sectors such as tourism and manufacturing industries. The unemployment rate grew dramatically in the country during the beginning of the pandemic, reaching 14,6% of the active population (IBGE, 2021).

As the pandemic numbers started growing in the country, most states adopted lockdown initiatives to preserve the population's life by avoiding a bottleneck in the hospitals. As a collateral effect, the domestic GDP fell 5% in a month (BCB, 2020) pushing the Brazilian Government to adopt measures to support the population in filing their most basic needs. One of the main actions the Brazilian Government took to minimize the situation of social vulnerability and protect the purchasing power of the most affected population was through law No. 13,982 enacted on April 2, 2020, which changed the benefit of continued provision (BPC) by including the Emergency Aid (EA) modality. The main objective of the EA was to offer the population financial support to face the pandemic crisis, including specifically the unemployed people, the informal population, individual microentrepreneurs (MEI), and the self-employed citizens. The amount offered by the Brazilian Government was R$ 600.00 (113 USD) per person in the target group or R$ 1,200.00 (226 USD) in the case of families where

the woman was the main and only responsible for the expenses (República, 2020). Benefited citizens received 5 full installments of aid, followed by 4 more installments of half the initial amount.

After the Ministry of Citizenship defined the public policy around the Emergency Aid, the distribution of benefits was left to two state companies: Dataprev (Social Security Technology and Information Company), in charge of processing the requests and check if the citizen is allowed to receive the benefit; and Caixa Econômica Federal, accountable for paying the approved amount.

Dataprev is a Brazilian public company, founded in 1974, and is responsible for providing technical information and communication solutions for the implementation of public policies in the Brazilian State. The state-owned company is a benchmark for quality in the processing and treatment of large volumes of data, storing and managing the National Social Information Register (CNIS), which enables the granting of social rights to the Brazilian population automatically, including pensions and maternity wages. As a result, the company processes around 8% of the Brazilian GDP per year (Dataprev, 2020).

Caixa Econômica Federal (CEF) is a Brazilian banking institution founded in 1861 and has around 105 million customers, the largest public bank in Latin America. It is currently responsible for the administration and payment of the social and labor benefits granted by the Brazilian Government. CEF also maintains several cultural institutions across the country and is responsible for the realization and administration of the federal lottery (CEF, 2021).

2.1 Technological Challenge

After law No. 13,982 was enacted, the Brazilian government faced the challenge of developing a database and system architecture, processing the emergency aid mobile application for millions of Brazilians in the shortest time possible. This technology should be designed to consider data processing on a large scale, allowing consultation with multiple databases from different Brazilian institutions, covering billions of records and with low processing time. As requirements, the system to be developed should be highly scalable, available, resilient, and offer high performance, in addition to implementing mechanisms that minimize the possibilities of fraud to grant benefits to the population.

In this context, the design of the technological solution included a complex analysis of scenarios, the definition of rules, and the adoption of appropriate technologies for big data and analytics. The system architecture team defined a database unification approach in an internal server environment, due to the solid infrastructure of the DataPrev data centers.

To validate the resulting data from the performed processing and analysis, the approval process was carried out by the Ministry of Citizenship, which used statistical techniques to validate the samples and analyze compliance. Such measures allowed the system to be progressively improved, correcting deficiencies and benefiting the transparency of the system before the effective data transmission process to CEF.

Another technologically challenging scenario was to enable tracking of the benefit request by the citizen, displaying details of the request, as well as the reason for granting or denying the aid according to the rules established by the Ministry of Economy. The targeted platform had to support millions of simultaneous accesses of citizens who were looking for information about their aid on specific dates. For this purpose, a web platform for consultation was

developed, including a result contestation tool for citizen's manifestation when he disagrees with the denial decision.

3. Literature Review

3.1 Data Structuring Models
Data and information are essential parts of a collection of facts and figures stored in a specific format. Data can be organized in several different ways, such as logical or mathematical models that are termed as a data structure. These data can be structured, semi-structured, and unstructured.

Structured data can be understood as static data that can be easily organized (Agrawal & Patel, 2016) in a relational format (Amin et al., 2018), easy to organize, and in a predefined format, which can be managed by technologies that allow consulting, analyzing and managing data and understanding their relationships (Weglarz, 2004).

Semi-structured data do not need a definition schemewhile having a flexible structure (Agrawal & Patel, 2016). Semi-structured are characterized by not having a clear or implicit pattern definition and can be composed of heterogeneous elements, resulting in an irregular structure without any predefined data model (Lin et al., 2018).

Unstructured data refers to the fact that no identifiable structure within this type of data is available and cannot be classified, researched, viewed, or analyzed in the same way as structured data (Sint et al., 2009). Unstructured data is chaotic raw material generated by companies, social networks, IoT devices, geolocation, text, among others.

3.2 NoSQL Databases
As technological development and the massive progress of the Internet take place, an enormous new amount of information from many different resources and services are made available to humanity. This extraordinary mass of data is produced by and about people, things, and their interactions. Thus, this large volume of information needs to be addressed to become useful (Fahad et al., 2014).

The relational database was the first computational way of organizing data proposed by IBM researchers Donal Chamberlin and Raymondy, originally called SEQUEL (Structured English QUEry Language) and later renamed SQL for legal reasons. Given the limitations of SQL databases for processing semi-structured and unstructured data, new solutions were developed based on the non-relational database approach, better known as NoSQL (Not Only SQL or Not Relational SQL). Relevant IT companies, such as Google, Amazon, Facebook, Alibaba, and IBM, are dealing with a huge amount of data and using NoSQL databases as a solution, instead of traditional relational database systems, which can't efficiently handle big data (Ahmed et al., 2018).

It is noteworthy that such systems do not apply exclusively to a specific technology, but several different ones that apply to specific big data situations (Čerešňák & Kvet, 2019). Unlike relational databases, data repetition is acceptable (Vyawahare et al., 2017). NoSQL databases can handle large, complex, varied, and constantly changing data sets, being appropriate to Big Data applications (Gupta et al., 2018).

Features	Relational Database SQL	No relational Database NoSQL	Source
Data Structure	Structured – RDBMS	No Structured	Ishwarappa & Anuradha (2015).
Data Storage	Tables	Key values, Documents, Columns, and charts	Padhy et al. (2011), , Gudivada et al. (2014).
Data Normalization	Tables Should be normalized	No normalization is required	Khasawneh et al., (2020).
Data Organization	Predefined layouts and scheme	Dynamics schemes	Gyorödi et al. (2015), Saxena & Sachdeva (2018).
Physical memory dependency	The amount of data stored depends mainly on the physical memory of the system	The amount of data stored does not depend on the Physical system memory. It can be scaled horizontally according to the requirement	Sharma et al. (2015), Amin et al. (2018), Fahd et al. (2019).
Processing Time	Processing time depends on server machine configuration	Processing time depends on the number of machines in the cluster	Padhy et al. (2011), Fahd et al. (2019).
Query Language	SQL	Proprietary	Sharma et al. (2015), Gupta et al. (2018), Khasawneh et al. (2020).
Processing	May effectively control millions and billions of records	May effectively control millions and billions of records	Gudivada et al. (2014), Khasawneh et al. (2020).
Scalability	Vertical	Horizontal	Gyorödi et al. (2015), Čerešňák & Kvet (2019).
Standard	ACID - Atomicity, Consistency, Isolation, and Durability	CAP - Consistency, Availability and Partition tolerance	Ahmed et al. (2018), Khasawneh et al. (2020).

Table 1: SQL and NoSQL comparison
Source: As shown in the last column of the table

3.3 Relationship Among NoSQL, Big Data, and Big Data Analytics

In the so-called data age, the term Big Data has gained importance in the academic and corporate world. Big Data is used to describe the amount of data beyond the capacity of traditional data processing technology and applications to efficiently process, store, manage, distribute and process them (Francisco, 2017) .

Big Data can be recognized through five dimensions known as Big Data 5Vs (McAfee & Brynjolfsson, 2012). It includes Volume, which refers to the large amount of data generated from the Internet, social media, IoT equipment, among others; Variety, associated with different data sources and types, including structured, semi-structured, and unstructured data; Velocity, referring to the speed at which data is generated and with the ability to process asynchronously and in real-time (Zikopoulos & Eaton, 2011); Veracity, in terms of trust in the information collected and processed that can be used for decision making (Gandomi & Haider, 2015); and Value, referring to the value of the information that will be explored and derived in favor of organizations.

The potential value of Big Data is unlocked when leveraged to drive decision making, using processes and technologies to prepare and retrieve data for analysis. Analytics refers to

techniques used to analyze and acquire intelligence from big data. Thus, BDA can be viewed as a sub-process in the overall process of 'insight extraction' from Big Data (Gandomi & Haider, 2015). Big Data and BDA have been used to describe the data sets and analytical techniques in applications that are so large (from terabytes to exabytes) and complex (from the sensor to social media data) that they require advanced and unique data storage, management, analysis, and visualization techniques (H. Chen et al., 2012).

Non-relational databases like NoSQL are appropriate to handle Big Data applications due to their ACID (Atomicity, Consistency, Isolation, Durability) properties (Ahmed et al., 2018). NoSQL technologies must also offer Consistency, Availability, and Partition Tolerance (CAP) to work effectively with Big Data (Brewer, 2000).

Based on this context and their capabilities, BDA has been used by governments extensively for public policymaking and reviewing purposes. Also, it has been used by companies and organizations to process social media data, analyze trends of massive diverse static and dynamic transactional data sets, address the clutter in data, perform statistical analysis, and store or search within both structured and unstructured data (Grover & Kar, 2017).

3.4 Data Lake

Data Lake is a highly scalable data repository containing data from one or more sources, stored natively, without manipulation, and in its raw state (Miloslavskaya & Tolstoy, 2016). Data Lakes reduce initial implementation efforts, as they ingest data in any format without requiring an initial scheme. They also facilitate the acquisition of new data, in addition to access to its original raw format (Llave, 2018). Data Lakes are typically built to handle large volumes of unstructured data that are generated at high speed, in contrast to Data Warehouses, which supports highly structured data. Data Lakes use dynamic analytical applications to generate insights, making processed data accessible as soon as they are created (Miloslavskaya & Tolstoy, 2016).

Khine & Wang (2018) highlight the importance of conducting case studies on Data Lake technologies and their applications in addition to business use cases, while there is still a large academic study field for greater and better use and exploration of that architecture.

3.5 Redis Database

Redis is a key-value NoSQL database that operates with in-memory mode, where a large part of the data is stored and processed in the memory, rather than in a file system and physical disks (Chopade & Pachghare, 2019). In Redis, as in other NoSQL databases, prior schema definition is not necessary. Designed as an open-source system, Redis implements a storage system through data structures that can be used as a database, cache, or message broker. Redis incorporates important features such as abstractions of many structures, replication, transaction support, persistence, automatic partitioning, atomic operations, asynchronous replication, and automatic failover (Redis.io, 2020).

Ingesting streaming data in real-time is a common requirement for many BDA use cases. In areas such as IoT, e-commerce, security, communications, entertainment, finance, and retail, which are highly dependent on timely and accurate decision-making processes, real-time data collection and analysis is indeed essential for business. Redis has become a popular choice for these scenarios, as it consists of a lightweight in-memory database platform, reaching millions of operations per second with latencies less than milliseconds while using minimal resources (Kumar, 2017).

4. Methodology

To analyze in-depth the impact of information technology in a social environment strongly impacted by the Coronavirus pandemic, this research opted for the qualitative method of participant observation. The data collection used in this modality had the participation of a researcher as an insider, which contributed to obtaining a detailed and sequential view of the observed events. Participant observation aims to produce a dense description of the research context in natural environments (Luiz Marietto & Sanches, 2013). For this matter, this research counted on the active participation of a member of the IT department from Dataprev, involved in the planning, implementation, and analysis of the Emergency Aid project.

In his seminal article, Gold (1958) determines the typology of the Participating Observer based on the intention and degree of involvement that the observer adopts during the research. This research adopts the degree of Full Participant, when the researcher, a routine member of the group has his scientific interest unknown to the group and keeps his interest in disguise. It should be noted that the publication of the research results on this article is approved by the institution's board of directors.

5. Emergency Aid and Big Data Analytics

The worldwide pandemic crisis demanded from governments the implementation of systems with the capacity to handle BDA in a very short timeframe, aiming at storing, processing, and consulting huge volumes of unstructured data coming from different sources at great speed, to help the decision-making of several departments and sectors. Data Lakes address such requirements, as they offer developers and data scientists repositories that enable broader access to raw data. Data Lakes can be used as a preparation environment for Data Warehouses, as experimentation platforms for scientists and data analysts, and finally, as a direct source for Business Intelligence in the self-service modality (Llave, 2018).

The Emergency Aid data lake combined 23 different databases from public administration that Dataprev already had access to. Those data included the National Register of Social Information (CNIS) and other sources from the Federal Public Administration, States, Municipalities, and Judiciary. A complete overview of the designed solution is displayed on the model from Figure 1. The figure displays the complete data source list used on the Emergency Aid data lake. After the initial processing, the analytical rules defined by the Ministry of Citizenship were applied and validated, with the results sent for the aid payment directly in the citizens' digital accounts.

The results of the processing needed to be presented to citizens transparently, informing the reason for granting or denying the payment. If a citizen believes that the result is not correct, a contestation form could be used to inform any mistaken applied business rule, to update their personal information, or to identify any fraud in the declaration process. Figure 1 summarizes all the data flow from the Emergency Aid data lake, including qualification, integration, and data security processes.

A multidisciplinary team was formed to deliver the project, composed of architects, developers, DBAS, data administrators, testers, leaders, and business analysts. The Emergency Aid application architecture was designed to enable simultaneous data consumption at both relational and No-SQL databases. This feature grants the solution data integrity, better response time, and flexibility.
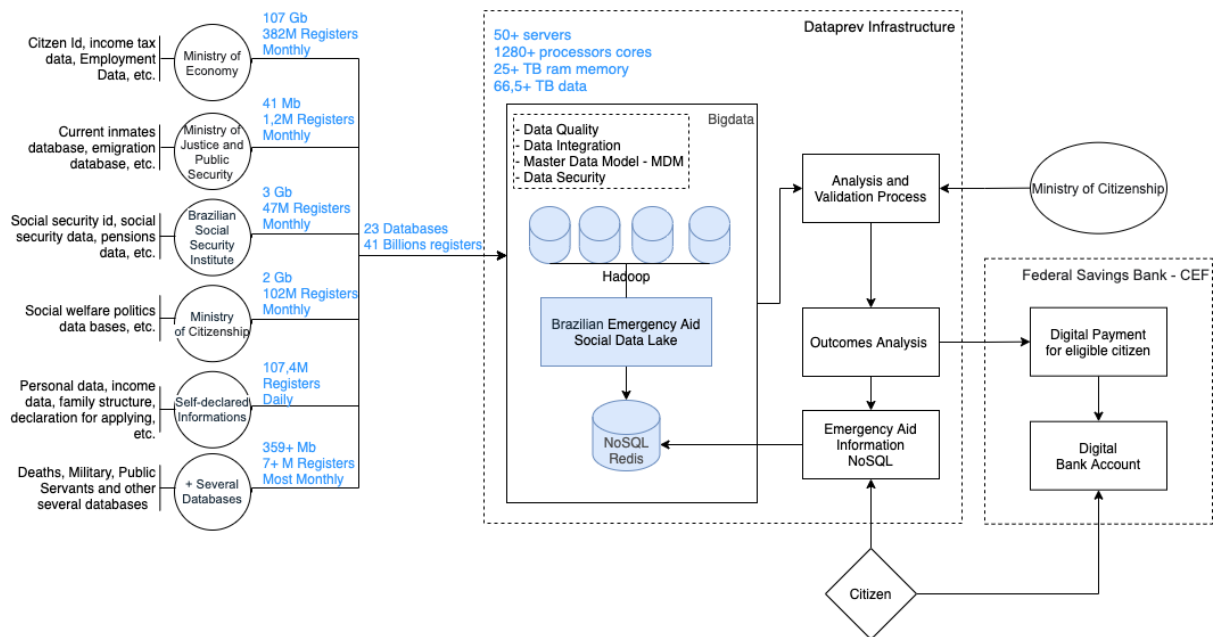
Figure 1: Conceptual Model of Dataprev's Emergency Aid solution
(Source: the authors)

As the requirements for Emergency Aid included the access and processing in almost real-time of an enormous data flow generated in high volume and speed, a non-relational database with a key-value type such as the Redis database revealed to be the most appropriate option for Dataprev's solution architects. Its features and architecture enable the creation of scalable databases, ranging from a simple prototype to systems with hundreds of gigabytes of data and millions of requests per second (Carlson, 2020).

To guarantee the number of simultaneous accesses to the Emergency Aid consultation application, Dataprev architects structured a responsive frontend based on React that serves for new and future data handling applications based on Redis technology with NoSql memory database. Additionally, the solution backend relied on Java Rest using Oracle Weblogic application servers.

Loads to the Redis database were made as soon as the update of the main relational database was changed by the benefit analysis processes. The application launch on the night of May 3rd, 2020 achieved 500,000 simultaneous accesses on the platform without any media advertisements. In less than 5 days, 21 million hits had been made with response times of less than 1 second. The overall infrastructure had more than 50 virtual servers, with its capacity tested in a pre-production environment with more than 1,000 views per second (Govbr, 2020). During the application go-live, a monitoring room was set up with panels based on Elasticsearch and Prometheus technologies, which enabled the application's telemetry around quantitative data access, including response time and errors.

The alternative of building and operating a Data Lake in a Redis database environment to support the Emergency Aid system was a highly coherent and feasible choice, as it would meet the requirements for implementing a high performance and capacity system, to be implemented in a very short space of time, unifying several databases (new and existing), dealing with a gigantic mass of structured and unstructured data, submitted to thousands of simultaneous requests for access and coming from the population of a country with continental dimensions.

6. Outcomes

Emergency Aid had a massive impact on protecting the most vulnerable citizens during the Covid-19 pandemic in 2020. According to the National Household Sample Survey (PNAD), the benefit was requested by 125 mi Brazilian citizens and approved for 67,8 mi, representing 32,13% of the country's population reached (Casa Civil, 2020). This reach was higher than other countries in Latin America, such as Argentina which covered 20% of its population with social protection (Blofield et al., 2021).

The total investment from the Brazilian Government on Emergency Aid exceeded 54,4 billion USD (Casa Civil, 2020). Poverty and inequality in the country have been reduced due to the impact of the EA, but after a reduction in the public policy payments, the average income is returning to the same levels before the pandemic (Duque, 2020). According to a study carried out by the Brazilian government, the income transfer programs managed to contain extreme poverty by 80% in 2020. If there is currently an estimated 2.1% of the population in a situation of extreme poverty, without the programs that index would be 12.4% of the population (Govbr, 2020).

7. Final Remarks

This study reveals how the evolution and use of NoSQL and BDA technologies were essential to meet the public measures taken by the Brazilian government to mitigate the social harms caused by the Covid-19 pandemic. Developed in only 14 days and first applied in May 2020, the Emergency Aid platform prevented more than 20 million Brazilians from returning to extreme poverty during 2020. Such application enabled the largest financial resources transferring for the most vulnerable population in Brazilian history.

The quick solution presented by Dataprev using Big Data technologies highlights the benefits of an effective and neutral IT Governance in the public sphere for the execution of public policies at the appropriate time. Moreover, the Emergency Aid case revealed the value that the NoSQL and BDA can provide to social programs. The Brazilian government's response to the social crisis suggests a trend of incorporating technology to foster and enable social policies around the world.

Although the Emergency Aid initiative was successful, it revealed some deficiencies regarding the data quality, resulting in fraud occurrences by people who should not receive the benefit according to interdisciplinary bodies such as the Federal Police and the Brazilian Justice. Moreover, a large amount of data in decentralized databases hindered the speed of updating and validating the request for certain groups of citizens.

The Brazilian Emergency Aid case proves that assimilated Big Data technology enables efficiency and agility for governments by solving complex needs. Data availability is a valuable asset for implementing public policies by identifying patterns, optimizing processes, and enabling decision-making.

Several questions around Big Data Analytics and public policies are yet to be answered by further research, including how to measure the effectiveness of income distribution; how can governments use NoSQL and BDA capabilities and technologies to prevent frauds and corruption in social services; how BDA can enable the creation of new smart public services; and how BDA can help governments to forecast the impact of new public policies.

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8. Digital Innovation for Financial Services Organizations: A Preliminary Consideration of Lines of Action for Organizational Practices

Wilfred Samuels
University of the Western Cape
3311334@uwc.ac.za

Malcolm Garbutt
University of the Western Cape
mgarbutt@uwc.ac.za

James Njenga
University of the Western Cape
jkariuki@uwc.ac.za

Abstract

As companies respond to digital disruption, traditional organizational practices are failing to respond rapidly enough. Traditional, pre-digital organizations are structured around practices in silos that enforce rules and legacy processes which result in "speedbumps" to digital innovation by slowing work and customer reaction times. Companies who have become reliant on digital innovation to improve service, such as financial services organizations, and do not adjust their organizational practices to respond to process changes may cease to exist. When considering digital innovation, a key challenge is a low level and fragmented understanding of organizational practices, even though there is an increasing number of documented benefits of transforming organizational practices. There is, therefore, a need for research to better understand organizational practices when considering digital innovation. This study responds to this call through a meta-aggregative approach to synthesize organizational practices associated with digital transformation when considering digital innovations. The meta-aggregative approach extracted recurring practices as lines of action guided by the Technology, Organization and Environment framework from which thirteen lines of action were identified. These lines of action provide recurring organizational practices affecting digital innovation in the financial services industry that affect digital innovation.

Keywords: Organizational Practices, Digital Innovation, Digital Transformation, Lines of Action.

1. Introduction

The increasing availability and application of information and communications technologies in organizations have led to widespread encoding, storage and dissemination of information in digital formats (Yoo et al., 2010). The encoding process is termed digitization and provides non-digital objects with qualities previously only found in digital objects (Yoo et al., 2010). Digitization provides digital innovation opportunities that combine digital and physical objects to add value to users (Legner et al., 2017; Yoo et al., 2010). Digital innovation is not limited to technology companies or information technology (IT) departments but extends to all industries and functional units (Yoo et al., 2010) and includes the innovation of products, processes, and organizational practices (Ciriello et al., 2018). Challenges in implementing digital innovation often arise due to a low level of understanding of the organizational practices (Ciriello et al., 2018) which hold potential to promote improvements in innovative performance (Chanias et al., 2019; Ciriello et al., 2018; Foss et al., 2010; Kohli & Melville, 2019). Over time, organizational practices become entrenched as the de facto way of doing things and become part of the organizational culture (Foss et al., 2010).

As companies respond to digital disruption, traditional organizational practices fail to respond rapidly enough to customers' demands and needs. Traditional (pre-digital) companies have successfully structured organizational practices around organizational silos in well-established management hierarchies that enforce rules and legacy processes which result in "speedbumps" to digital innovation by slowing work and customer reaction times (Dery et al., 2017). Companies that do not adjust their organizational practices to respond to digital innovation in their services and products offered may cease to exist (Kohli & Melville, 2019; Lokuge et al., 2019). Despite the benefit of organizational practices, research is fragmented with no definitive understanding of how organizations use these practices to advance digital innovation (Ciriello et al., 2018; Tumbas et al., 2018; Faulkner & Runde, 2013). Ciriello et al., (2018) view these organizational practices as to how innovators use digital artefacts to contribute to the innovation agenda, which makes it imperative to understand the role of organizational practices in mediating innovations. The organizational practices are little understood, are evolutionary and with far-reaching consequences (Faulkner & Runde, 2013). Therefore, there is a need for studies on how organizational practices affect digital innovation (Ciriello et al., 2018; Tumbas et al., 2018; Faulkner & Runde, 2013).

Fintechs are technology-enabled financial services organizations that use digital innovation to improve their service offerings (Arner et al., 2016; Mention, 2019; Schueffel, 2017). In Africa, the most successful Fintech application currently is M-Pesa which converts cash into e-money for secure transfer between mobile phones (Coetzee, 2019). In South Africa, digital banking, often by non-bank financial organizations, has created significant competition for the traditional banks (Camarate & Brinckman, 2017) who are risk-averse, have incompatible legacy systems and are heavily regulated (Coetzee, 2019). Those who have adopted digital innovation and adapted their practices are slowly disrupting traditional financial markets. However, digital innovation for financial organizations separates the customer from the organization resulting in a loss of trust (Coetzee, 2019). Fintech organizations who do not modify their organizational practices risk losing relevance and potentially their existence (Gomber et al., 2018; Mungai & Bayat, 2018).

In the following pages, section two provides a brief background of digital innovation in the financial services industry and organizational practices together with the research objectives. Section three outlines the research design with the finding presented in section four. Section five summarizes the findings and presents the limitations to this study and future research.

2. Literature review

Innovation is vital for new products and services which add value for customers, create a competitive advantage for firms and provide a better quality living environment for citizens (Lee & Trimi, 2018). Innovation is defined as the implementation of a new or significantly changed product, service, process, organizational practices, or relationship (Gault, 2018). Innovation refers to outcomes, processes and mindsets. As outcomes, innovation is pragmatic in considering the results that an organization seeks to achieve. Innovative processes are the initiatives through which innovation can be achieved while mindsets cultivate the culture needed for innovation (Kahn, 2018). Although innovation may achieve competitiveness and economic success, it increases complexity and requires diverse, dynamic capabilities and organizational routines (Mousavi et al., 2018). Out of four types of innovation - product, process, marketing, and organization - Harel et al. (2020) emphasize process innovation due to its potential impact on an organization's efficiency, quality and extent of product offerings.

Digital innovation is a transdisciplinary topic fusing digital and physical across levels, settings, technologies, and organizational functions (Nambisan et al., 2020). It is a sociotechnical

phenomenon which encompasses a wide range of outcomes from products and services to platforms, customer experiences and value propositions (Nambisan et al., 2017). Hess et al. (2016) regard digital innovation as the enacted combination of digital technologies, digital solutions and digital business concepts. They warn that if digital innovation is to succeed then the organizational practices need to change lest the barriers between the old and new be strengthened. Consequently, there is a need for theorizing about digital innovation management (Nambisan et al., 2017; Nambisan et al., 2020). Digital innovation has prompted a fluid entrepreneurial culture, empowering digital investments and undertakings to grow significantly due to two essential features (Huang et al., 2017). First, digital products are often inexpensive to scale after their initial creation. Second, digital technologies are malleable and can enhance an existing product without significant change to the current design (Huang et al., 2017). Therefore, organizations need to balance digital approaches with traditional business principles for emerging technologies (Hess et al., 2016). Organizations adopting digital innovation require digital transformation (Fichman et al., 2014) as digital innovation transforms the way the employees work due to digital innovation. Research has shown a moderating effect of process innovations between IT and productivity (Kijek & Kijek, 2019), increasing the organization's responsiveness and productivity (Brynjolfsson & Mcafee, 2013; Lucas et al., 2013; Yoo et al., 2012). This requires understanding the organizational practices which support the innovation process (Ciriello et al., 2018; Kohli & Melville, 2019).

2.1 Digital Innovation in the financial industry

The financial services industry includes insurance, banking, credit markets and investment management services (Thakor, 2020). Digitizing financial institutions can extend financial services to a broad consumer group (David-West et al., 2018), which in developing countries, such as South Africa, can increase access especially among rural peoples (Chigada & Hirschfelder, 2017; Coetzee, 2019; Mungai & Bayat, 2018). With the incompatibility of legacy systems limiting the effectiveness of potential financial services networks (Coetzee, 2019), it is essential to understand what factors influence the adoption of new technological innovations in financial companies (Hoti, 2015). Digital innovations deliver cheaper ways of transacting, resulting in lower customer acquisition costs, improved customer experience, lower verification costs and cheaper information transmission (Boratyńska, 2019; Gomber et al., 2018; Thakor, 2020). Digitization also offers regulators better knowledge sharing and insights, which can be leveraged to improve customer experience and assist organizations with compliance of regulatory obligations (Mention, 2019). However, financial services organizations differ from other industries (Zhu et al., 2006) as these organizations are linked through complex networks to each other and their customers (Mulligan & Gordon, 2002) and generic digital innovation factors may not be appropriate for Fintechs. Consequently, this research sought to identify organizational practices that could influence the adoption of digital innovations, particularly for Fintechs.

2.2 Organizational practices for digital innovation

Practice is useful for framing and orienting organizational research as practices are recurrent sets of activities reproduced over time (Orlikowski & Scott, 2008). Reckwitz (2002) describes practice (*praktik*) as routinized behaviors comprising several interconnected elements: bodily activities; mental activities; material things and their use; background understanding; know-how; emotion and motivation. Studying organizational practices can provide insight into how people's actions contribute to organizational outcomes (Feldman & Orlikowski, 2011). Although practice may not produce the same results in all organizations (Slowinski & Sagal, 2010), some innovation management practices are essential for adopting innovation (Oke, 2007). Oke (2007) determined three forms of innovation - radical, me-too (emulating a

competitor) and incremental, and encouraged companies to define formal processes for implementing these forms of innovation. Oke (2007) further identifies innovation management practices in relation to organizations' innovation strategy, managing creative ideas, selecting and managing portfolios, implementing ideas, and managing people. These practices are conducted by skilful, purposeful and social humans who use resources "to satisfy their needs and intentions" (Ciriello et al., 2018, 565) leading to innovative solutions. For Financial organizations, organizational practices would entail providing the necessary artefacts to skillful, purposeful and social humans to create new solutions.

Theoretical frameworks provide reliability and validity when researching a phenomenon (Saunders et al., 2009). One popular and proven theoretical framework to frame technology innovation is the technological, organizational and environmental (TOE) framework (Bhattacharya & Wamba, 2015; Oliveira & Martins, 2011). TOE is a comprehensive organization level theory (Baker, 2011) with technological innovation at its core and three points of view from which to evaluate technology innovation (Bhattacharya & Wamba, 2015). The first view is the technology which serves as a prism for evaluating the technology factors (Ngah et al., 2017). The second view is the organizational viewpoint related to various aspects of the organization (Gutierrez et al., 2015). Finally, the environmental context concerns the organization's environment (Harfoushi et al., 2016). The TOE framework has been used to examine the adoption of digital innovations in diverse industries, including financial services (Zhu et al., 2006) and Fintechs (Varma, 2019).

2.3 Research objectives
The objective of the research was to identify organization practices essential to digital innovation in Fintech organizations. Two research questions are posed to guide the study: What organizational practices assist in producing digital? And, how do the identified organization practices assist in producing digital innovation?

3. Research design and method
A meta-aggregative approach was used to synthesize recurring organizational practices affecting digital innovation (Hannes & Lockwood, 2011) with particular attention to Fintech organizations. A meta-aggregative approach is a form of systematic qualitative review originating at the Joanna Briggs Institute in Australia and inspired by American pragmatism to produce "lines of action" from synthesized statements (Hannes et al., 2018). The lines of action are directive, providing direction and advice for practical decision-making (Hannes et al., 2018). However, to reach its full potential, meta-aggregation requires a mixed-methods approach to determine effectiveness (Hannes & Lockwood, 2011).

Meta-synthesis is a coherent analysis of data by selecting, appraising, summarizing and combining qualitative evidence to address a research question (Erwin et al., 2011). The meta-synthesis approach begins with defining inclusion and exclusion criteria for identifying research articles, analysis and screening methods for refining the selected articles and generating lines of action for identified processes. Noblit and Hare (1988) describe synthesis as an activity in which different parts are brought together to form a whole. Unlike other qualitative approaches, the meta-aggregative approach lessens the interpretation of findings. It is used to identify and summarize existing themes by selecting and systematically reviewing research articles (Hannes et al., 2018). This approach proves useful where concepts are predefined rather than redeveloped and saves time as it provides a direct path to qualitative evidence produced for a specific phenomenon of interest (Hannes et al., 2018).

3.1 Instrument Development

This study followed the four-phased model outlined by Hannes et al. (2018). Searching and selecting studies using inclusion criteria was followed by a critical analysis of each research paper to exclude papers based on pre-determined exclusion criteria. Data were extracted from the resultant papers and categorized through the sensitizing lens of the TOE framework.

3.1.1 Search strategy and selection of studies

A set of inclusion and exclusion criteria depicted in Table 1 was developed for the search process. The keywords included "organizational practices", "digital innovation", "digital transformation" and "financial services" or "fintech". The inclusion keywords were used in the Google Scholar search engine with the time option set to "Since 2016". Preference was given to the basket of eight journals (AIS, 2020). This rendered a total of 439 articles.

Criteria	Inclusion Criteria	Exclusion Criteria
Keywords	"organizational practices", "digital innovation", "digital transformation" and "financial services" or "fintech" and derivatives.	
Language of articles and publications.	Articles and publications must be written in English.	
Year of Publication.	Published from 2016 to the beginning of 2019.	
Relation to organizational practices affecting digital innovation.	Strong relation to respective organizational practices affecting digital innovation.	Vague/weak relation respective to organizational practices affecting digital innovation.
Publication status.	Only international peer-reviewed journal articles and book chapters from renowned publishers.	
Article Methodology.	Qualitative Methodology.	Quantitative Methodology to limit preconceived constructs. (only the themes of TOE were used as a sensitising lens)

Table 1: Inclusion and Exclusion Criteria

3.1.2 Critical appraisal

The second phase of the meta-aggregative synthesis critically appraised the methodological quality of papers collected during the search and selection stage (Hannes et al., 2018) in two stages. First, the selected articles' abstracts were assessed based on the exclusion criteria that excluded 370 articles. Second, the 69 retained articles were read in-depth and assessed using the JBI Qualitative Assessment and Review Manual appraisal checklist (JBI Global, 2020). Four of the ten criteria for assessing the validity of the articles were applied in this study. The four selected criteria assess (i) the congruity between the methodology and the research questions and objectives, (ii) the representation and analysis of data, (iii) the interpretation of the results, and (iv) the conclusions made from the analysis and interpretation of the results. The checklist resulted in the exclusion of a further 28 articles to retain 41 articles. Due to lack of space, neither the instrument nor the assessment are included in this paper.

3.1.3 Data extraction and categorization

In the third phase, findings from the 41 articles were coded based on comparison and theoretical similarity. Analogous codes were combined into thematic categories (Hannes et al., 2018) guided by the TOE framework.

3.1.4 Synthesis of findings

The fourth and final phase in the meta-synthesis in the aggregative approach was the conversion from categories to lines of action (Hannes et al., 2018). The categories were linked to the TOE framework constructs and are discussed in the next section.

4. Findings

The categories generated from the 41 selected articles associated with each TOE theme are described here. Lines of action were formed for each category and validated based on conceptual commonalities observed in cross-comparing the articles (Hannes et al., 2018). Thirteen categories were identified as depicted in Table 2.

Theme	Category	Line of Action
Technology	Access to technology	Ensuring secure access to technology
	Appropriateness of technology	Ensuring an appropriate scalable technology base
	Affordability of technology	Manage costly technology acquisitions
	Maintenance and support	Leverage competencies and agile practices to provide a responsive maintenance and support structure
	Integration into daily routines	Integrate digitally-enabled processed into current organizational practices
Organization	Organizational structure	Redefine organizational strategy and structures to include digital innovation
	Collaborative capacity	Encourage collaboration within the organization
	Governance and compliance	Develop business rules incorporating governance and compliance policies and procedures
	Funding	Ensure adequate funding for innovation
Environment	Locally relevant content	Participate and nurture the digital innovation ecosystem
	Socio-cultural factors	Encourage awareness of diversity and entrepreneurial thinking
	Legal and regulatory issues	Develop regulatory policies to ensure consistent, reliable and secure access
	Political and government structure	Align continuously with public structures to avoid political and governmental hindrances

Table 2. TOE framework for Fintech digital innovation showing the lines of action.

4.1 Technology

Five categories, each matched with lines of action were observed for the technology construct - access to technology, appropriateness, affordability, maintenance and support, and integration into the daily routine.

4.1.1 Access to Technology

Digital innovation necessitates access to technology with the capabilities and strategies for implementing emerging technologies such as big data, social media, cloud, emerging and other disruptive digital technologies (El Sawy et al., 2016; Dremel et al., 2017; Günther et al., 2017; Huang et al., 2017; Ives et al., 2016; Scuotto et al., 2017). Connectivity technologies require appropriate firewalls to control unauthorized access (El Sawy et al., 2016; Rolland et al., 2018; Sia et al., 2016; Svahn & Mathiassen, 2017). Access to adequate processing power must be available for implementing big data and data analytics for customer retention (El Sawy et al., 2016; Rolland et al., 2018; Suseno et al., 2018; Svahn & Mathiassen, 2017).

4.1.2 Appropriateness of Technology

Appropriate applications with relevant digital platforms must be deployed to digitize traditional services and process financial services (Huang et al., 2017; Jensen & Bækgaard, 2016; Marcinkowski & Gawin, 2019; Rolland et al., 2018; Saunila et al., 2019; Scuotto et al., 2017). A layered module architecture can provide a robust technical foundation by digitizing the installed base modularly. This can enable traditional organizations to drive digital innovation and create networks of consumers, producers, service providers, and third-party developers to create value (Constantinides et al., 2018; Herterich et al., 2016).

4.1.3 Affordability of Technology

Costly technology investments can be made more affordable through appropriate management practices and by exploiting collaborations, open innovation models and software-as-a-service

(SaaS). Collaboration can enable organizations to launch digital initiatives that include suitable specialized technical expertise and incubate and accelerate emerging digital innovations (Dremel et al., 2017; Kaulio & Thorén, 2017; Scuotto et al., 2017; Svahn & Mathiassen, 2017; Winkler & Kettunen, 2018; Yeow et al., 2018). Open innovation is based on permeable organizational boundaries that provide access to knowledgeable external sources while increasing the internal knowledge pool's diversity and improving cost efficiency (Huang et al., 2017; Leminen & Westerlund, 2019; Panopoulos et al., 2018; Scuotto et al., 2017). SaaS can provide economical, manageable and scalable digital solutions (Dremel et al., 2017; El Sawy et al., 2016; Oliveira et al., 2019).

4.1.4 Maintenance and Support
IT departments must be integrated into the organizational processes in close collaboration with business departments to leverage the IT departments' competencies to maintain and support digital innovation (Chanias et al., 2019; Dremel et al., 2017; Ravichandran, 2018; Scuotto et al., 2017). A platform must be established for agile adaptation to rapidly changing technology and organizational practices (Dery et al., 2017; El Sawy et al., 2016). Rapid changes require that Fintechs leverage practices such as agile methodologies to respond to these changes (Chanias et al., 2019; Dremel et al., 2017; Ravichandran, 2018; Saldanha et al., 2017).

4.1.5 Integration into Daily Routine
Effective use of digital innovation requires that daily routines incorporate digitally-enabled processes. Although digital transformation builds on many smaller, manageable digital innovations, it is disruptive. The better an organization is at leveraging existing business as a digital innovation, the faster and, potentially, the more successful it will be. Integrating digital innovation into daily practices will enhance and support the existing business processes and enable quicker acceptance of the innovations (Dremel et al., 2017; Kaulio & Thorén, 2017; Saldanha et al., 2017; Svahn & Mathiassen, 2017; Winkler & Kettunen, 2018).

4.2 Organization
Four categories and matching lines of action were observed for the organization construct - organizational structure, collaborative capacity, governance and compliance, and funding.

4.2.1 Organizational Structure
Digital transformation requires a digital transformation strategy. The strategy must set roles and responsibilities (Dremel et al., 2017; Saunila et al., 2019; Sia et al., 2016; Tumbas et al., 2018) and should establish digital innovation hub driven by a visionary chief digital officer (Chanias et al., 2019; Dremel et al., 2017; El Sawy et al., 2016; Kaulio & Thorén, 2017; Mathiassen, 2017; Sia et al., 2016; Yeow et al., 2018). Human resources play a vital role in the success of these initiatives as without the relevant roles, responsibilities and competencies, most digital initiatives fail (Dery et al., 2017; Dremel et al., 2017; Jensen & Bækgaard, 2016; Saunila et al., 2019; Sia et al., 2016; Svahn & Mathiassen, 2017; Yeow et al., 2018). Human resources must ensure purposeful training to broaden the business and IT skillsets to support infrastructure and data integration (Chanias et al., 2019; Dremel et al., 2017; Ravichandran, 2018; Scuotto et al., 2017).

4.2.2 Collaborative Capacity
Collaboration is essential for digital innovation. Leveraging existing collaborations assures cost-efficient coordination of internal resources (Dremel et al., 2017; Scuotto et al., 2017; Svahn & Mathiassen, 2017; Vetterli et al., 2016; Yeow et al., 2018). Intra-organizational and inter-organizational collaboration shares knowledge, technologies and other resources between

and across organizational boundaries (Dremel et al., 2017; El Sawy et al., 2016; Herterich et al., 2016; Ollila & Yström 2016; Sia et al., 2016; Yeow et al., 2018).

4.2.3 Governance and Compliance
Digital innovation which shifts organizations to bottom-up processes must include business rules enforced by governance for compliance in the collaborative networks (Bunduchi et al., 2019; Dery et al., 2017; Dremel et al., 2017; Rolland et al., 2018; Saldanha et al., 2017). Likewise, flexible, reactive customer-driven innovations need robust governance frameworks (El Sawy et al., 2016; Yeow et al., 2018), which must balance control and flexibility (Svahn et al., 2017).

4.2.4 Funding
Although collaboration and sharing of resources can provide more affordable technologies, digital innovation still requires high levels of funding with a willingness to invest aggressively in digital technology, process competence and research and development (Ravichandran, 2018; Scuotto et al., 2017; Winkler & Kettunen, 2018; Yeow et al., 2018).

4.3 Environment
Four categories and corresponding lines of action were observed for the environment construct - locally relevant content, socio-cultural factors, legal and regulatory milieu, political and government structures.

4.3.1 Locally Relevant Content
Practical digital innovation that is relevant in multiple contexts requires knowledge of local content for each context. Collaboration platforms must integrate local organizational and user knowledge into the innovation process (Abrell et al., 2018; Saunila et al., 2019; Sergeeva & Trifilova, 2018) while maintaining a balance between global and local content and processes (Dremel et al., 2017; Rolland et al., 2018; Yeow et al., 2018).

4.3.2 Socio-cultural Factors
The success of digital initiatives depends on transforming the workplace culture and instilling entrepreneurial thinking. The financial services organizational culture should include the norms, beliefs, values and behaviors that influence employee performance and help to develop core competencies relevant to the digital age (Dery et al., 2017; Dremel et al., 2017; El Sawy et al., 2016; Saunila et al., 2019; Sia et al., 2016).

4.3.3 Legal and Regulatory Milieu
Financial services organizations must ensure reliability, security and privacy. Flexible access to back-end systems must be balanced with authorized access (El Sawy et al., 2016; Herterich et al., 2016; Ives et al., 2016; Svahn & Mathiassen, 2017). Legacy IT system should be replaced with standardized business processes built on business process blueprints (Marcinkowski & Gawin, 2019; Winkler & Kettunen, 2018). Strict contractual and relationship management must be established with external partners (Constantinides et al., 2018; Sia et al., 2016) and strong governance (Winkler & Kettunen, 2018).

4.3.4 Political and Government Structures
Government, public and political agencies follow a logic different to financial services organizations and may influence the organization's digital innovation vision (Bunduchi et al., 2019; Svahn et al., 2017). Continuous alignment is required to relieve political tensions brought about by public structures that hinder digital innovations (Chanias et al., 2019).

5. Discussion and Conclusion

The objective of this study was to identify lines of action for organizational practices essential to digital innovation in financial services organizations as current research of organizational practices affecting digital innovation is fragmented. A meta-aggregative approach to synthesize organizational practices for digital inclusion in Fintechs, identified 41 articles between 2016 and early 2020. From these articles, thirteen lines of action were generated as guidelines for digital innovation efforts. The TOE framework provided three primary themes - technology, organisation and environment - to guide the lines of action.

The technology line of action guides access, appropriateness, affordability, and technology support, which must to be integrated into daily routines. Access is required for emerging and digital technologies with adequate processing power protected from unauthorized access. Technology must be appropriate and integrate the organizational processes into collaborative networks. Conservative fiscal management of technology costs is mandatory and cost-lowering initiatives that exploit collaborations, open innovation models and software-as-a-service should be explored. Continuous support for the deployed technology must be assured. Organizations should leverage existing technology knowledge enhanced through agile methodologies for support.

The organization line of action guides organizational structure, collaborative capacity, compliance governance, and funding. Digital innovations require a digital transformation strategy to set roles and responsibilities for which human resources are relied upon for implementation and training. A digital innovation hub with a visionary chief digital officer is recommended. Collaborative capacity leverages cost-effective resources and provides support by combining knowledge and resources throughout the Fintech supply chain. Governance is imperative for compliance in these collaborative networks. However, governance must maintain a balance between control and flexibility. Digital innovation requires high levels of funding which may be reduced through collaboration and diligent management.

The environment line of action guides locally relevant content, socio-cultural factors, legal and regulatory milieu, political and government structures. Global organizations must incorporate local knowledge and processes, maintaining a balance between local and global. Digital innovation is dependent on the workforce, which requires a digital-age work culture and entrepreneurial thinking. Financial services organizations must ensure reliability, security and privacy. Standardized business processes and strict contractual relationships aid in adherence to legal and regulatory requirements. Continuous alignment is required to relieve political tensions brought about by public structures that could hinder digital innovations.

Methodologically, the meta-aggregation synthesis approach, which generated the lines of action, proved useful for investigating digital innovation. Nevertheless, several limitations were noted. The selected research methodology has been criticized for focusing on the quality of articles more than the relevance of the article findings (Pearson, 2004). However, the methodology does not provide clear guidance on the definition of quality ratings or how to deal with low-quality articles (Hannes et al., 2018). Further restrictions include only selected journals between 2016 and 2019 and exclusion of quantitative articles.

Future research can extend the time frame and include other journals and articles with quantitative methods. A comparative study of the identified lines of action in financial services with other industries is indicated. Future research could include quantitative methods to

confirm the lines of action. Further work could explore governance and collaboration and an in-depth understanding of the process changes required for digital transformation.

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9. Digital Maturity Level of a B2B Company: Case Study of a Brazilian Complex Manufacturing Company

José Airton de Santos
FGV EAESP
jose_airton@hotmail.com

Eduardo de Rezende Francisco
FGV EAESP
eduardo.francisco@fgv.br

Abstract

This paper aims to analyze the digital maturity level of a large Brazilian B2B packaging company and the main challenges this company faces on its digital transformation journey. To this end, the authors conducted a case study and took a hybrid (qualitative and quantitative) approach to data analysis. The main findings include the B2B company's low digital maturity level and its difficulty in transitioning from an operational efficiency-focused culture to a digital one. It can be inferred from the findings that there is a low degree of concordance among the organization's executives regarding their understanding of digital resources and digital leadership capability. It is also plausible to assume that employees are unfamiliar with digital transformation concepts because the organization is not successfully informing all its staff about the subject. This study points out that digital technologies add another dimension to the challenges faced by traditional businesses, and shows the importance of rethinking traditional corporate culture and organizational boundaries, as well as of exploring new assets, such as data and insights, through a digital lens, thus creating new opportunities to add value to a traditional organization in a digital world.

Keywords: B2B industry, Digital transformation, Digital maturity, Digital technologies.

1. Introduction

According to Clark (2019), quoting *Double-Digit Growth* author Michael Treacy, "we are at the dawn of a revolution of how businesses do business with other businesses." Internet 2.0 was a revolution for the relationship between companies and consumers, but "Internet 3.0 is at our doorstep and that will be a business to business revolution". Agreeing with Treacy, Clark admits that digital transformation in the B2B industry "will not be as easy as what Amazon did to retail sales, but it is going to have the same effect. B2B selling is more complicated, but we are headed toward an Amazon world in the B2B environment."

According to Westerman, Bonnet and McAfee (2014), few organizations are using digital technologies to generate higher levels of profit, productivity, and performance, despite their enthusiasm for digital transformation. The authors attribute this state of affairs to the lack of the necessary capabilities to make technology work in a different way, and to insufficient development of the skills on which depend the planning, execution, and exploitation of digital strategies.

This paper aims to analyze the digital maturity level of a large Brazilian B2B packaging company which, despite having an innovation DNA in its production process, struggles with the challenges of digital transformation. The results of the qualitative and quantitative data analyses support the inference that there is a low degree of concordance among the organization's executives and employees regarding their understanding of digital resources and

digital leadership capability. This study points out that digital technologies add another dimension to the challenges faced by traditional companies. In the case of the company under study, these challenges include low level of digital maturity, capability and leadership; difficulty in transitioning from an operational efficiency-focused culture to a digital one; the employment of new digital technologies to add value to its business; the fast pace of change; and the shift in how to engage with customers and meet their expectations.

2. Theoretical Framework

2.1 Digital Transformation

According to Liu (2011), digital transformation is defined as "the integration of digital technologies into business processes," whereas Bharadwaj (2013) defines it as "organizational strategy formulated and executed by leveraging digital resources to create differential value." For Fitzgerald (2013), digital transformation, defined as the use of digital technologies, enables "major business improvements," while Lucas (2013) holds that digital transformation is fundamentally altering the traditional ways of doing business, and is redefining business resources, processes, and relationships. According to Vial (2019), digital transformation is defined as "a process that aims to improve an entity by triggering significant changes to its properties through combinations of information, computing, communication, and connectivity technologies." Digital transformation is related to the adoption of digital technologies with different impacts on business strategies. The deployment of such technologies can boost operational efficiency and organizational performance, add value to a business, uncover new ways of engaging with customers, and establish a digital culture.

2.2 Difference Between a Digitized and a Digital Company

According to Ross (2019), digitizing means converting from analog into digital form with the purpose of optimizing existing processes, building an operational backbone, or introducing ERP systems through a standardized process whose final state is known. On the other hand, digital refers to digital value propositions that require continuous and iterative testing and reviewing of market offerings, given that the final state is unknown. Being a digital company involves not only converting physical data to a digital format, but also adopting digital technologies to add value to a business.

2.3 Customer Experience

According to Zolkiewski et al. (2017), "existing measures of customer experience are problematic when applied in a B2B context. Rather than adopting input- and output-based measures, widely used in a business-to-consumer (B2C) context, a B2B context requires a more strategic approach to capturing and managing customer experience." The authors add that "improving understanding of customer experience in a B2B context should allow organizations to design better services and consequently enhance the experiences" of their customers. According to Pine (2015), "because the Internet has empowered buyers with so much information about sellers, business to business (B2B) companies face the threat of increasing commoditization, a market environment where their customers relentlessly seek to buy physical goods on the basis of price. To get out of the commoditization trap, B2B businesses need to continuously innovate how they attract, engage and excite customers by finding new possibilities for creating value."

2.4 Digital Transformation Maturity

Before embarking on a digital transformation journey, companies must make a clear picture of their starting point and their current level of digital maturity by comparing themselves with their competitors and with different segments and industries. This stage is key for planning a company's digital strategy, which consists in determining its digital maturity level, its goals concerning digital transformation, and its digital ambition. Westerman, Bonnet and McAfee (2014) have developed a methodology for identifying an organization's digital maturity level. According to this methodology, organizations that are at the beginning of their digital journeys tend to adopt a wait-to-see strategy, in an attempt to obtain certainty before acting.

2.5 Digital Transformation Strategy

According to Matt (2015), "in recent years, firms in almost all industries have conducted a number of initiatives to explore new digital technologies and to exploit their benefits. This frequently involves transformation of key business operations and affects products and processes, as well as organizational structures and management concepts. An important approach is to formulate a digital transformation strategy that serves as a central concept to integrate the entire coordination, prioritization, and implementation of digital transformations within a firm." B2B companies should prioritize their digital transformation strategies and take advantage of the full potential of digital technologies to find new ways of engaging and communicating with their customers, suppliers, and ecosystem. They should also identify innovations that can lead to increased productivity and competitiveness, with the goal of changing their revenue levels, and make the most of the digital transformation underway to add value to their businesses.

3. Objective

During the research process, a gap was identified in the literature on digital transformation in the B2B industry in Brazil. This prompted the formulation of this study's main objective, which is to analyze the digital maturity level of a large Brazilian B2B packaging company and the main digital transformation challenges faced by it. The study also aims to somehow contribute to raising awareness in society and companies about the digital transformation challenges, risks and opportunities in the Brazilian B2B industry. For this purpose, an organizational-level exploratory case study was conducted to identify the main digital transformation challenges faced by this century-old complex manufacturing company in the packaging segment.

4. Methods

4.1 Case Study

The case study in this paper is about a B2B complex manufacturing company which is a global leader in the packaging segment. The company's strategic ambition is to position itself as the go-to, lowest cost supplier in the global market. Although continuously striving to boost its operational efficiency, reduce costs, and ensure product quality, the company is struggling to move from an operational efficiency-focused culture to a digital one. Collis and Hussey (2013) point out that exploratory case studies are appropriate for investigating phenomena that are not well documented in literature, which is the case for the field under study here, with a shortage of empirical research and lack of consensus among authors.

4.2 Theoretical review

The research method was also based on secondary data sources. Relevant peer-reviewed articles on the subject were consulted, in addition to documentation, books, publications by governmental and non-governmental organizations, websites from trusted sources, and

previous research in the field of study. This study's theoretical review was limited to the concepts and data resulting from the field research on the organization that is the subject of this case study. It is therefore assumed that this theoretical review did not exhaust all the concepts and themes related to digital transformation in the Brazilian B2B industry.

4.3 Methodology
This research took a hybrid (qualitative and quantitative) approach to data analysis in order to achieve a better understanding of this case study's results. According to Merriam (1998), triangulation or a hybrid approach to data collection and analysis enhances data reliability and internal validity.

5. Data Collection
For the case study in this paper, the following data collection techniques were used: semi-structured interviews, online self-assessment survey questionnaires, and document analysis. The semi-structured interviews were the primary form of data collection used to answer the research question, whereas the other techniques were applied with the secondary purposes of context exploration and result validation. The script and questions of the semi-structured interviews and the questionnaire were extracted from the book *Leading Digital: Turning Technology into Business Transformation*, by Westerman, Bonnet and McAfee (2014). These questions were created and validated by the authors to help organizations to understand their level of digital maturity, given that, before setting out on their digital transformation journeys, organizations need to determine their starting point. It is important to highlight that the reliability, stability and results of the practical studies reported by Westerman, Bonnet and McAfee (2014) were key in deciding to apply their questionnaire to this case study.

6. Results

6.1 Analysis of the Interview Data
An initial analysis of the interview data resulted in the establishment of a certain number of categories. Then, the qualitative analysis of the interview content, using NVivo 11 software, started by the volumetric analysis of the interviews' codified segments, which were sorted out into categories and subcategories. The categories *digital transformation*, *B2B*, and *customer experience* were mentioned 74, 62, and 30 times respectively. All the six interviewees mentioned these categories in their interviews. It is worth highlighting that the subcategory *digital transformation maturity* was mentioned 42 times, and the subcategory *culture* of the category *B2B* was mentioned 45 times. All the six interviewees mentioned these subcategories in their interviews. The sunburst chart in Figure 1 shows the hierarchical levels of the categories and subcategories mentioned in the interviews, as well as their respective volumes of segments.

The interviewees varied in their understanding of digital transformation in the organization that is the subject of this case study. According to interviewee E1:

> *[...] for the company to move towards digital transformation, we need the company as a whole to have a similar mindset to that we are trying to implement through the actions in partnership with the consultancy firm, that is, how we use these digital tools, this world of artificial intelligence and Big Data, so we can really solve our day-to-day challenges.*
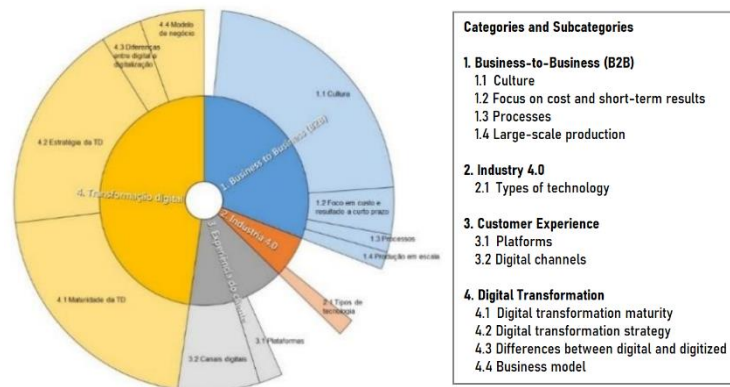
Figure 1
(Source: created by the authors using NVivo 11 software)

Interviewee E2 mentioned some cultural changes that the organization is promoting:

I think the company is promoting cultural changes for digital transformation, doing it in partnership with a university and such; but I think it is not yet investing, not yet training people, for example.

For interviewee E3, the organization must invest in and prioritize the innovation project of its production process:

So, Magma (the company's new process for manufacturing glass packages) *brings us to Taylorism, to the 1950s, because the glass packaging industry hasn't even arrived there yet. So, I don't think it's a digital revolution or transformation. Now, if you ask me whether I think the company's strategy is correct, I think it is, because I think we have to take this step in order to take the next.*

A point highlighted by interviewee E4 is that people, not technologies, are responsible for digital transformation:

Digital transformation lies in the mindset, not in technology. And if I'm talking about changing the mindset, I'm talking about changing the behavior. The main pillar is the connectivity mindset, which consists in expanding the decision chain and the value chain. And it's people who are going to manage it and lead it. So that's the point.

Respondent E5 fears that digital transformation could become another fad:

We talk about digital transformation, we have invested in digital transformation – there is also the partnership with a university, which is quite challenging. But we may not achieve all the results we are expecting from digital transformation. So, my fear is that this will become just another fad and we will have just wasted money.

Interviewee E6 points out that the organization's culture is focused on improving performance and reducing costs, and not necessarily focused on its end customer:

I think we have developed some technologies to improve performance, we have been working a lot on cost reduction. I have seen great effort by the company in this respect. Now, I do think we need to increase performance and added value, but I think we still have a... how can I express this? It is very much up to us to say what we think our clients need.

6.2 Analysis of the Online Self-Assessment Questionnaire Data

The analysis of the online self-assessment questionnaire consists of descriptive and multivariate analyses based on a database generated with the tool Microsoft Forms. The sample comprised 105 respondents (n = 105), 99 of whom were employees who answered the online questionnaire, and six were executives who filled out the questionnaire at the moment of their interviews.

6.3 Box Plots and Bar Graphs of the Questionnaire Answered by Employees and Executives

Part 1 of the Questionnaire: How well is your organization building digital technologies (digital capabilities)?

Question 1: Are we using digital technologies (such as analytics, social media, mobile, and embedded devices) to understand our customers better?
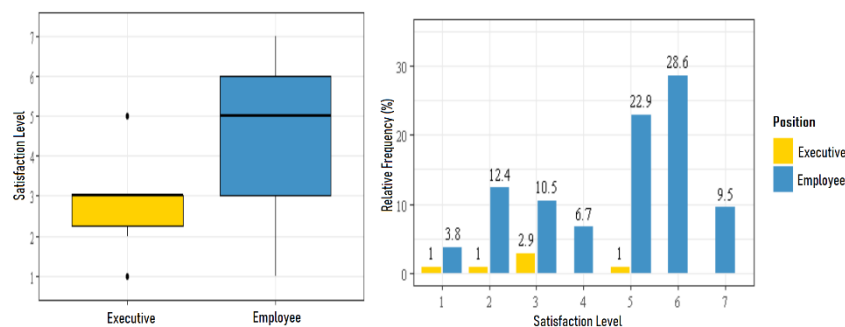

Figure 2

(Source: created by the authors using RStudio software (n = 105))

This first block of questions about the organization's digital capabilities shows significant variation in the answers of employees and executives, as shown in Figure 2. The answers given by employees can be seen to differ markedly from those given by executives. Data dispersion, box size, and relative frequency dispersion are very high. It might be speculated that employees are not familiar with digital transformation concepts, or that the organization is not imparting digital transformation knowledge to all staff levels. A considerable level of divergence can also be seen in the answers given by executives. Regarding question 1, from the observation that there are two outliers with satisfaction levels 1 and 5 respectively, it can be inferred that two of the executives do not share the same opinion because they are either unaware of digital technologies or do not know which tools are used by the organization to better understand its customers and meet their demands.

Part 2 of the Questionnaire: How well is your organization building leadership capabilities (digital leadership)?

Question 11: Do senior executives have a transformative vision of the digital future of our company?
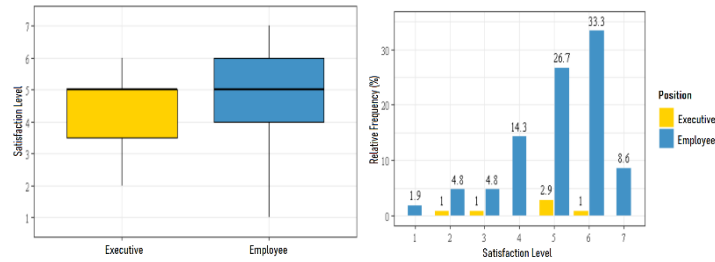
Figure 3
(Source: created by the authors using RStudio software (n = 105))

In the second block of questions, which assess the organization's digital leadership capabilities, lower variability is observed in the employees' answers, whereas it is higher in the answers given by executives. Data dispersion, box size, and relative frequency dispersion are also very high. Regarding question 11, an outlier can be seen in the answers given by the executives (Figure 3), while a high level of dispersion in the employees' opinions is observed from their answers. In this case, it can be speculated that the organization is not investing in digital skills, at least not in a way that is noticeable to all the staff. In the following dispersion and correlation analyses, the goal will be to show whether the discrepancies seen in Figure 3 are distributed according to company department, period of employment, or whether there is no relation with these factors.

6.4 Correlation Coefficients of the Questionnaire Answered by Employees and Executives
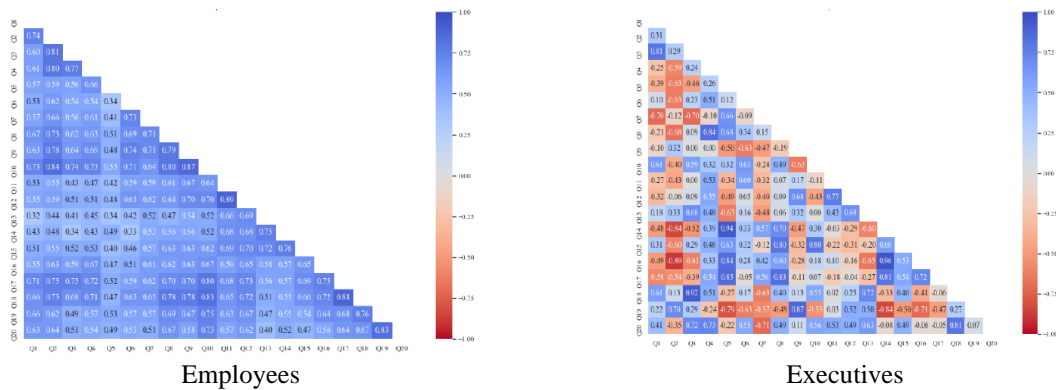

Figure 4: Pearson Correlation Coefficients for the Answers Given by Employees and Executives
(Source: created by the authors using RStudio software (n = 105))

The correlation graph of the executives' answers (Figure 4) shows three types of correlation: positive or direct, negative or inverse, and nearly nonexistent (close to zero), with positive and negative correlations being predominant – particularly the positive ones, represented in blue. Unlike with the executives' answers, which show the three correlation types, the answers given by employees show only positive (direct) correlation.

6.5 Scatter Plot of the Questionnaire Answered by Employees and Executives
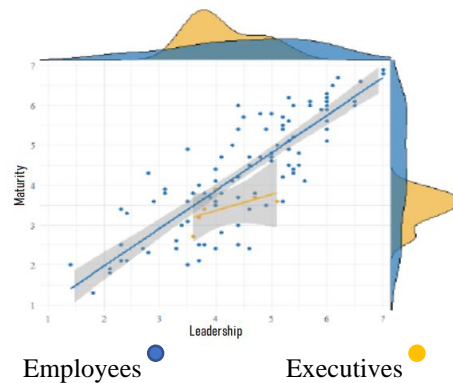

Figure 5: Digital Leadership in Relation to Digital Capability
(Source: created by the authors using RStudio software (n = 105))

The scatter plot shown in Figure 5 points to a positive correlation between digital capability and digital leadership, since the trend line that best fits the data is ascending. However, when we compare both sets of answers for correlation strength, it can be seen that the correlation found in the executives' answers is weaker than that found in the employees'. This is corroborated by comparing the correlation matrices of the employees' and the executives' answers. It can be concluded that the employees' perception of the organization's digital capability and digital leadership capability is quite distinct from that of the executives.

6.6 Principal Component Analysis (PCA) of the Questionnaire Answered by Employees and Executives

The questionnaire data also underwent principal component analysis (PCA), resulting in the reduction of 20 variables (questions) into only two components which represent the 20 questions. The value of either component was then entered into a dot graph according to company department and period of employment (Figure 6).
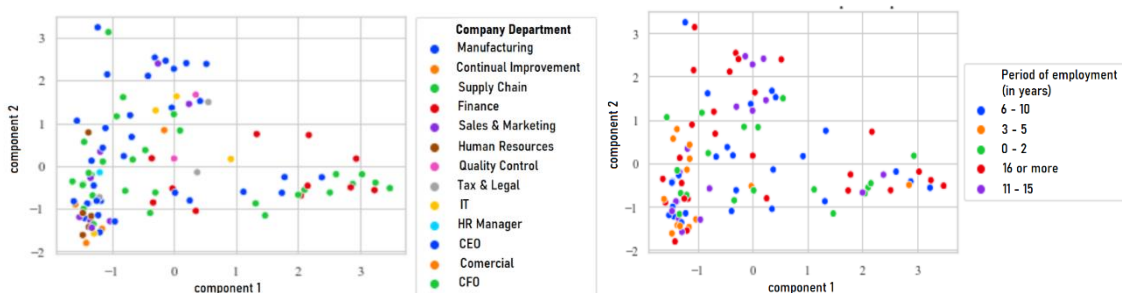
Figure 6: PCA Graphs According to Department and Period of Employment
(Source: created by the authors using Python (n = 105))

Note that it is not possible to visually identify any group that stands out. Therefore, to corroborate this visual analysis, the k-means clustering algorithm was applied to identify groups within the organization. Then the normalized mutual information (NMI) algorithm was used to compare the results obtained through k-means clustering with the actual departments

of the organization. The NMI algorithm verifies whether the classes predicted by k-means clustering are similar to the organization's actual departments, and returns a value ranging from 0 to 1, with 0 signifying that there are no defined groups, and 1 that there are well defined groups. The k-means algorithm yielded the groups shown in Figure 7.

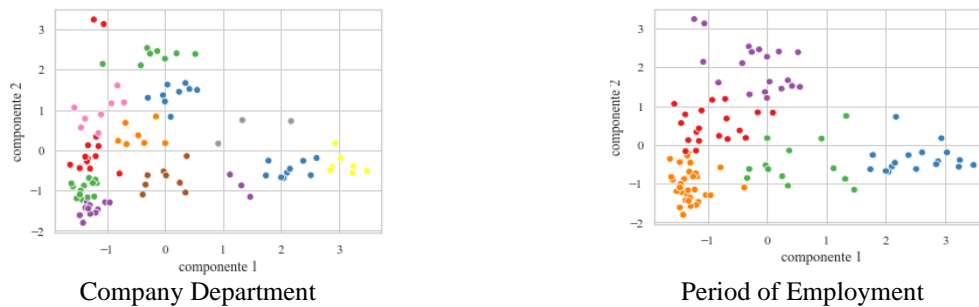Company Department   Period of Employment

Figure 7: Predicted Groups Divided by Company Department and Period of Employment
(Source: created by the authors using Python (n = 105))

Then the NMI algorithm was run on the groups predicted by k-means. The score obtained for each group is shown in Table 1.

Test Label	NMI Score
Company department	0.29112
Period of employment	0.09578
Job position	0.04319

Table 1

These values show a weak relationship between the questionnaire answers and the department an employee works in, but no relationship with period of employment and position in the organization. Additionally, linear discriminant analysis (LDA), another technique for dimensionality reduction, was used. Unlike PCA, however, LDA is a supervised technique because it predicts which group each employee belongs in, thus maximizing variance between groups and minimizing it within each group itself. Running LDA resulted in the graphs shown in Figure 8.
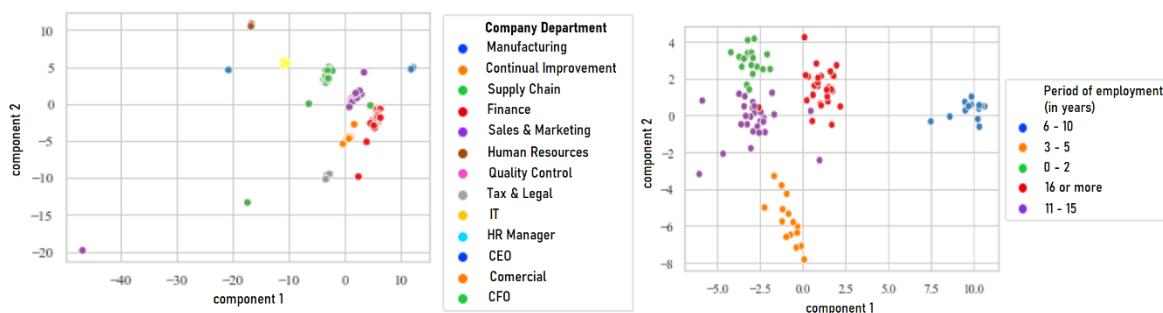

Figure 8: LDA on Data About Company Department and Period of Employment
(Source: created by the authors using Python (n = 105))

It can be seen that different groups are obtained depending on whether data are analyzed in relation to company department or period of employment, and that the groups comprise individuals with shared characteristics in terms of digital capabilities and digital leadership capabilities. There is potential for the incorporation of these characteristics into this study's managerial vision for the development of a digital culture and the attainment of digital transformation maturity by the studied company.

7. Conclusion

From the qualitative analysis of the executives' transcribed interviews and the quantitative analysis of the data collected from the online survey with employees, it was possible to conclude that the B2B company studied in this research is positioned, according to the methodology laid down by Westerman (2014), as a digital transformation beginner, due to its low level of digital maturity.

There is not clear understanding in the company of the difference between a digitized and a digital organization, since there was, at various stages of the research, great variation in the opinions on the use of digital tools, with management and automation applications being often taken for digital technologies. According to Ross (2019), being a digital company involves not only converting physical data to a digital format, but also adopting digital technologies to add value to a business.

Another observation is that the company does not have a governance instance that is explicitly dedicated to managing digital initiatives. According to Matt (2015), an important approach is to formulate a digital transformation strategy that serves as a central concept to integrate the entire coordination, prioritization, and implementation of digital transformation within a company. In this regard, there are isolated initiatives within the company, but no clear leadership and resources aimed at implementing them either through a minimum viable product, a strategic process, or an experimental pilot project with the application of digital technologies and concepts.

Also, no initiatives were observed for applying digital tools to improve customer experience at the company. Engagement with customers still follows the traditional model of in-person visits, phone calls, e-mail, and text messages. According to Zolkiewski et al. (2017), "improving understanding of customer experience in a B2B context should allow organizations to design better services and consequently enhance the experiences."

Worth noting is that one of the company's strategic processes for handling operational planning, demand, and sales is executed on the company's management system, and supported by different management tools and manual simulations. This process is still executed in a traditional way, in which demand and sales forecasting is based on past history and information on customer experience and engagement provided by salespeople, as well as on additional information such as finance and market variables.

This B2B company has an industrial innovation DNA, a fact that was observed at different stages of the research. It is investing in an innovative production process with various new embedded technologies. Because the process is still in pilot phase, it was impossible to examine whether this initiative will employ any Industry 4.0 digital technologies. It is important to highlight that observations and information collected in the fieldwork point to an incremental

innovation, not to a disruptive one or to the digital transformation of the company's business model.

Throughout all the stages of this research, it became clear that this B2B company has a backbone of well-structured processes, management tools, and infrastructure, which can be further developed with digital initiatives. It is key for the company to include digital transformation into its strategy roadmap, so that the topic becomes a priority at all levels of the organization. According to Vial (2019), digital transformation is defined as "a process that aims to improve an entity by triggering significant changes to its properties through combinations of information, computing, communication, and connectivity technologies." The digital transformation challenges for the B2B industry in Brazil are considerable, but they are proportional to the transformative opportunities offered by the available digital technologies.

According to Ramakrishnan (2016), "the age of digital transformation is truly upon us and going strong." Digital transformation, however, is not restricted to retail. Traditional B2B companies are awaking to the potential of digital technologies, and are seeking ways of using them to offer their customers new services.

The characteristics found in the case study of this B2B complex manufacturing company of the packaging segment may be shared by other B2B companies. Therefore, the patterns resulting from the qualitative and quantitative analyses conducted in this research can generally be applied to other B2B companies that show a low level of digital maturity and need to develop a digital transformation strategy.

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10. Enablers of and Barriers to Digital Innovation Success: A Systematic Literature Review from 2010 to 2020

Lorna Mutegi
University of Cape Town
Mtglor001@myuct.ac.za

Jean-Paul Van Belle
University of Cape Town
Jean-Paul.VanBelle@uct.ac.za

Abstract

In a (post-)pandemic world, digital innovation has gained relevance as an important driver of digital economies. This paper combines systematic literature review and thematic analysis to isolate enablers of and barriers to digital innovation success. The review draws on an initial set of 421 papers, sourced from Google Scholar and the Web of Science databases, selected by title, topic, abstract and keywords. Out of the 421, 38 papers were selected. Unique and similar factors that emerged from the review have been isolated and discussed in more detail. By understanding the enablers and barriers, digital entrepreneurship stakeholders in the Global South can embrace best practices towards creation of an enabling environment that supports successful implementation of digital innovations. Particularly, this research has potential to influence favorable policy formulation and the targeting of funding to support technology innovators to stimulate digital innovations that power digital economies.

Keywords: Digital Innovation, Digital Innovation Success, Enablers, Barriers

1. Introduction

In a (post-)pandemic world, information on enablers of and barriers to digital innovation success has become an important resource for building digital economies. Although current research on innovation in general has made relevant contributions, digital innovation success phenomenon continues to receive little attention. Research on digital innovation success is largely focused on top-down innovations or innovations that emanate from large firm's research and development initiatives (Ross, Mitchell & May, 2012), digital or otherwise. In the last decade, digital start-ups have made important contributions towards the rise of ground-breaking digital innovations. There is little research on what enables or hinders the success of innovations emanating from these digital start-ups. This paper combines a systematic literature review with thematic analysis to find "relevant and quality" literature (Rowe, 2014) on enablers of and barriers to digital innovation success emanating from digital start-ups.

1.1 Background Information

Digital innovation involves the application of digital technology to improve an existing or develop a new service embedded with software-based capabilities (Yoo, Henfridsson, & Lyytinen, 2010; ITU, 2017). Fichman, Santos, and Zheng (2014) define digital innovation as "a product, process or business model that is perceived as new, requires significant changes on the part of adopters, and is embodied in or enabled by IT". Uber, Airbnb, Amazon, Netflix, Alibaba, Facebook, Skype, Google are some of the prominent examples of global digital innovations that have caused a disruption in their sectors of influence (Demirkan, Spohrer, & Welser, 2016). Digital innovation and digital entrepreneurship continue to be used interchangeably in extant literature. Digital entrepreneurship is the economic exploitation of digital innovation. Bogdanowicz, (2015) defines digital entrepreneurship as an "economic activity that involves identification and exploitation of new ICT or ICT-enabled products,

processes and corresponding markets. Elia, Margherita, & Passiante, (2020) define it as "the convergence of entrepreneurship and digital technologies" resulting to new business ventures. They note and address a gap in entrepreneurship research on the role of digital technology and the need for new definition of entrepreneurship within the context of digital economies. Their study recommends research agendas, one being the need for further investigation on "motivating drivers" of digital entrepreneurship stakeholders.

It is important to define digital innovation success. Ross, Mitchell and May, (2012) use the terms "progression of a digital innovation" to mean success. Hirose, (2018) views digital innovation or technology entrepreneurship success as "successful commercialization and business development, often over long periods of time". This paper combines the SLR results on digital innovation, technology innovation, digital entrepreneurship, and technology entrepreneurship success as relevant unified outcome of the study.

2. Methodology

This study follows a phased systematic approach to literature review to isolate enablers of and barriers to digital innovation success from the years 2010 to 2020. Systematic literature review (SLR) method is praised for its "transparency in data collection and synthesis that results in a higher level of objectivity and reproducibility" (Kraus et al., 2020) and capability to enable a researcher to "identify, evaluate and synthesis" existing literature on phenomenon of interest (Kitchenham et al. 2010; Massaro, 2016). The approach allows for objective and scientific account of literature, ensuring rigour, transparency, and reproducibility of results (Transfield et al, 2003). It is a "repeatable process that documents all available studies relevant to a research area or question" (Balaid, Rozan, Hikmi, & Memon, 2016). A thematic analysis approach was used to categorize relevant studies identified through SLR into themes and sub-themes as shown in Table 3. Thematic analysis (TA) is a "process of identifying patterns or themes within qualitative data" (Maguire & Delahunt, 2017). Briefly, the study summarizes available literature on enablers of and barriers to digital innovation success from the years 2010 to 2020. The following steps were followed and adapted from Oosterwyk, Brown, & Geeling, (2019).

Step 1: Planning
The literature search strategy identified studies on enablers of and barriers to sustainable innovation, with a focus on digital or technology innovation, digital entrepreneurs, user innovation, digital startups, social innovations, bottom-up innovations and grassroots innovations. This is because the aspect of sustainability was prominent in most definitions of 'innovation success'.

Step 2: Selection
The review focused on peer reviewed journals and conference proceedings from IS, entrepreneurship and innovation, product innovation management, innovation and technology management. Google Scholar was the main source of literature. The Web of Science database was also searched to ensure all relevant studies were included. It was important to perform a search for enablers and barriers separately and together, due to heterogeneity and fragmentations in literature on the phenomenon under study. The following search terms were used over a timespan starting from 2010 to 2020: 'enablers of digital innovation success' OR 'enablers of digital entrepreneurship success' OR 'enablers of social innovation success' OR 'enablers of grassroots innovation' OR 'enablers of bottom-up innovation' OR 'enablers of user innovation success' to isolate studies on enablers. For barriers, the search strings contained one of and/or a combination of the following: 'barriers to digital innovation success' OR

'barriers to digital entrepreneurship success' OR 'barriers to social innovation success' OR 'barriers to grassroots innovation' OR 'barriers to bottom-up innovation' OR 'barriers to user innovation success'.

Studies on 'user innovation', 'social innovation', 'bottom-up innovation', 'grassroot innovation' or 'digital entrepreneurship' were included as they had some relatable results relevant to the phenomenon under study. This is because they are not driven by the "traditional R&D and market research" (Ross, Mitchell & May, 2012). This ensured all relevant literature was included in the review. The approach however had some disadvantages as the search results yielded more studies that were out of scope, thereby consuming a lot of time. The decision to narrow the search to two databases was informed by this to ensure the emergent results were manageable. In addition, synonyms or related terms for the words 'barrier' and 'enabler' were used to widen the search. For instance, 'inhibitor, constraints and hindrance were used in place of the word 'barrier'. To isolate enablers, 'motivation, supporting mechanism, success factors, driver, catalyst, proven paths, and facilitator' were used. The asterisks truncation symbol (*) was used to capture all variations of a word or term, especially for searches done in the Web of Science. For example, 'inhibitor*' would retrieve studies that used either 'inhibitor' or 'inhibitors'. Studies that evaluated enablers of and barriers to digital entrepreneurs or technology-based MSMEs' innovation success were also considered.

Initial set of papers on enablers and barriers were searched by title, topic, abstract and keywords resulting to 421 papers. Table 2 shows the distribution of the 421 papers from both databases. The papers were reviewed further by content in the introduction and conclusion sections. Papers that touched on the concept of innovation success were selected resulting to 154 papers, having also eliminated papers not written in English language, citations and patents. Third and final round of selection was based on full paper review, and backward and forward reference searching, with a keen focus on the results, findings and discussions sections resulting to 38 papers, having eliminated duplicates. The 38 papers were considered adequate as they each had full text available, had rigor and relevance to the phenomenon under study. Particularly, they brought to light unique and similar enablers of and barriers to digital innovation success. Figure 1 illustrates the literature search and selection criteria employed.

Summary of the Inclusion and Exclusion Criteria

Inclusion Criteria	Exclusion Criteria
Published within timespan 2010 to 2020	Not within the search timespan
Addresses research questions	Research questions not addressed
Written in English	Not written in English
Full-text available	No full-text available
Peer-reviewed	Citations or Patents
	Lack of credibility and rigor
	Duplicate studies

Table 2: Inclusion and Exclusion Criteria Summarized.

Table 2 displays count of search results for enablers and barriers from each database before and after exclusion criteria. A search on just barriers returned over 75% of similar results as the enablers' search query on Web of Science and Google Scholar. Therefore, the count for barriers on exclusion of duplicates includes only unique studies that had not been selected on running the query for enablers.

Database	Enablers		Barriers	
	Count before exclusion	Count after exclusion	Count before exclusion	Count after exclusion
Web of Science	32	7	10	2
Google Scholar	278	26	101	3
Total Selected	310	33	111	5

Table 3: Count of Search Results before and after Exclusion Criteria.

Search

Journals: MIS quarterly, Information Systems Research, Journal of Cleaner Production, Business & Information Systems Engineering, Strategic Entrepreneurship Journal, Journal of Technology Management & Innovation

Conferences: International Conference on Modern Educational Technology and Innovation and Entrepreneurship (ICMETIE 2020)

Initial set of papers were selected based on title, topic, abstract and keywords. Introduction and conclusion sections of resultant papers were reviewed

Selection

Resultant set of papers selected based on Full paper review.

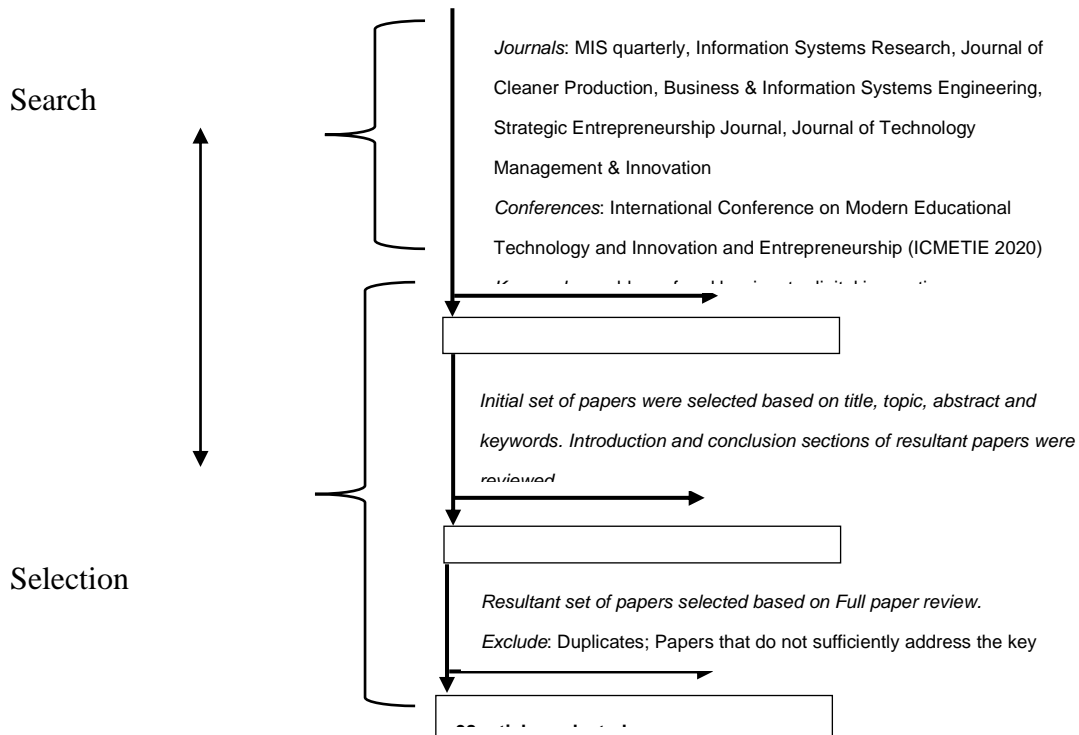*Exclude*: Duplicates; Papers that do not sufficiently address the key

Figure 1: Search and Selection Criteria (adopted from Günther, Mehrizi, Huysman, & Feldberg, (2017))

Step 3 and 4: Extraction and Execution

Thematic analysis was employed at this stage. A latent-level, top-down approach (Braun & Clarke, 2006) – where initial themes derived from research questions and additional themes included on in-depth systematic analysis of relevant literature – was followed. A total of 49 sub-themes – representing all influencing factors – were extracted. These could, in turn, be grouped in ten grouping or major themes (Table 3). These themes will be discussed in greater detail in the results section. The major themes allowed the logical classification of all the information derived from the systematic review in an orderly and coherent manner. The themes were sourced from 32 journal articles, 1 book, 3 book chapters, 1 conference paper and 1 master's thesis. Top 5 journals reviewed include Information Systems Research, Journal of Cleaner Production, The Journal of Technology Transfer, MIS Quarterly and Journal of Business Research. Figure 2 is a chart that shows peak of publications in years.

Major (grouping) themes	Sub-themes (factors)	Citations
Digital Technology	Technology, ICT, mobile penetration, internet, open-source tools and platforms, unrestricted access to information	(Maiolini et al., 2016); (von Briel, Davidsson & Recker, 2018); (Yoo, Henfridsson, & Lyytinen, 2010; (Ross, Mitchell & May, 2012); (Demirkan, Spohrer, & Welser, 2016); (Ciriello, Richter, & Schwabe, 2018); (Butler, Garg & Stephens, 2020);

Major (grouping) themes	Sub-themes (factors)	Citations
		(Nielsen, Reisch & Thogersen, 2016); (Fichman, Santos, & Zheng 2014)
Incubators and Accelerators	Technology hubs, research, and innovation labs, living labs, business incubation, makerspaces, hackerspaces, accelerators	(Sörvik, 2018); (Ester, 2017); (Mas-Verdú, Ribeiro-Soriano, & Roig-Tierno, 2015); (Nielsen, Reisch & Thogersen, 2016); (Schwartz, 2013); (Mas-Verdú, Ribeiro-Soriano, & Roig-Tierno, 2015); (Edwards-Schachter, Matti & Alcántara, 2012); Baccarne et al., 2014)
Education and Training	Universities, technical skills, innovation and entrepreneurship curriculum, talents, competencies	(Calcagnini et al., 2016); (Nielsen, Reisch & Thogersen, 2016); (Xu, Wang & Yang, 2020); (van Den Berg, C. L., 2018); (Manning, Engelke & Klein, 2018); (O'Kane et al., 2019); (Nielsen, Reisch & Thogersen, 2016); (Ester, 2017); (Ross, Mitchell & May, 2012)
Capital	Financial capital, Venture Capital (VC) investment, Angel Investor, start-up capital, intellectual capital, human capital, social capital, psychological capital, talents, capabilities	Ester, 2017); (Manning, Engelke and Klein, 2018); (Ester, 2017); (Andrikopoulos, 2020); (Nielsen, Reisch & Thogersen, 2016); (Paschen, 2017); (Oranburg, 2020); (Bocken, 2015); (Wang et al., 2019); (Ross, Mitchell & May 2012); (Rashid, Alzafari and Kratzer, 2020); (Baron & Henry, 2010); (Nielsen, Reisch & Thogersen, 2016); (Drencheva, 2018); (Stephan & Drencheva, 2017); Ester, (2017)
Networks	Resilient networks, business advice, linkages, informal networks (friends and family)	(Dana et al., 2020); Seet et al., (2018); (Cantù, Giorgia and Tzannis, 2018); (Ross, Mitchell & May, 2012); (Bocken, 2015); (Ester, 2017); (Nielsen, Reisch & Thogersen, 2016)
Business model	Innovative business models, business model design, business model management	(Trimi & Berbegal-Mirabent, 2012); (García-Gutiérrez & Martínez-Borreguero, 2016); (Bocken, 2015)
Leadership	Leadership styles, transactional leadership, laissez-faire leadership and transformational leadership	(Zaech & Baldegger, 2017); (Ester, 2017); Nielsen, Reisch and Thøgersen, (2016);
Open Innovation	Collaboration, co-design, co-creation, co-design, co-production	(Teha & Keeb, 2020); (Stroh, 2018); (Toros et al., 2020); (Nielsen, Reisch & Thogersen, 2016); (Baccarne et al., 2014)
Government	Policy, ease of doing business, laws and regulations, government funding	(Manning, Engelke & Klein, 2018);
Culture	Start-up culture, entrepreneurship culture	(Manning, Engelke & Klein, 2018); Ester, (2017); (Bocken, 2015)

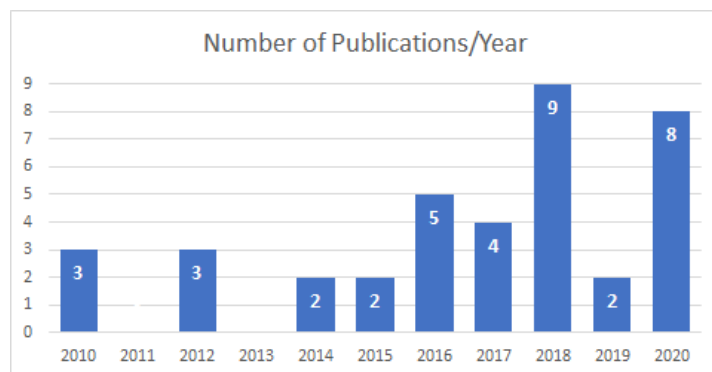*Table 3: Emergent Major Themes and Sub-themes (factors)*

Figure 2: Number of Publications in Years

3. Results

An enabler can be defined as that which contributes to or favors innovation success (Camps & Marques, 2014). A barrier on the other hand slows down or completely hinders success. The reviewed literature brought to light forty-nine factors that could pose as enablers and/or barriers to digital innovation success. It is possible that a factor could pose as either an enabler or a barrier. For instance, a disengaged government that fails to create an enabling environment for digital innovations to thrive, could pose as a barrier. A government that provides such an environment could pose as an enbaler.

3.1 Digital Technology

Digital technology is an important enabler of digital innovation success (Maiolini et al., 2016; von Briel, Davidsson & Recker, 2018) . By definition, digital innovation involves application of digital technology to improve an existing or develop a new service embedded with software-based capabilities (Yoo, Henfridsson, & Lyytinen, 2010; ITU, 2017). Researchers attribute the rise of digital innovations to increased access to digital technologies (Ross, Mitchell & May, 2012) and connectivity between people through mobile devices (Demirkan, Spohrer, & Welser, 2016). Ciriello, Richter, and Schwabe, (2018) posit that "digital technology is both the result of and the basis for developing digital innovations, enabling high scalability and low entry barriers that lead to wide participation and democratized innovation". Butler, Garg & Stephens, (2020) note that digital technologies have reduced start-up costs tremoundously. Ease of access to digital resources, such as open data, open sources tools, platforms and communites (Nielsen, Reisch, & Thogersen, 2016) enables digital entrepreneurship success. Fichman, Santos, and Zheng (2014) conclude that digital innovations can be embodied in or enabled by technology.

3.2 Technology or Innovation Hubs, Business Incubators, Accelartors and Living Labs

Technology hubs, digital innovation hubs (Sörvik, 2018), business incubators and accelarators are seen to provide an enabling environment that steer digital innovations to success. It is common in literature for these terms to be used interchangebly though they are heterogenous. For instance, incubators defer from accelerators in that the former "focuses on very early-stage business ideas, whereas the primary goal of accelerators is to grow new ventures that already have a product, a business model, and even some traction" (Ester, 2017). The concept of business incubation has been around for decades. The first World's business incubator is said to have been set up in the year 1959 in Batavia Industrial Center, Batavia, New York (Hackett & Dilts, 2004). Business incubators are institutions set up to provide support services needed for "creation and development" of a company or "to accelerate the creation of successful firms" (Mas-Verdú, Ribeiro-Soriano, & Roig-Tierno, 2015). Hackett and Dilts (2004) define a business incubator as "a shared office space facility that provides its incubatees (i.e. ''portfolio-'' or ''client-'' or ''tenant-companies'') with a strategic, value-adding intervention system (i.e. business incubation) of monitoring and business assistance". Business incubators can be affiliated to a university, government, civil society, a private company, a non-profit institution, or hybrid. They can be physical spaces or virtual or both (Hackett & Dilts, 2004). They provide support services such as affordable working space (co-location) (Nielsen et al., 2016), access to capital, training, mentoring and coaching among other services (Schwartz, 2013; Mas-Verdú, Ribeiro-Soriano, & Roig-Tierno, 2015; British Council, 2016). Other similar initiatives that have come up in the last decade include accelerators, co-working spaces, fab labs, tech hubs, makerspaces, hackerspaces (Söderberg & Delfanti, 2015), research parks, science parks and living labs. The concept of a "living lab" (Edwards-Schachter, Matti, & Alcántara, 2012) is also seen as an important enbaler of success especially for bottom-up digital innovations. The Labs provide a platform for "open innovation between innovators, encourage

user engagement, private and public partnerships leading to development of inclusive and sustainable innovations" (Baccarne, Mechant, Schuurman, Colpaert, & De Marez, 2014).

3.3 Universities and Research Centres

The "geographical proximity" of startups to universities and research centres could have a positive implication on performance (Calcagnini, Favaretto, Giombini, Perugini, & Rombaldoni, 2016). Education has been addressed by a myriad of studies as an important enbaler of innovation where accessible or a barrier where access is limited (Nielsen et al., 2016). Formal Entrepreneurship education in the Global North dates back to the late 1940s, with pioneer programs such as "new venture enterprise management" by Havard University. The program has been praised for it contribution to "development of the American economy" (Xu, Wang, & Yang, 2020). Initiatives such as incoporation of innovation and entrepreneurship curriculum (van Den Berg, C. L., 2018) in institutions of higher learning may increase compentency in running digital innovations successfully. STEM education (Manning, Engelke, & Klein, 2018) in particular has potential to build technical competenticies that can be applied in building relisient technology innovations. Ultimately, universities churn out compentent talent that contribute to a sustainable pipeline of skills (O'Kane, Zhang, Daellenbach, & Davenport, 2019), which digital startups can employ or source for volunteers from. Informal education initiatives can also enable innovation success. For instance "do-it-yourself" training bootcamps and "self-led self-paced" learning are important competency building platforms on digital innovation succes (Nielsen et al., 2016). Business incubators and accelarators also do inculcate training programs geared towards developing requisite skills and compentencies that enbale the successful implementation of an incubatee's technology innovation venture during incubation (Ester, 2017). Research centres on the other hand can release empirical research, information and technology, which digital startups can leverage on. Briefly, "pocessing the right technical skills" (Ross, Mitchell & May, 2012) and knowledge is seen as an important enabler of success for digital startups.

3. 4 Financial Capital

Financial capital is a key enabler of digital startup success (Ester, 2017). Manning, Engelke and Klein, (2018) report a national investment of $4.8 billion into Israel's technology innovation ecosystem, thereby contributing to the success of technology innovations witnessed in Israel. They note that the lack of technology giants in Europe, which are prominent in United States of America and China, can be attributed to the "chronic shortage of investment capital" because of the risk aversion of most private investors. Research confirms startup financing in the Global North is well structured. Venture capital funding leads in Silicon Valley with established sources such as "public and private pension funds, university endowments, and foundations" (Ester, 2017). Funding from venture philanthropists could also enable the successful implementation of digital innovations that "pursue social impact" (Andrikopoulos, 2020). Other financing options include microloans (Nielsen et al., 2016), crowdfunding among others. Crowdfnding not only provides financial capital but also "crowd capital" (Paschen, 2017) , an impotant enabler of success. Literature confirms that some financing options may bar innovation success, especially where a funding source imposes unfavourable contractual obligations or leaves the digital startup in debt (Oranburg, 2020). Ester, (2017) advocates on sourcing financing from angel and venture capitalists as opposed to "family, friends and fools", which he considers a "vulnerable source". A "short-term investor mind-set" and lack of "suitable investors" (Bocken, 2015) could also hinder digital innovation success.

3.5 Intellectual Capital

Intellectual capital (Wang, Tsai, Lin, Enkhbuyant, & Cai, 2019) is an emerging area of research in entrepreneurship with important theoretical and practical contributions on digital innovation or digital entrepreneurship success. As an "intangible capital", literature argues that it cannot be ignored, especially in studies related to startup performance. Wang et al., (2019) posit that three types of intellectual capital that is, "psychological capital (intra-personal attributes such as hope, optimism), human capital (personal attributes such as age or education) and relational capital (interpersonal attributes such as trustworthiness) cannot be neglected for new venture success". Tang and Shao, (2019) report "positive pychological foundation, that is hope, optimism, self-efficacy and resilience" as potential enablers of success. Other literature refer to the "individual characteristics" of an innovator (Ross et al., 2012) as an enabler. Rashid, Alzafari and Kratzer, (2020) research on "entrepreneurial success from a behavioral lens" depicts human behaviour as a pontetial enabler of or barrier to digital innovation or entrepreneurship success. Seet et al., (2018) research (conducted in a startup accelarator in Malaysia) further emphasizes on the importance of human and social capital. The study reports that the "processes of 'know-what', 'know-how' and 'know-who' are interrelated – by knowing 'who', innovators learnt 'what' and 'how to' through social learning". Social capital is reported as an enabler where used to support commercialisation of resultant innovation (Ross, Mitchell & May, 2012). Other behavioural studies discuss the concept of "deliberate practice" (Baron & Henry, 2010) as an enbaler where digital startups or innovators dedicate their time and effort in building resilient and successful digital innovations. Also, the level of "personal investment" or commitment (Nielsen et al., 2016) to the innovation process could contribute to success. "Self-interests motivation" (Drencheva, 2018) could also be an enabler. Briefly, the innovator personality or "'social traits' and identities" that are pro-success (Stephan & Drencheva, 2017) could have positive impact on resultant digital innovations. In summary, as an enabler, Ester, (2017) views intellectual capital as "outstanding soft skills such as creativity, flexibility, curiosity, passion, an orientation towards achievement, the ability to work in teams, openness, a willingness to share, an entrepreneurial mindset, a pro-customer attitude, being good at networking, being willing to learn, and being focused on personal development".

3.6 Networks

Networked digital startups have capability to birth and sustain successful technology innovations. Research found informal networks comprising of family and close friends to be a great enabler of success (Dana et al., 2020). Cantù, Giorgia and Tzannis, (2018) study identifies four key types of networks relevant at each stage of startup creation as "social networks comprising of family and friends, business networks, reputational networks and co-opetition networks". Ben White, (2020) advocates on building "resilient networks for digital innovation", especially in "times of crisis" such as the COVID-19 pandemic. Briefly, access to "business advice and network support" (Bocken, 2015) for digital innovators could steer them to success. Incubated digital startups are at a better advantage concerning ease of access to reliable networks (Schmitt & Muyoya, 2020). This is because the incubators or technology hubs or accelarators already have set structures and mechanisms of engagement that expose their incubatees (digital startups or technology innovators) to networking opportunities (Ester, 2017). A good example is access to a network of mentors with expertise in various subject matter areas such as technology (Woodley, Burgess, Paguio, & Bingley, 2015). Ester, (2017) notes that "mentorship by experienced serial entrepreneurs can prevent startup founders from making the most common business development mistakes". In this case, accelerators are seen as instrumental in providing requisite support and technical advice to enable

commericialization of promising digital innovations. Briefly, "supportive intermediaries" (Nielsen et al., 2016) could be important enablers of digital innovation success.

3.7 Business Model

Literure presents an innovative business model as a critical success factor for startups (Trimi & Berbegal-Mirabent, 2012), especially for technology-based startups that operate in "extreme uncertainities" due to the "volatility and unpredictable nature" of new technologies (García-Gutiérrez & Martínez-Borreguero, 2016). They report business model innovation as a "more important" enabler of success compared to product or service innovation. They note that for digital innovators, building innovative business models might be a challenge as they are "specialists in technical innovation" and not "business design or management". In the long run, this could pose as a barrier to innovation success especially for technology innovators who fail to "target and pursue" the right market or rather build commercialisable digital innovations. Briefly, "failed business model" (Bocken, 2015) may result to digital innovation failure.

3.8 Leadership

Reviewed literature links leadership as highly relevant to a entrepreneurial venture success, digital or otherwise (Zaech & Baldegger, 2017; Ester, 2017). Nielsen, Reisch and Thogersen, (2016) note that a "dynamic and effective" leader (founder or CEO) can influence startup success. Zaech and Baldegger, (2017) study evaluates the impact of three types of leadership styles (transactional, laissez-faire and transformational) emanating fom (Bass & Avolio, 1996) research, on startup perfomance. "Transactional" and "laissez-faire" leadership behavious are associated with "less activity" or rather a "watch and wait" approach that may hinder success compared to "transformational leadership" style where the leader is engaged in the day to day operations.

3.9 Open Innovation, Hackathons and Code Sprints

Some of the most prominent digital innovations have occurred in an environment of open innovation and were spearheaded by startups. Open innovation (Teha & Keeb, 2020) provides opportunities for co-creation, co-design, co-production (Stroh, 2018; Toros et al., 2020) or collaboration with potential customers or other innovation stakeholders (Nielsen et al., 2016) in the ecosystem. Teha & Keeb, (2020) note that open innovation allows for exploration and exploitation of previously inaccessible knowledge and resources. Hackathons and code sprints (Coetzee, 2010; Ross, Mitchell & May, 2012; Baccarne et al., 2014b; Toros et al., 2020) or innovation competitions are important avenues that encourage open innovation or co-creation of digital innovations, leveraging on the diverse compentencies (technical and non-techinical) of collaborating innovators. Post innovation competion or hackthon support can be an enabler where innovators receive financial and/or technical support to scale their prototypes or minimum viable products (MVPs) to success. Where such support is lacking, misplaced or the value add to particpating innovators is unclear, then success could be hindered as resultant innovations are normally abandoned at pre-mature stages of development. Hjalmarsson et al., (2014) study focuses on understanding the constraints or limiting factors that hinder the success of innovations that emanate from innovation competitions. They bring out the concept of perceived versus actual barriers. Both types have the potential to hinder innovation.

3.10 Government

Government is an important player in influencing digital innovation or digital entrepreneurship success. On the flip side, a disengaged government that fails to create an enabling environment for digital innovations to thrive, can pose as a barrier. A dictatorial regime that imposes digital solutions or are pro "digital solutionist approach" as put by Rowe, Ngwenyama and Richet,

(2020) on its citizenry can pose as a barrier to success of such innovations. Initiatives such as "national R&D funding" and "economic incetives" (Manning et al., 2018) are among key government contributions towards streghthening or building of a technology innovation ecosytem. In Silicon Valley, government funding, partipation as a "launching customer of technology innovations" and supply of requisite resources for innovation is reported as some of the factors that have enabled digital startup success (Hess, 1997). As an innovation market regulator (Ester, 2017) the "ease of doing business" is another key government role that can pose as an enabler of or a barrier to digital innovation success. A World Bank report on the ease of doing business (World Bank, 2020) notes that its take "six times" longer for digital entrepreneurs in developing economies to start a business compared to their counterparts in developed economies. Further, they use up to 50% of the "country's per capita income to launch a company while their counter parts in developed world take only 4.2%". Laws, regulations and policy are key contributers to the ease of doing business.

3.11 Culture
Culture is an important aspect of entrepreneurial innovativeness (Manning et al., 2018). In Silicon Valley, Ester, (2017) argues that a culture that encourages and rewards innovation, openess in sharing ideas, feedback and learning, expectation to "launch disruptive technologies", "risk taking and tolerance of failure", "24/7 business economy", "diversity in innovation teams" among others could be contributing factors that continue to steer new innovators towards building successful digital innovations. He concludes that such a culture could be the reason why Silicon Valley has maintained its position as "the global paradise for high-tech startups". This does not however mean that failure is non-existent. In the Global South, digital startups, especially those under a structured digital innovation environment, are said to face pressure to employ a 'silicon valley startup mindset', which is assumed to be an enabler of success. The lack of a "strong incumbent industry" (Bocken, 2015) or an environment embended with an entrepreneurial culture could deter innovation success.

4. Conclusions and Recommendations
This paper set out to uncover barriers and enablers for successful digital innovation. From a shortlisted 421 academic papers, 38 papers were analyzed in-depth using a Structured Literature Review (SLR) process. In total, 49 different factors were uncovered (Table 3). These can then be grouped under the following major themes or headings: digital technology, incubators and accelerators, capital, business model, leadership, networks, culture, government, education and training, and open innovation. Some factors can pose as both an enabler and barrier.

This study has two implications for practice. First, by understanding the enablers of and barriers to digital innovation success, such a research can inform development of a guiding framework that can influence policy and action by explaining how the effects of the enablers or barriers can be enhanced or moderated by digital innovation stakeholders such as government, incubators and investors. Secondly, the study results can be used by digital startups and innovators, to develop sustainable strategies that can support success of their digital innovations. The study recommends two research agendas. First, there is need for more research on digital innovation success, particularly contextualized studies. Future IS researchers investigating success in digital or technology innovations could explore the differences between the Global North versus Global South contexts. This agenda stems from fragmented research on digital innovation success as evidenced in the SLR. The review confirmed that digital innovation success has not been addressed in a systematic manner. The search for relevant literature was complicated through the fact that there were few studies that

directly addressed enablers of and barriers to "digital" innovation success (Vega & Chiasson, 2019), thereby contributing to the fragmentation. Because of the fragmentation, studies on "user innovation", "social innovation", "bottom-up innovation", "grassroot innovation" or "digital entrepreneurship" were included in the SLR process as they had some relatable results relevant to the phenomenon under study. Secondly, the review revealed that nnovation concepts such as the triple helix model and the "Silicon Valley syndrome" amalgamates some of the factors discussed, specifically government, industry and academia. An important research agenda would be a review of linkages between the discussed factors to investigate their impact on digital innovation success. In particular, the linkages between incubators or technology hubs or accelerators or living labs is seen as critical.

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[NOTE: Reference list for Systematic Literature Review excluded to meet the 12-page limit requirement.]

11. Examining the impact of FinTechs in extending capital access to MSMEs

Syed Abdullah Ashraf
Indian Institute of Management Ranchi
Syedabdullah.ashraf18fpm@iimranchi.ac.in

Rahul Kumar
Indian Institute of Management Ranchi
Rahul.kumar18fpm@iimranchi.ac.in

Abstract

The advancement in technology in the finance sector has given birth to FinTech. South Asia will be witnessing the highest FinTech growth rate in the next five years. Indian MSMEs have been seen to be riding this tide, and FinTechs are well aware of that. This study aims to examine the role of Fintech-based microfinancing in the growth and sustainability of MSMEs. We have followed qualitative methodology to understand the impact of FinTech services on the MSMEs' overall development. Insights from interviews revealed many problems, especially credit-related, faced by MSMEs. The participants accepted that FinTechs have helped them overcome the problems by offering quick and customized short-term loans. The study establishes that the support from FinTech has made the MSMEs more financially stable, resulting in their growth. This study will be the first to investigate this relationship between Fintech and MSMEs. The evidence found in our work points towards the overarching effect of such ecosystems on the nation's economy.

Keywords: FinTech, MSME, entrepreneurship, microfinancing

1. Introduction

Globally, the landscape of the financial sector is changing in this digital era (Mention, 2019). The reason behind the change is the advancement in cyberspace that is giving birth to several innovations. With the changes in the financial sector due to advancements in technology, financial services have become more affordable (Leong et al., 2017). The innovation also helps in the financial inclusion of the people living in a remote geographical area. The role of technology in managing the resources efficiently and effectively is increasing day by day, which is also beneficial for the community (Goldstein et al., 2019). The advancements in technology and its use in the financial sector have led to the emergence of Financial Technology or FinTech, in short, a new way of doing finance through artificial intelligence-powered algorithms. A number of the start-up involved in financial services have tried to offer financial services to the community. Technological innovation in the financial sector has brought new ways of doing things and can be seen as a clear departure from the traditional setup (Nakashima, 2018).

In the future, with the help of quantum computing, FinTech will grow exponentially. FinTech has already grown beyond the Internet of Things (IoT). On the one hand, IoT has created an ecosystem interrelating business. It has become such a phenomenon that those not directly involved can also experience the disruption (Nakashima 2018; Schulte and Liu 2017). On the other, FinTech led to creating(Nakashima, 2018; Schulte & Liu, 2017). On the other, FinTech led to creating innovative asset classes and technologies that will create a revolution in contemporary business customs. According to Mordor Intelligence (2020) report, FinTech in

South East Asia will have the highest growth rate in the next five years (Figure-1). According to Mordor Intelligence (2020) report, FinTech in South East Asia will have the highest growth rate in the next five years (Figure-1). FinTech has propelled rapid growth in numerous sectors globally, starting from payment start-ups, crowdfunding, lending, personal finance, financial research, retail investment, remittances, etc. The payment business and loans are the top two contributors in the FinTech business, followed by aggregation and crowdfunding (Deloitte Touche Tohmatsu Limited, 2019).
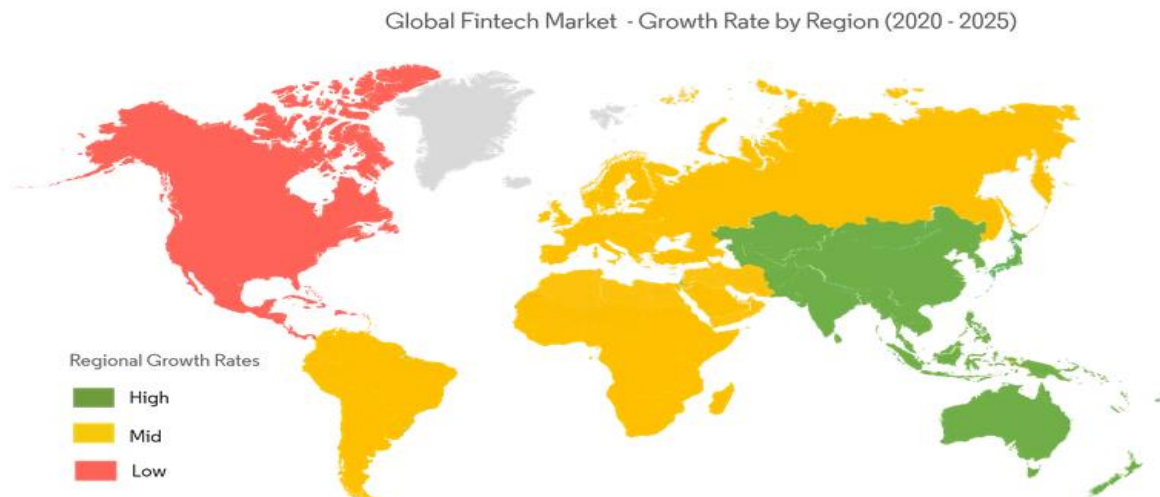

Figure 1: Global FinTech Landscape (Source: Mordor Intelligence)

Micro, Small, and Medium Enterprises (MSMEs) are considered as the growth engine of the nation in India (Singh, 2015). The Government of India have laid down the following criteria for the categorization of an organization as MSMEs (*What's MSME | Ministry of Micro, Small & Medium Enterprises*, 2020):
"
- a micro-enterprise, where the investment in Plant and Machinery or Equipment does not exceed one crore rupees and turnover does not exceed five crore rupees;
- a small enterprise, where the investment in Plant and Machinery or Equipment does not exceed ten crore rupees and turnover does not exceed fifty crore rupees;
- a medium enterprise, where the investment in Plant and Machinery or Equipment does not exceed fifty crore rupees and turnover does not exceed two hundred and fifty crore rupees."

It employs almost 124 million people in the country, second to the agricultural sector. At present, nearly 56 million MSMEs are engaging in various industries across India. Out of which nearly 14% of enterprises are owned, controlled, and managed by women entrepreneurs, and almost 60% are grounded in rural areas. MSME contributes 45% of merchandise exports and contributes 8% in overall Gross Domestic Products (GDP) (Ministry of Micro, 2021; Vasal, 2020). Moreover, the disbursement of business credit and debtors is witnessing sustained growth post-liberalization era. According to the Reserve Bank of India (RBI), the public sector bank lending has stood at Rs 8.20 lakh crore, Rs 8.28 lakh crore, and Rs 8.64 lakh crore in FY16, FY17, FY19, respectively (RBI, 2015). In 2019, it was recorded that public sectors made the Rs 8.81 lakh crore loan disbursement to MSMEs. Afterward, the target in 2020 will be to cross Rs. 9 lakh crores, but the Covid-19 pandemic may impact the disbursement of the business credits. As shown in Figure 2, the annual gross loan portfolio is expected to reach INR

3,627 Bn, whereas the clientele will reach 64 Mn by FY 2022 (KPMG International Cooperative, 2019).
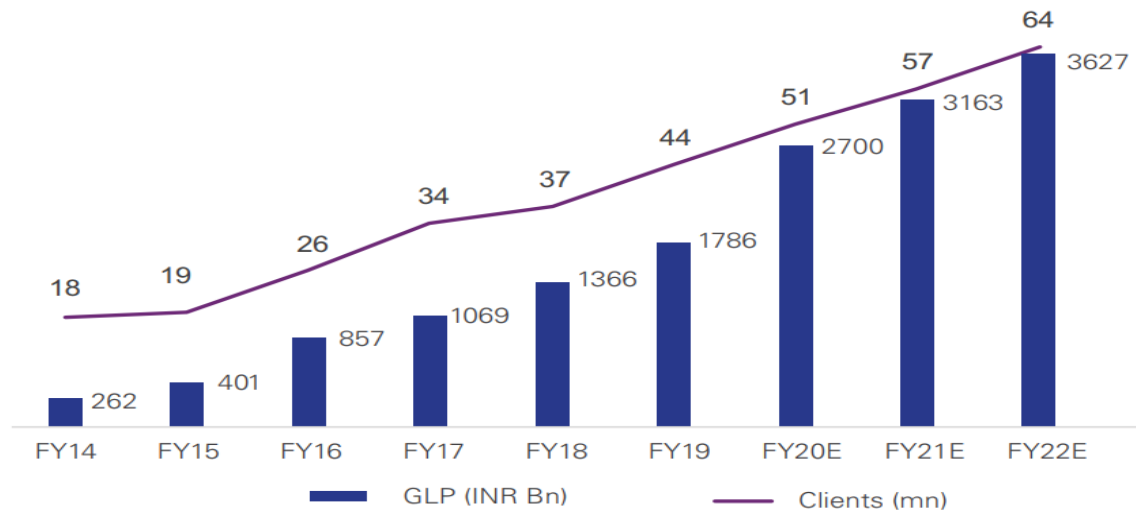

Figure 2: Microfinance growth in portfolio size/number of client (Source: MFIN Micrometer report FY 14-19)

The lack of capital, channelizing of goods, licensing, and administrative tasks like bookkeeping are common difficulties that entrepreneurs and MSMEs face in managing their business activities (Kumar et al., 2009). Apart from these, managing other functions like marketing, product development, product pricing, human resources, and their promotional task adds to the woes of the entrepreneurs. Several studies present that (Ghouse, 2017; Hamid, 2017; Harvie, 2019; Kumar et al., 2009). The collateral is one important obligation that has to be fulfilled by the MSMEs for applying for the loan from banks and such institutional setups. Lack of collateral is the major hurdle to raise business capital faced by MSMEs. These problems must be assessed while forming the policies for the MSMEs so that it becomes painless for them to access loan assistance. One way to deal with these problems is to streamline the process, remove unnecessary compliances caused by existing policies and institutional setup (Guild, 2017).

It is expected that an artificial intelligence-driven financial model will help overcome the problem of business capital in the days to come, in the way helping MSMEs with their operation. The spectrum of services provided by FinTech will play a pivotal role in the development of MSMEs. Therefore, this study aims to examine the role of FinTech based microfinancing in the sustainability of MSMEs in India.

The key objectives of this paper are:
- To analyze the key problem faced by MSMEs.
- To examine whether FinTechs have improved the availability of capital to the MSMEs.

The rest of the paper is organized as follows. Section 2 presents the methodology, Section 3 presents the findings, and Section 4 summarizes the conclusions.

2. Methodology

In our study, we have followed qualitative research methodology. We have conducted a few pilot interviews to develop a better understanding of the phenomenon. Based on the findings of the interviews, we will proceed with the survey. We interviewed the clients of FinTech dealing in microfinance; the interview focus was broadly around the problems they were facing earlier and how FinTech helped them get around them. We also enquired about how FinTech helped them increase overall efficiency, and they were financially beneficial. During the pilot study, we opted for purposive sampling. Due to COVID-19, the interviews were conducted over the telephone or via zoom meeting. The interviews were semi-structured. The average duration of the interviews was around 45 to 50 minutes and was conducted once per respondent. The educational level of all the respondents was graduate or above, and the average age was 30 years. During our qualitative study, we adhered to guidelines laid down by Klein and Myers (1999) specifically, and we remained cautious about the interaction between interviewer and respondent to avoid any possible biases. We started with some basic questions about the respondents, their educational background, and their work to set the context. So far, we have conducted 10 interviews and will continue conducting more interviews until theoretical saturation is achieved.

Once the interviews were conducted, they were transcribed manually. Since India is a non-English speaking nation, some interviews were conducted in the local language as the respondents were not well versed in English. Those interviews were translated to English for analysis. Both the authors performed the translation separately and the help of an English language scholar to review those translations to arrive at a final version. The interviews were examined using the narrative analysis technique. The narrative analysis is suitable when the information collected via interviews is functional and purposive (Figgou & Pavlopoulos, 2015). We used the dialogic/ performance analysis as it is concerned with who, what, and why (Riessman, 2008).

Findings

From our qualitative study, we were able to gain considerable insights. The study suggests FinTechs have been instrumental in meeting the short-term capital requirements of the borrowers.

When asked about the minimum amount of loan they have taken, participant 3 mentioned, "The loans were available for as low as Rs 2000/- for a period as short as 30 days".

When enquired about their problems and factors affecting their growth, participants 4 and 7 highlighted several problems. They mentioned, "the regulatory requirements were proving difficult to meet sometimes, and terms and conditions were unfavorable especially interest rates, borrowing period, repayment schedule, minimum amount, etc."

Participants 5 and 8 mentioned "how the limited working hours during COVID, weekends, and public holidays made it difficult for them to obtain a loan quickly."

These and other problems got aggravated during the COVID-19 lockdown.

When speaking about how FinTech-based solutions have helped them with the problems, they mentioned, "With FinTech operating 24x7, not only were they able to apply for the loan at any time of the days through app or website but were also able to get a quick response from the company. With flexible terms and conditions and lenient approach, the respondents were able to procure the loan, bypassing most of the paperwork required with conventional Microfinance Institutions (MFIs)."

The respondents also reported that they could get the required capital directly from the investors with a peer-to-peer lending platform. The respondents also revealed that their cost of funds had declined significantly because they provide a customized loan in terms of payment schedule compared to the stringent payment schedule of banks and other financial institutions.

From the insight obtained from the qualitative study, it can be said that FinTechs are indeed helping MSME in their growth. The gamut of solutions provided by Fintech companies is helping MSMEs in navigating through the complex institutional structure of regulations. We believe it won't be too early to say that if fully realized, Fintech-based innovation will become a catalyst for the growth of the MSME sector that will, in turn, propel India to become an economic superpower.

Conclusion

Fintech is an intervening improvement between user and saver of the fund in the economy through an expanded money-related transaction. In the era of the digital revolution, where technology is changing rapidly, the overall community should practice this ongoing innovation as a fashion (Darma et al., 2020). Financial services became more affordable and assessable because of the innovation done by FinTech in their product portfolio. The prospects of Indian MSMEs are enormous. However, the inadequate financial resources availability and low penetration of financial inclusion hamper their growth. FinTech based microfinancing can help MSMEs to raise business capital quickly, enhancing which in turn enhances customer experience, promoting customer engagement, helps in sharing of information, providing provides payment schemes, collaboratively providing systems provides system like identity verification, and quickening quicken money- related administrations. The advancement in technology in the financial sector also shields systems and shoppers from highly hazardous conduct and possible interruptions.

MSMEs are at the core of ATMANIRBHAR BHARAT. MSME revolution is a must for the resurgence of the Indian economy. Fintech-based innovation can be seen as the potential solution for the long-standing problems ailing the growth of MSMEs. Only by maneuvering through these issues will we be able to realize the growth of the country as a whole. This type of growth will generate large-scale employment and put India in the global spotlight as the go-to destination in the manufacturing and assembling sector.

The key findings of this paper are:
- The MSMEs are facing a myriad of problems, especially during the COVID pandemic. All our participants have mentioned the difficulty in gaining access to capital as their single most ailing pain point. Except these, the paper works, and excess documentation has also been mentioned by most of our participants as a problem.
- From the narrative analysis conducted over the interviews, one common theme emerged: FinTechs have been phenomenal in extending capital access to the MSMEs. From quick

credit assessment of the application to all-day availability to customized terms and conditions have been the constant underlying theme identified from the interviews.

Research Limitations

Gaining our respondents' trust proved to be the single most challenging task apart from lack of financial knowledge and proper financial records. When we talk about a firm's performance or unit generally, we talk about its financial performance, for which there are standard measures such as return on investment, return on asset, and other similar measures. But lack of financial knowledge in our respondents forced us to limit our finding on qualitative evidence only that mostly revolves around perceived business performance. Existing financial reporting regulations don't help us as they exempt MSMEs from maintaining books of financial records. Another major limitation was the coronavirus pandemic, due to which we had to limit our data collection method to phone and video calling. The advantage of these techniques is that you can reach anybody anywhere, but the absence of face-to-face interaction that could have helped us establish rapport severely constrained our interactions with the respondents. In addition to that, the technical communication medium proved to be a major inconvenience to our respondents and us. So far, our findings are based on qualitative study only. However, we will have to complement them through quantitative study to make them more robust and generalizable. We shall further strengthen our findings with a quantitative study.

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12. Factors Influencing the Adoption of Digital Technologies in South African SMMEs

Raul-Pierre Classen
University of the Western Cape
3669520@myuwc.ac.za

Malcolm Garbutt
University of the Western Cape
mgarbutt@uwc.ac.za

James Njenga
University of the Western Cape
jkariuki@uwc.ac.za

Abstract

The increased use of interactive digital technology and the Internet are forcing organisations to have a digital presence. For small, medium and microenterprises (SMMEs), this is an opportunity to expand communications with consumers and improve sales in the digital economy. However, SMMEs in developing countries, including South Africa, are slow to adopt these technologies, thereby impacting their survival. This preliminary study explored five SMME top management's perceptions of digital technology adoption towards enhancing their digital presence based on the technology-organisation-environment framework. The study used in-depth interviews with managers from five SMMEs in the Western Cape province of South Africa. The study found that SMME owners' awareness of the relative advantage of the technology for an enhanced digital presence, the perceived SMME's capabilities, the compatibility of the technology with existing processes, and effort expectancy in time influenced the adoption of technology for digital presence. The adoption of technology is moderated by prior digital technology experiences, perceived pressures from customers and competitors, and external support availability.

Keywords: Digital Technologies; Digital Presence; SMMEs; Adoption Factors; TOE.

1. Introduction

The rapid advances and prevalence of the Internet and information and communication technologies (ICT) are forcing businesses to transform how they conduct operations (Fosu, 2018). Organisations communicate and interact with consumers and stakeholders through new digital channels that increase their digital presence (Fosu, 2018; Elia et al., 2020). Digital channels utilise digital technologies, including websites and social media, to interact and communicate directly with consumers (Elia et al., 2020). Some of the benefits derived from ICT-based customer interactions include improving the organisation's competitiveness, efficiency, and cost-effectiveness (Fosu, 2018). In particular, small businesses have reaped the benefits of digital technologies that enable them to compete with larger organisations to cost-effectively access markets and maintain customer relationships (Matikiti et al., 2018).

For developing countries, such as South Africa, small, medium and microenterprises (SMMEs) are essential for job creation and economic growth (Botha et al., 2020). However, SMMEs have high failure rates (Mukwarami et al., 2020). SMMEs' inability to forge and maintain communication with their customer base is one of the most significant causes of failure (Fosu, 2018). Despite the benefits and the ubiquity of digital technologies that enable a digital presence, many SMMEs still lack a meaningful digital presence (Maduku et al., 2016). These SMMEs risk becoming irrelevant and losing consumers to competitors in an increasingly

competitive and digital environment (Nuseir, 2018). This study's primary question sought to identify the factors that influence the adoption of digital technologies by SMMEs in South Africa to enhance their digital presence.

The next section provides a brief background to preliminary study with a limited sample, followed by the research objectives and theoretical framework. Section three describes the research design, and section four discusses the findings. Section five provides a conclusion and lists limitations and future work.

2. Background

Creating a digital presence entails adopting digital technologies, such as e-commerce websites, social media, and other internet technologies (Banner, 2018). E-commerce enables organisations to trade via the Internet (Alzahrani, 2019) and establish their market presence and improve their current market position (Banner, 2018). Social media are internet-based applications that enable user-generated content creation and exchange (Kaplan, 2015), enabling a business to improve its digital presence at a relatively low cost (Ainin et al., 2015). Social media adoption enables organisations to increase market penetration, competitiveness, and increased awareness of the business (Matikiti et al., 2018) and extend customer relationships (Harrigan et al., 2010). SMMEs play a pivotal role in South Africa as they contribute towards economic growth and job creation (Botha et al., 2020). An increasing number of South Africans use the Internet and digital technologies to search for products and services online, which presents firms' opportunity to gain consumers and penetrate the market (Kemp, 2020). The adoption of digital technologies enables organisations to promote their business, engage with consumers, convey real-time information and improve communication with consumers, ultimately contributing towards their growth and survival (Abed, 2020). Fostering a digital presence would enable SMME's to remain relevant. It provides a platform for market penetration, and it can directly increase sales revenue while providing a means of survival in the digital economy (Fosu, 2018).

2.1 Factors Affecting Digital Technology Adoption by Organisations

Organisations are influenced in their decision to adopt digital technology by internal and external factors (Matikiti et al., 2018). The internal factors refer to the organisation's capabilities and characteristics (Abed, 2020), while the external environment includes factors and events over which the organisation has limited control (Kuratko et al., 2014). For SMMEs, the factors that facilitate or inhibit digital technologies' adoption are influenced by top management perceptions (Matikiti et al., 2018; Zadok, 2018). The challenge is to identify the factors that enhance or inhibit the adoption of a digital presence.

2.2 Research Problem

Adopting a digital presence is essential for organisations to remain relevant, to keep consumers satisfied and survive in the digital economy (Fosu, 2018; Rahayu & Day, 2015). While there is increased use of technology by consumers and larger organisations to enhance their digital presence, SMMEs in developing countries are slow to adopt these technologies (Eze et al., 2020). At the same time, there is little research on the digital presence of SMMEs in developing countries (Matikiti et al., 2018).

2.3 Research Objectives and Research Question

To investigate the research problem, the study sought to qualitatively explore SMMEs' top management's perceptions of digital technology adoption for enhancing SMMEs' digital presence by posing the question: What factors do top management of SMMEs in the Western

Cape province of South Africa perceive to influence their digital technologies adoption? Although this was an inductive study, it was deemed necessary to position and guide the research and the interviewees through the use of a single theoretical framework.

2.4 Theoretical Framework

Theoretical frameworks provide a lens of the empirical investigation (Saunders et al., 2009). There have been various theories developed to study technology adoption at both the individual and organisational levels. Two popular theoretical frameworks that investigate a phenomenon from an organisation, technology and environment point of view is the diffusion of innovation theory (DOI) (Hillmer, 2009) and the technology organisation environment (TOE) framework (Baker, 2012). Some constructs that influence the adoption and usage of technology in organisations are common to DOI and TOE (Odoom et al., 2017). However, the TOE framework's strengths lie in its ability to look at multiple dimensions of variables (Olanrewaju et al., 2020). The TOE framework is recommended when there is a need to consider external factors that could affect technology adoption, whereas the DOI neglects external factors (Maduku et al., 2016). Baker (2012) defines the TOE framework as an organisation-level theory that explains how the different elements of a firm's context influence technology adoption. The three elements are the technological context, the organisation context, and the environmental context. The technological environment refers to the available technologies and could be useful to the firm and indicates the relevant skills required to use the particular technology being adopted (Matikiti et al., 2018). The TOE framework highlights organisations' external and internal aspects that influence the adoption of digital technologies required to create a digital presence. It has been used in several studies related to adopting new technologies by organisations (Rahayu & Day, 2015), including social media (Wamba & Carter, 2015).

2.4.1 Technology Factors

Technological factors include relative advantage, compatibility, and complexity, influencing an organisation's technology adoption process (Olanrewaju et al., 2020). The relative advantage of digital technology comes from technological innovation's anticipated benefits (Maduku et al., 2016). Compatibility with the organisation's culture, existing technology, value, and work practices (Rahayu & Day, 2015) is a significant determinant of technology adoption in an organisation (Chairoel et al., 2015). Complexity influences technology's adoption as challenging to use technology may require significant business process changes (Alshamaila et al., 2013).

2.4.2 Organisational Factors

The organisational factors that influence technology adoption include organisation size, top management support, and prior technology experience (Igwe et al., 2020). The organisation size is a significant factor in influencing technology adoption (Hagsten & Kotnik, 2017;Ifinedo, 2011). Large organisations have more significant resources and the ability to survive compared to smaller firms. On the other hand, smaller firms are more flexible and innovative (Alshamaila et al., 2013). Top management support is essential when adopting technology (Jere & Ngidi, 2020) as top management must approve of the technology adoption and allocate resources (Maduku et al., 2016). Prior experience of users with technology correlates to current practice (Alshamaila et al., 2013). Thus, the organisation will be more likely to adopt the technology if its employees and top management are familiar with similar technology.

2.4.3 Environmental Factors

An organisation's decision to adopt technology can be impacted directly by environmental factors (Olanrewaju et al., 2020). Customer and competition are the most investigated external factors that affect organisations' adoption of technology (Shaltoni, 2017). The fear of losing to competitors arises from the external environment and usually leads the organisation to adopt the technology to maintain its competitiveness (Soto-Acosta et al., 2014).

3. Research Design and Methodology

The study sought to explore factors that influence digital technology adoption to create a digital presence by South African SMMEs within their natural settings (Aspers & Corte, 2019). Data was collected using semi-structured interviews using themes and questions (Saunders et al., 2009). With themes derived from the TOE framework constructs, semi-structured interviews provided an in-depth understanding of digital technology adoption by SMMEs. Five face-to-face interviews were conducted with owners of SMMEs at the premises of the organisation. Each interview between 20 and 30 minutes was voice recorded and transcribed for further analysis with the interviewees' permission.

Instrument Development

The unit of analysis was the digital presence of SMME businesses located within the Western Cape province of South Africa. An interview protocol was developed based on the TOE framework with open-ended questions adapted from Alshamaila et al. (2013).

Data Sources and Sampling

Judgmental sampling was used for the study since it enabled the observed unit/units to be selected based on the interviewer's judgment about the most useful or representative interviewees (Babbie, 2008). Owners and managers are primary decision-makers in the SMMEs (Jere & Ngidi, 2020) and were the respondents of this study.

Data Analysis

Thematic analysis was used to analyse the data (Nowell et al., 2017). The contexts of the TOE framework (technology, organisation, and environment) formed the initial coding system and were identified as the main themes. The interview voice recordings were first transcribed using Microsoft Word and then coded using Atlas.ti (Saldana, 2013). The codes were sorted and categorised under the TOE framework's respective main themes based on the reference, relationship, and underlying meaning.

4. Findings and Discussion

Five diverse SMMEs (named SMME1 through SMME5), as shown in Table 1 were interviewed. SMME1 was a second-hand motor dealership with a repair and services workshop that sells cars and car parts and had been in operation since 2003. SMME2 was a small retail business established in 2015. SMME3 and SMME4 were printing businesses and had been in existence since 2000 and 2005, respectively. SMME5 was a family retail business and has been in existence for about 40 years. Only SMME5 had no digital presence.

4.1 Technology Factors

Technological factors influencing digital technologies adoption were the relative advantage, compatibility, complexity of the technology, and engagement, as shown in Figure 1.

4.1.1 Relative Advantage

Organisations with a digital presence were aware of the benefits derived from the use of technology. Benefits included connection with customers, the potential to reach more customers, and a cost-effective way to increase sales. "More people became aware of my business, which gave me a broader customer base over a short period when I started using social media for my business." (SMME2). "We made more sales once we started using social media … to make more sales during COVID-19 than we would have made under normal circumstances." (SMME3). The organisation that had not adopted digital technology was unaware of the benefits technology could provide; hence, it did not adopt the digital technology. "… our operations don't require any digital technology." (SMME5).

Number	Industry	Interviewee role	Number of employees	Digital media technology adopted
SMME 1	Motor trade and services	owner	16	E-mai, Social Media, E-commerce
SMME 2	Retail trade	owner	5	Social Media, E-mail
SMME 3	Printing industry	owner	10	Social Media, E-mail, E-commerce
SMME 4	Printing industry	owner	7	Social Media, E-mail
SMME 5	Retail trade	owner	4	None

Table 1: Summary/description of research participants4

4.1.2 Complexity / Perceived Ease of Use

All organisations that had a digital presence viewed digital technology as easy to use except for the non-adopter who was sceptical of the complexities of digital technology use. "Once I started using social media and realised … it was much easier to use than I anticipated." (SMME2). "Social media and these new technologies has its own problems. I would rather stick to what I know works for my business." (SMME5). However, adopting an e-commerce website was more complicated than social media. "Having a business website or incorporating e-commerce for my business requires a bit of IT skill … it also has to be maintained regularly, however social media is relatively easy to use" (SMME1).

4.1.3 Compatibility

Compatibility was a crucial factor influencing the organisation to adopt digital technology to align with the organisation's values, needs, and resources. "I adopted digital technology like social media because my business products need to be visually promoted … helped me reach many people while giving my products visual exposure." (SMME2). "I can access and manage my online business presence through my social media pages using my phone, which makes it so much easier." (SMME4). The non-adopter business indicated that technology was not compatible with their existing work practices. "Our customers make use of our services and purchase goods in person. This is why I haven't adopted digital technologies for my business." (SMME5).

4.1.4 Engagement

Engagement with digital technology influenced the organisation's decision to adopt it. "Tailoring our products and services to the needs of our customers is enabled by the level of engagement that digital technology provides." (SMME3).
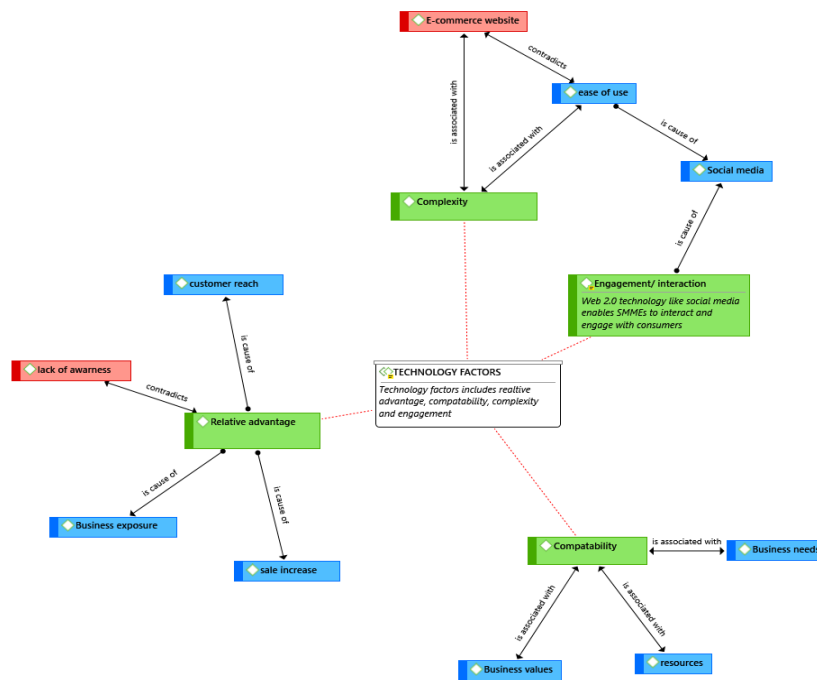
Figure 1: Technology Factors Influencing Digital Technology Adoption.

4.1.5 Discussion of Technology Factors

As in Abed (2020), this study found that the advantages include direct interaction with consumers, wider market reach, cost-effective means to maintain communication with consumers, and promoting their business, leading to increased sales. In contrast, the non-adopter business did not recognise the advantage of digital technologies. Complexity, also referred to as perceived ease of use, influenced digital technology adoption by SMMEs, consistent with Igwe et al. (2020). Relatively easy to use digital technology such as social media was more likely to be adopted than technologies that were perceived to be complicated. Compatibility observations supported the findings of Ainin et al. (2015). Digital technology, like social media that follows existing practices, is more likely to be adopted than a technology that does not align with the organisation's resources and needs. Top managements' need for engagement using digital technologies was an essential factor that led SMME owners to adopt digital technology consistent with Ainin et al. (2015). Social media's interactivity and engagement through two-way communication influenced the SMMEs to adopt the technology.

4.2 Organisation Factors

Organisational factors that influence digital technologies adoption were top management support, organisation size, prior technology experience, and time, depicted in Figure 2.

4.2.1 Top Management Support

The decision to adopt digital technology was supported and initiated by the owners of the technology adopting SMMEs. In contrast, the non-adopter was resistant to implement digital technology. "Although sceptical at first, once I realised the potential and benefits … I decided to adopt the technology" (SMME1). In comparison, comfort in past success is a hindrance to technology adoption. "My family business has been thriving for a long time without an online presence, and therefore I am not willing to change anything" (SMME5).

Figure 2: Organisation Factors Influencing Digital Technology Adoption.

4.2.2 Organisation Size

The organisations' size was observed to influence the decision to adopt digital technology. "The use of affordable technologies like social media enables us as a small business to create a presence with little resources." (SMME2).

4.2.3 Prior Technology Experience

Prior technology experience influenced the decision to adopt the technology within the organisations. "My previous experience working with technology allowed me to apply my knowledge and utilise the technology that is available" (SMME3).

4.2.4 Time

Many participants highlighted that the lack of time was a significant concern and prohibited digital technologies adoption within the organisation. "Time is a problem since we have to continuously engage and respond to consumers as soon as possible." (SMME2). The non-adopter business also remarked that time was a factor that influenced the decision not to adopt the technology. "My business duties keep me busy 24/7, I do not have much time to promote my business online." (SMME5).

4.2.5 Discussion of Organisation Factors

Top management support significantly impacts the organisation's digital technology adoption decision, consistent with Maduku et al. (2016). The organisation size was not perceived as a barrier to digital technology adoption, which aligns with Ifinedo (2011), particularly technologies such as social media, which are relatively easy and inexpensive to adopt and aligns with the organisation's resources. Resonating with Maduku et al., (2016), prior experience and technology capabilities enabled the users to be aware of the benefits that could

be derived and facilitated adopting the organisation's technology to enhance a digital presence. Lack of time was identified as a factor that negatively affected digital technologies adoption by the organisation.

4.3 Environment Factors

Environmental factors that influence digital technologies adoption were customer pressure, competitor pressure and external support, depicted in Figure 3.
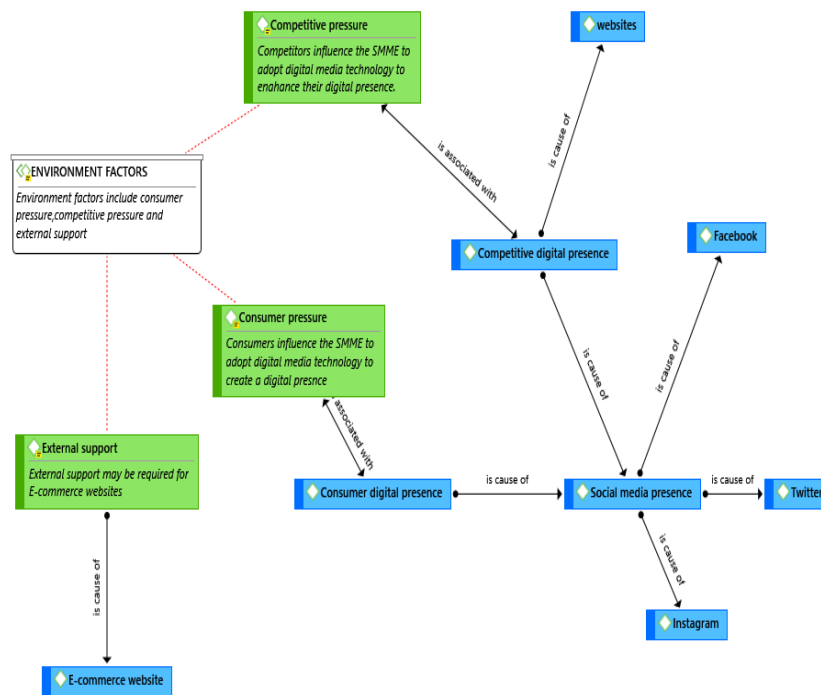

Figure 3: Environmental Factors Influencing Digital Technology Adoption.

4.3.1 Customer Pressure

Customers significantly influenced the decision to adopt the technology. The organisations indicated that it is essential to be easily found and have a presence where consumers are. "Our consumers expect us to be found online via social media or website; therefore, we are expected to have a digital presence." (SMME4). On the other hand, the non-adopter business did not encounter the same customer pressure, "…our consumers know us and prefer doing business the traditional way." (SMME5).

4.3.2 Competitor Pressure

Competitors also influenced SMME decisions to adopt digital technologies for the organisation. **"**It was essential to adopt digital technologies for my business because my competitors have a strong online presence which was beneficial for their business." (SMME4). Likewise, the non-adopter expressed no interest in using digital technologies due to competitors not using it either. "none of my competitors are using digital technologies, so as it does not affect my business" (SMME5).

4.3.3 External support

External support was not considered an influencing factor of digital technologies adoption of social media. "I did not require any external IT support as I know how to use social media

effectively to promote my business." (SMME1). However, external support could be an influencer for more advanced digital technologies. "As I have adopted both social media and E-commerce, I require external IT support for my website. However, I don't for my social media business account." (SMME3).

4.3.4 Discussion of Environmental Factors

Customers were observed to be a significant external factor that influences digital technology adoption, consistent with Bogea and Brito (2018). Competitor pressure influenced the adoption of technology to maintain competitiveness, as Rahayu & Day (2015) indicated. External support was not considered an influencing factor of easy-to-use digital technologies but could influence more complex technologies requiring external support.

5. Conclusion

This preliminary study explored top management's perceptions of digital technology adoption for enhancing digital presence for SMMEs in the Western Cape in South Africa. Five SMME owners in the Western Cape were interviewed using open-ended questions guided by the TOE framework. The findings indicate that different digital technology complexities have different factors that promote or inhibit the organisation from adopting the technology. For example, social media was more readily adopted than e-commerce which was more complex and took more effort.

The study underlines the TOE framework's applicability for exploring technology adoption in organisations. It also showed that technology, organisation, and environment are interrelated and influence digital technologies adoption. Technological factors that significantly influence digital technologies adoption are relative advantage, compatibility, complexity, and engagement. The organisation factors that influence digital technologies adoption in SMMEs were top management support, size, previous digital technology experience and time. The environmental factors that influence digital technology adoption were customer pressure, competitive pressure, and external support. Both forms of pressure were perceived as positive influencing factors of digital technology adoption. The conditions and factors impacted each other and differed between SMMEs and the level of digital technologies. For example, the relative advantage of technology, which is the perceived benefit derived from the adoption of digital technologies, may not be realised after implementation and could influence the organisational construct of prior technology experience. Meanwhile, the lack of awareness and benefits of digital technologies hindered SMMEs technology adoption. Likewise, relationships were observed in the adoption of digital technologies which directly impacted sales, although the need to respond to online consumers timeously constrained the organisation from adopting the technology.

In sum, for an enhanced digital presence, SMME owners should be aware of the relative advantage of the technology, which must be within the business's capabilities, compatible with existing processes and operable within available time frames of the business. Adopting technology is moderated by prior experiences with technology and the perceived pressure of customers and competitors. For innovative technologies, external support may further moderate adoption.

The study was limited by a small sample size and a purely qualitative approach concentrating on owners' perceptions and the use of a single theoretical framework. Future research could expand the scope and consider a mixed-methods approach and apply related theories to expand the understanding of digital adoption amongst small businesses. Quantitative research may also

benefit from input from other staff. Future work is needed to determine levels of technology that may differently impact the factors affecting adoption. For example, social media, which was observed to be relatively easy to implement, support and operate, would be ranked lower than e-commerce, which requires more effort and external support.

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13. Ferramenta de Visualização de Dados Públicos da Saúde Disponibilizados pelo DATASUS

Paula Monteavaro Franceschini
Universidade do Vale do Rio dos Sinos
paula.franceschini@edu.unisinos.br

Josiane Brietzke Porto
Universidade do Vale do Rio dos Sinos
josibrietzke@unisinos.br

Rafael Kunst
Universidade do Vale do Rio dos Sinos
rafaelkunst@unisinos.br

Abstract

For a long time, health data visualization techniques have been an essential and determining field for generating knowledge and directing public policies. In Brazil, the Informatics Department of the Unified Health System (DATASUS), is main responsible for storing brazilian public health-related data. Nowdays, data is considered a valuable item, thus, access to public information must be facilitated in order to be explored and understood by a greatest amount of people. This article presents a visualization tool for the Brazilian public health hospitalization system dataset, provided by DATASUS. The developed tool uses different data visualization techniques to support the analysis of epidemiological data. With the tool developed through the Design Science Research, it is possible to analyze the behavior of the causes of SUS hospital admissions, by gender, age or time of year. It is also possible to compare reasons for hospitalization over the past ten years and the main causes of hospitalizations in all states of Brazil.

Keywords: Big Data, Health Data Visualization, DATASUS, Covid-19, Design Science Research.

1. Introdução

A Lei de Acesso à Informação (Lei 12.527/2011) regulamenta o acesso e permite consulta aos dados de diversos órgãos governamentais pela população brasileira (Brasil, 2011). Em consonância com essa lei, o portal do Departamento de Informática do Sistema Único de Saúde (DATASUS), que já disponibilizava diversas bases de dados desde sua criação, se tornou importante ferramenta para consulta de dados abertos da saúde pública no Brasil (Ventura, 2013)

Nesse portal há dois aplicativos para consulta de dados abertos: o *TabNet* e o *TabWin*. Entretanto, os dados disponibilizados não são padronizados nem integrados e não são usadas técnicas e ferramentas avançadas para visualização, tornando a obtenção de informações uma tarefa extremamente árdua (Pires et al., 2011). Por esse motivo, dificuldades podem ser encontradas para explorá-los, além de ser uma experiência complexa para um cidadão sanar dúvidas a respeito da saúde no Brasil, uma vez que a visualização dessas informações não é intuitiva nem trivial no portal.

A visualização de dados é uma forma de apresentar histórias sobre dados para humanos, que são mais orientados visualmente (Qin et al., 2020). Desta forma, técnicas de visualização de dados aplicadas aos dados abertos do Sistema Único de Saúde (SUS) podem fazer com que mais pessoas consigam conhecer, compreender e explorar estes dados. Diante deste cenário surgiu a seguinte questão norteadora da presente pesquisa: Como facilitar e tornar acessível

informações sobre saúde pública brasileira, a partir de dados abertos disponibilizados pelo DATASUS?

Nesta direção, em busca de uma possível resposta para tal questão de pesquisa, esse estudo teve por objetivo facilitar o acesso e a exploração dos dados do DATASUS, usando conceitos de *Big Data* e técnicas de Inteligência Artificial, para implementação de uma ferramenta web de visualização desses dados, sob o método *Design Science Research*. Para isso, foi necessário o alcance dos seguintes objetivos específicos: *(i)* obter e analisar os dados disponibilizados pelo DATASUS; *(ii)* definir visualizações para exploração desses dados, de acordo com suas características; *(iii)* desenvolver uma ferramenta de visualização de dados, a partir desses dados abertos.

Justifica-se por prover transparência aos cidadãos brasileiros e por permitir acompanhamento social acerca de saúde pública em contexto nacional, com base em dados de fontes públicas e confiáveis. Torna-se importante para fins de monitoramento periódico de informações de interesse público, especialmente, em tempos de pandemia como a de Covid-19, em que se observa desinformação e diferentes visões de fatos, em múltiplos canais de comunicação. Essa ferramenta é relevante, inclusive, após essa pandemia, pois pode contribuir para uma melhor gestão do conhecimento e dos recursos, geralmente, escassos e dispendiosos, nas esferas de governo municipal, estadual e federal.

Por meio de emprego de tecnologias emergentes, a arquitetura da solução e a ferramenta construída nessa pesquisa podem auxiliar no tratamento dos desafios referentes à transformação digital nos processos de saúde pública, a partir do suporte a uma análise de dados abertos de forma visual, confiável e eficiente, possibilitando a descoberta de conhecimentos relevantes, não facilmente identificados, sem certo tratamento e preparação, via tecnologias especializadas. Ademais, os resultados dessa pesquisa facilitam iniciativas de educação para cidadania e para a saúde coletiva, oportunizando uma melhor experiência para todas as partes interessadas nessas informações.

Além dessa introdução, o artigo está organizado em: seção 2 traz conceitos de *big data* e visualização de dados em saúde pública; seção 3 explica os dados do DATASUS e traz trabalhos relacionados; seção 4 explica como foi desenvolvida a ferramenta; a seção 5 mostra os resultados obtidos e a seção 6 apresenta as considerações finais.

2. *Big Data* e Visualização de Dados na Saúde Pública

Os dados relacionados à saúde pública geralmente podem ser caracterizados como *big data*, pois são altamente complexos, em função do grande volume, várias fontes, velocidade em que são gerados e, algumas vezes, baixo grau de veracidade (Sedig, 2014). Neste contexto, técnicas de visualização de dados são extremamente úteis e podem ajudar a examinar as várias dimensões desses dados (temporal, espacial, entre outras), além da análise estatística (Joshi et al., 2017).

Além disso, a visualização de dados é uma ferramenta crítica e poderosa para auxiliar no descobrimento e entendimento dos dados da saúde, auxiliando na tomada de decisões e na comunicação entre os interessados (Martinez et al., 2016). Para tanto, os dados devem ser coletados, explorados, armazenados, analisados e finalmente convertidos em informações, sendo importante saber como mostrar essa informação de forma adequada e compreensível, para que todos os destinatários possam entendê-la. (Few, 2007).

14.   Diante de uma pandemia, como a da Covid-19, a visualização de informações mostra-se essencial para pesquisas e descoberta de conhecimentos a respeito da evolução da doença e para comunicar melhor a população sobre riscos e evoluções do cenário pandêmico. Nas diferentes esferas, como por exemplo, na federal, o governo criou o "Painel Coronavírus" (Ministério da Saúde, 2020a), que apresenta um *dashboard* com diversas informações sobre a doença no Brasil. Em contexto internacional, também existem outras ferramentas de visualização de dados na saúde como o portal *HealthData.org*, que disponibiliza diversas visualizações organizadas por estudos.

3. Dados do Sistema Único de Saúde Brasileiro

O SUS é um dos maiores e mais complexos sistemas de saúde pública do mundo, garantindo acesso integral, universal e gratuito para toda a população do Brasil (Ministério da Saúde, 2020b). O DATASUS tem como responsabilidade prover sistemas de informação e suporte de informática aos órgãos do SUS, além de ser o principal responsável pelo armazenamento de dados acerca da saúde da população brasileira (Ministério da Saúde, 2019.).

Através do seu portal, o DATASUS disponibiliza conjuntos de dados de alguns sistemas sob sua gestão, além de dois programas para consulta e exploração dos dados: o *TabWin* e *TabNet*. Porém, ambos possuem limitações, como compatibilidade com apenas um sistema operacional (*Windows*), no caso do *TabWin* e o fato de só permitir tabulação de dados, sem explorar diferentes formas de visualização, no caso do *Tabnet* (Silva, 2009). Além destes programas, o DATASUS disponibiliza as bases de dados de alguns sistemas para *download*, em formato *Data Base Container* (DBC), no qual os dados são armazenados de modo compactado. Porém, pelo formato próprio, somente pode ser lido pelo *TabWin* e por uma ferramenta de linha de comando, disponibilizada pelo DATASUS (Petruzalek, 2016).

Estudos anteriores também criaram ferramentas para auxiliar na análise ou processamento dos dados do DATASUS. Para *R*, por exemplo, existem os pacotes *Microdatasus,* com função de *download* e pré-processamento desses dados (Saldanha et al., 2019) e o *read.dbc*, que lê arquivos de dados do formato ".DBC", facilitando o processamento (Petruzalek, 2016). Outro exemplo é uma ferramenta em *Java*, para tratar os dados do DATASUS e exportá-los para um banco de dados relacional (Mendes et al., 2020). No presente trabalho foi utilizado o *PySus* (Coelho, 2020), biblioteca *Python* que disponibiliza diversas funções para auxiliar na obtenção e na análise de dados do DATASUS, inclusive, descompactando os arquivos ".DBC".

4. Metodologia de Pesquisa

O objetivo deste trabalho foi criar uma ferramenta de visualização de dados públicos de saúde disponibilizados pelo DATASUS, facilitando análise e entendimento das informações por qualquer cidadão interessado em conhecê-los. Foi desenvolvida sob o paradigma *Design Science*, operacionalizado pelo método *Design Science Research* (DSR)*,* visando projetar, desenvolver e avaliar um artefato de visualização de dados, conforme mostra a Figura 1 (Dresch; Lacerda; Antunes, 2015). Atualmente, as etapas Avaliação e Conclusão de DSR estão em andamento, portanto, destacadas em cinza nessa figura.

Conscientização	• Revisão da literatura e de ferramentas existentes • Identificação do problema • Definição do escopo
Sugestão	• Artefato: Ferramenta de visualização de dados do DATASUS
Desenvolvimento	• Escolha de uma das bases do DATASUS e de técnicas de visualização • Projeto e arquitetura da ferramenta • Desenvolvimento da versão inicial da ferramenta
Avaliação	• Entrevistas com representantes da Quádrupla Hélice • Revisão e refinamento do artefato
Conclusão	• Discussão e divulgação dos resultados parciais • Discussão e divulgação dos resultados finais • Publicação do artefato

Figura 1: Etapas da pesquisa sob o método *Design Science Research*

Em Conscientização, a partir da literatura e de ferramentas existentes, o problema identificado foi a dificuldade de exploração e de consulta de dados disponibilizados pelo DATASUS. A partir disso definiu-se o escopo e como solução proposta, o desenvolvimento de ferramenta *web*, com diferentes possibilidades de visualização e de exploração dos dados, de acordo com suas respectivas características, em Sugestão. Para projeto e construção desse artefato, na etapa Desenvolvimento foi escolhida uma das bases do DATASUS, explorada e categorizada, conforme os tipos de dados contidos nela. Após foram escolhidos dados relevantes e técnicas de visualização para exibi-los de forma a extrair informações e facilitar o entendimento.

A partir de pesquisa na literatura e de exemplos de ferramentas existentes de visualização de dados da saúde, as técnicas de visualização escolhidas foram: *Dashboard*, Linha do tempo, Pirâmide de Resultados, Evolução CID, Ocorrência por UF e Visualizações Combinadas. Em especial, Preim et al. (2019) fez pesquisa sobre visualizações analíticas em dados de saúde pública, destacando técnicas comumente usadas, visando dar suporte aos profissionais dessa área e, consequentemente, às medidas de prevenção. Entre as técnicas estão: os *dashboards* e visualizações combinadas, que apresentam diversas informações relevantes sobre determinado processo ou tarefa, de maneira integrada; os gráficos de linha do tempo, que se sustentam no fato de dados da saúde pública serem contínuos, geralmente (por exemplo, o número de casos de uma doença é continuamente monitorado); e a pirâmide de resultados, que mostra a frequência de determinada doença de acordo com idade e gênero da população. O *Global Burden of Disease* (GBD) é o estudo epidemiológico observacional mundial mais abrangente até o momento e examina tendências desde 1990, incluindo dados sobre mortalidade e morbidade de diversos países, informando médicos, pesquisadores e formuladores de políticas (University of Washington, 2013). As visualizações de "Evolução CID" e "Ocorrência por UF" foram inspiradas neste estudo anterior.

A construção das visualizações levou em consideração a Classificação Estatística Internacional de Doenças e Problemas Relacionados com a Saúde (CID). A hierarquia da CID possui até quatro níveis, sendo cada subnível mais específico em relação ao anterior. Para a construção da ferramenta considerou-se apenas o primeiro nível de hierarquia da classificação CID-10. Quanto à base dados e pipeline de processamento dos dados, para implementação das visualizações foi escolhida a base de dados do Sistema de Internações Hospitalares (SIH) do

SUS, que contém dados de grande parte das internações hospitalares no Brasil. Esses dados são disponibilizados em arquivos ".DBC", separados por estado, mês e ano. Os arquivos de dados mais recentes possuem 113 colunas, com várias informações sobre cada internação. O processamento de dados divide-se em 4 módulos, cada um com objetivos e tarefas específicos, conforme Figura 2. A seguir, a arquitetura e o funcionamento de cada um deles são descritos.
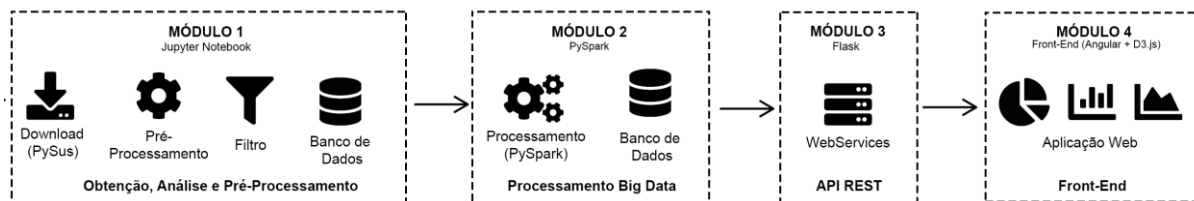

Figura 2: Módulos da ferramenta desenvolvida

O **Módulo 1** foi desenvolvido em *Python*, usando *Jupyter Notebook*, para realizar obtenção, análise e pré-processamento dos dados e o armazenamento em um banco de dados. A obtenção dos dados foi feita por meio da biblioteca *PySUS*, que disponibiliza função para buscar arquivos de dados do SIH por FTP, retornando o arquivo já descompactado e transformado em um *dataframe* da biblioteca *Python* de processamento de dados pandas (McKinney, 2010). Após análise foram escolhidas colunas referentes à UF, onde ocorreu a internação, sexo e idade do paciente, CID de diagnóstico principal e indicativo se houve morte, para compor as visualizações da ferramenta implementada. Com esses atributos, a obtenção dos dados foi feita da seguinte forma: Obtenção do arquivo de dados para cada estado do Brasil e para cada mês e ano do intervalo escolhido (2010 - 2020), utilizando a biblioteca *PySUS*; Filtro para manter apenas as colunas desejadas; Transformação dos tipos de campos de acordo com o tipo de dado; Gravação dos dados em um banco de dados *PostgreSQL*, sendo uma tabela para cada estado.

No **Módulo 2 (*PySpark*)**, após obtenção e pré-processamento dos dados, foram definidas as técnicas de visualização implementadas (ver seção 5) e o formato dos dados necessário para cada uma delas. Trata-se de outro *Jupyter Notebook*, desenvolvido para preparar os dados a fim de facilitar desenvolvimento destas técnicas de visualização. Neste módulo, dados obtidos foram processados e armazenados de acordo com as técnicas de visualização implementadas, com o objetivo de diminuir o tempo de processamento no momento da visualização. Foi criada função para cada uma das visualizações escolhidas e foi utilizado o *PySpark* para processamento dos grandes conjuntos de dados. Por fim, cada tabela criada no Módulo 1 foi processada por cada uma dessas funções e os dados gerados armazenados em tabela específica da visualização. Por exemplo, para visualização de dados que mostrará apenas quantidade de casos por CID de acordo com o gênero foi criada uma tabela, contendo o ano, estado e código CID de referência, juntamente com o total de casos para cada gênero. Desta forma, o cálculo já fica armazenado nesta tabela e não é necessário processar grande volume de dados em tempo real, diminuindo consideravelmente o tempo de espera para renderização dos gráficos.

Com os dados prontos foi construído o **Módulo 3**, uma *API REST* usando o framework *Flask*, que disponibiliza dados para consulta por *webservices*. Nesta API foi criado um *webservice* para cada tipo de visualização, que recebe como parâmetros os filtros informados na ferramenta, busca e filtra os dados na tabela específica do banco de dados e retorna um arquivo *JSON*. Por fim, o **Módulo 4**, um *front-end* da aplicação web foi construído em *Angular*, com a biblioteca *D3.js*, para construção dos gráficos. Para cada tipo de visualização foi criada uma página com um componente de filtros, que podem mudar de acordo com o tipo de visualização. Ao alterar os filtros e/ou atualizar a página o módulo de *front-end* chama o *webservice* referente

àquela visualização, informando os filtros selecionados, recebe o *JSON* com os dados filtrados e renderiza o gráfico. As visualizações desenvolvidas estão descritas na próxima seção.

5. Resultados

Na ferramenta *web* de visualização de dados do SIH do SUS é possível manipular e filtrar de acordo com o estado (UF), ano (entre 2010 e 2020) e o código do CID do grupo de classificação da doença, conforme visão geral das visualizações na ferramenta, a seguir.

5.1 *Dashboard* com Dados do SIH - SUS

Um *dashboard* é uma exibição visual das informações mais importantes, necessárias para atingir um ou mais objetivos, consolidadas em uma única tela, de forma que possam ser monitoradas e entendidas à primeira vista (Few, 2006). A visualização de *dashboard* da ferramenta criada visou demonstrar visão geral sobre os dados de cada UF em cada ano, em uma tela. A Figura 3(a) mostra a tela com os dados de 2020, no estado do Rio Grande do Sul (RS), por exemplo. Nela são exibidos primeiramente 4 indicadores numéricos, que apresentam: o número total de internações, a média de internações por dia, o número de altas e o número de mortes. Depois são exibidos dois gráficos: um de pizza, que mostra a divisão das internações entre homens e mulheres e outro com total de novas internações, ao longo do tempo.
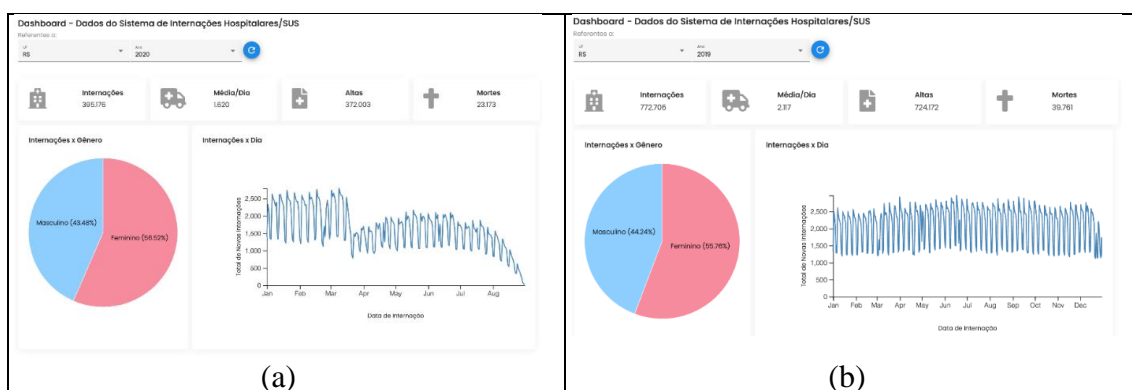

Figura 3: *Dashboard* com dados do SIH - SUS no RS nos anos de 2020 e 2019

Analisando este *dashboard* se tem panorama geral das internações pelos indicativos numéricos. Também é possível ver no primeiro gráfico, que o número de mulheres internadas foi um pouco maior do que ode homens. E, no gráfico da linha do tempo, percebe-se que houve queda no número de internações, a partir do meio de Março de 2020, quando iniciou a quarentena da Covid-19, na maior parte dos estados brasileiros. Esse dado fica mais evidente, quando comparado ao *dashboard* do RS de 2019 na Figura 3(b), em que o número de internações manteve mesmo comportamento, ao longo de todo ano.

5.2 Linha do Tempo

Geralmente, dados de saúde pública são contínuos, por serem agregados e se referirem às populações. Esse é o caso dos dados de internações, que servem para monitorar o número de casos de internação, por uma dada doença ao longo do tempo. A "Linha do Tempo" mostra essa característica dos dados, sendo possível ver se o número de casos aumentou ou não em uma época do ano e comparar o número de casos, entre diferentes grupos de doenças.
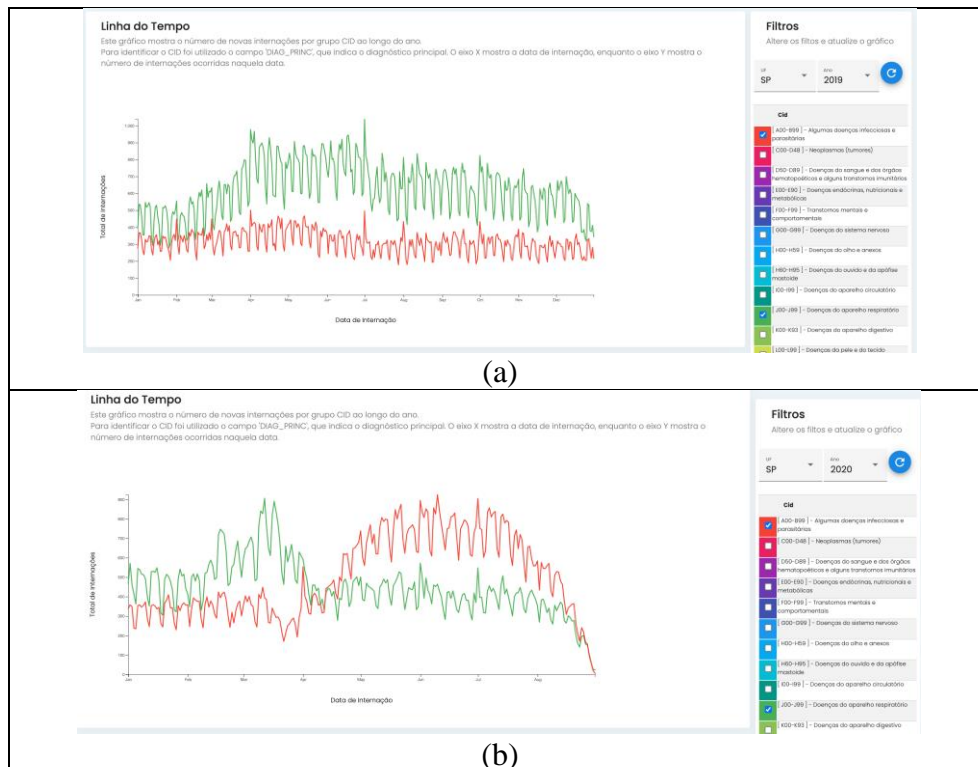
Figura 4: Linha do tempo com dados das internações no estado de SP em 2019 e 2020

Por exemplo, a Figura 4 mostra a comparação entre o número de internações por "Algumas Doenças Infecciosas e Parasitárias" e "Doenças do Aparelho Respiratório", em São Paulo (SP). No lado direito é possível ver o componente de filtro usado na maioria das visualizações da ferramenta. Com ele, dependendo do tipo de visualização, é possível escolher um ou mais grupo CID para filtrar os dados. Além ver que, para cada grupo CID foi atribuída uma cor, com o objetivo de facilitar a identificação ao visualizar os gráficos gerados pela ferramenta. Na Figura 4(a) pode-se ver que o total de internações de "Algumas Doenças Infecciosas e Parasitárias" manteve comportamento parecido ao longo do ano, enquanto, as internações pelo outro grupo tiveram um pico no meio de 2019. Ao passar o mouse pela linha referente ao CID, essa linha fica em destaque e o sistema apresenta uma *tooltip*, com informações detalhadas sobre aquela data e de uma das linhas do gráfico. Comparando os dados de internações dos mesmos capítulos CID, entre os anos de 2019, na Figura 4(a) e de 2020, na Figura 4(b), se pode ver que nesse último ano houve inversão em SP: a partir de Março, as internações por "Algumas Doenças Infecciosas e Parasitárias" aumentaram, enquanto, as internações por "Doenças do Sistema Respiratório" diminuíram.

5.3 Pirâmide de Resultados
Uma pirâmide de resultados é baseada em uma pirâmide populacional, que é um tipo de gráfico comumente usado para descrever composição por sexo e idade de uma população. As pirâmides populacionais possuem dois histogramas justapostos verticalmente, um para pessoas do sexo masculino e outro para pessoas do sexo feminino, com um eixo vertical comum para idade, que geralmente é representada por um ano único ou categorias de intervalos de 5 anos. Quanto maior a barra do eixo vertical, maior a proporção de indivíduos daquela idade e o eixo horizontal representa o número de casos de uma determinada doença (Chui et al., 2011). Ao observar uma pirâmide de resultados, é possível perceber, pelo seu formato, se um grupo de idade e/ou gênero teve um número maior de internações por aquele motivo.
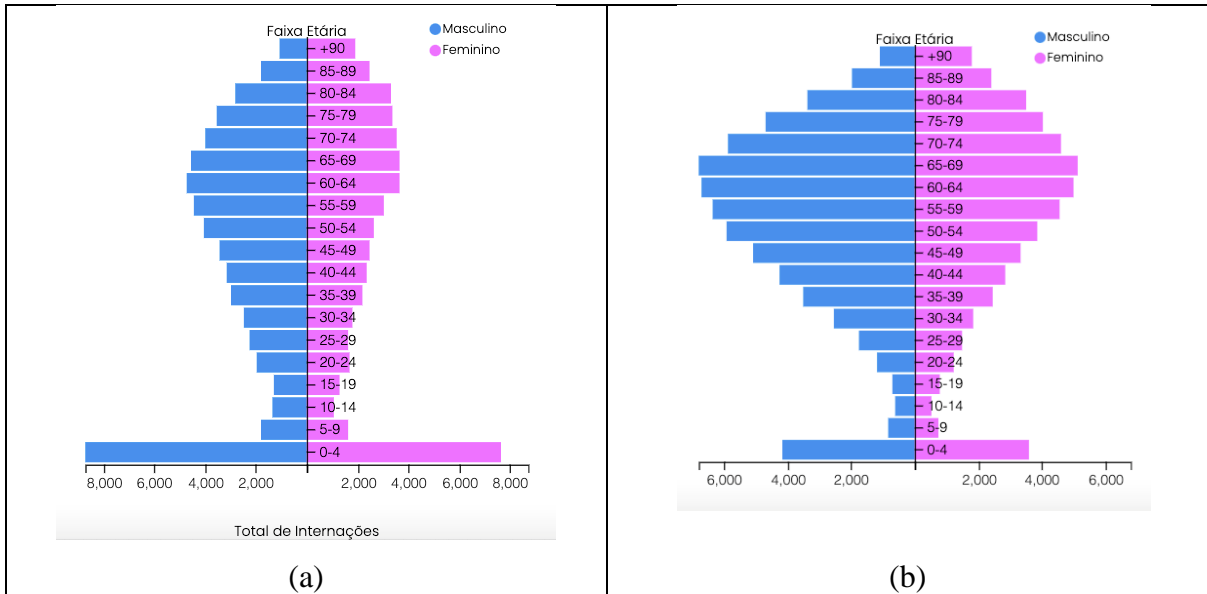
Figura 5: Pirâmides de "Algumas doenças infecciosas e parasitárias" em 2019 e 2020 em SP

A Figura 5 compara a incidência de "Algumas doenças infecciosas e parasitárias" em 2019 em SP (à esquerda) com a incidência em 2020 (à direita), por exemplo. Enquanto, em 2019, a maioria das internações desse grupo era de crianças, em 2020 houve aumento significativo da internação de adultos, o que corrobora com as características de faixa etária dos principais afetados pelo vírus Covid-19.

5.4 Diagnóstico por CID

Com objetivo de explorar o comportamento das doenças entre homens e mulheres, esta visualização compara a incidência da doença em cada gênero. Para montar o gráfico é possível escolher um ou mais grupos CID. A Figura 6 mostra a incidência de todos os grupos CIDs, nas internações em 2020 no RS, divididas por gênero. Este gráfico mostra, por exemplo, que a principal causa de internações entre indivíduos do sexo masculino no ano de 2020 no RS foi "(S00 – T98) Lesões, envenenamentos e algumas outras consequências de causas externas'', sendo também o grupo de maior diferença entre os gêneros, exceto, por "(O00 – O99) Gravidez, parto e puerpério".
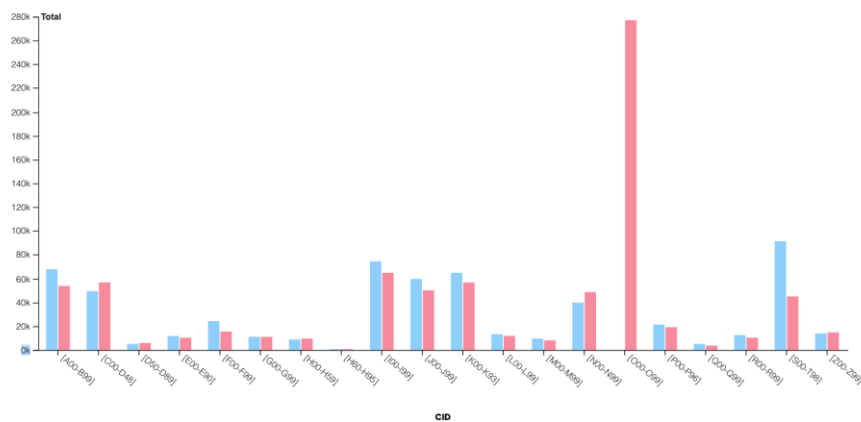

Figura 6: Incidência de internações por cada grupo CID no RS em 2020 por gênero

5.5 Evolução CID

Esta visualização foi inspirada no estudo GBD e mostra mudanças no *ranking* de internações, quando se compara um intervalo de anos. A Figura 7 mostra as dez primeiras posições dos grupos CID por internações, nos anos de 2010 e 2020, no RS. Na comparação entre esses anos houve mudanças significativas, como a queda das internações por "Doenças do aparelho respiratório", que era a primeira posição em 2010 e foi para a sétima posição em 2020 e o aumento das internações por "Algumas afecções originadas no período perinatal", entre outras.

Figura 7: Dez primeiras posições de grupo CID no *ranking* de internações em 2010 e 2020
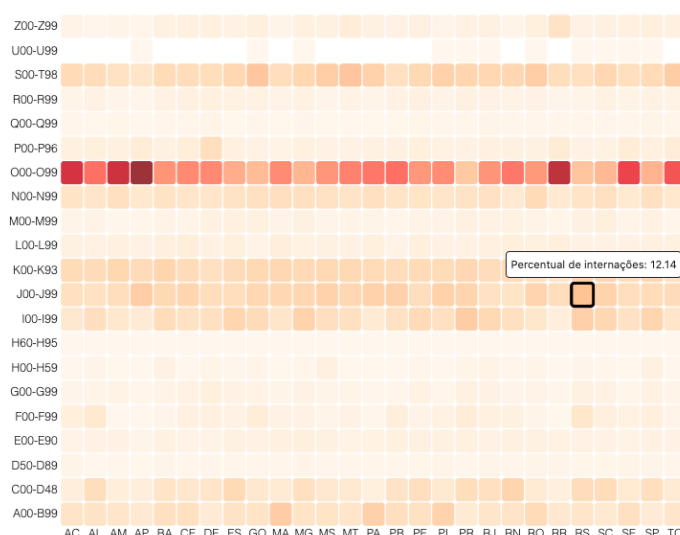

Figura 8: Mapa de calor com incidência de cada grupo CID em cada estado brasileiro

5.6 Ocorrência por UF

Inspirada em visualizações do GBD, a Figura 8 acima mostra mapa de calor entre UFs e capítulos CID. A cor de cada quadrado indica percentual de internações para aquele grupo CID naquela região. Quanto mais próximo do vermelho, maior percentual de internações e quanto mais próximo do branco, menor número de internações. Analisando-se dados de 2019 de todos estados brasileiros, o principal motivo de internações foi "(O00 – O99) Gravidez, Parto e Puerpério", sendo maior em Amapá (AP) e Roraima (RR) e menor, no Paraná (PR) e RS.

5.7 Visualizações Combinadas

Esta visualização baseia-se em estudo anterior (Chui et al., 2011), chamada de *Multiple Coordinated View*' (MCV). São exibidos gráficos com eixos combinados, permitindo visão

geral sobre dados e visões específicas ao mesmo tempo, como na Figura 9(a), que exemplifica os dados de internações por "Algumas doenças infecciosas e parasitárias" em SP, em 2019.
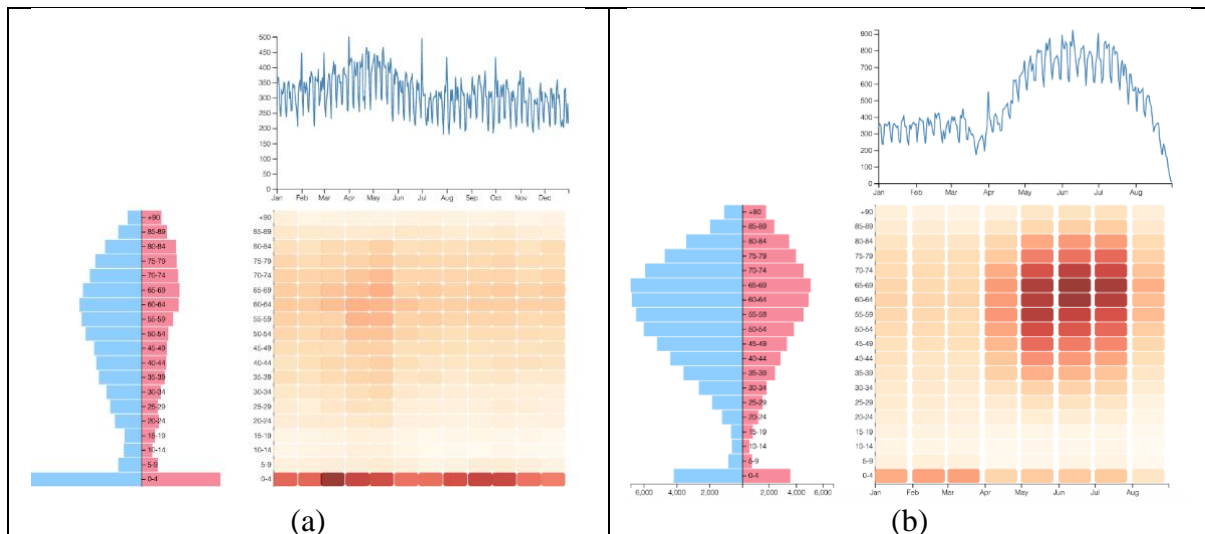

Figura 9: MCV de "Algumas doenças infecciosas e parasitárias" em SP em 2019 e 2020

Na Figura 9, o gráfico mais acima mostra a linha do tempo das internações, o mais à esquerda mostra a pirâmide de gênero e idade e o gráfico abaixo, à direita mostra um mapa de calor referente às internações ao longo do tempo e por grupo de idade. O gráfico de linha do tempo e o mapa de calor compartilham o mesmo eixo *x*, que indica os meses do ano. Desta forma, se vê que onde o mapa de calor apresenta cores mais escuras, a linha do tempo também apresenta valores mais altos. Além disso, o gráfico de pirâmide e o mapa de calor compartilham o mesmo eixo *y*. Mostra-se nos grupos de idade em que a incidência da doença é maior, o mapa de calor também possui cores mais escuras.

No exemplo da Figura 9(b) é possível ver em detalhes o que foi mostrado na Figura 5 sobre incidência de "Algumas doenças infecciosas e parasitárias' ' de SP em 2020 e, na Figura 4, que trouxe linha do tempo com internações nesse mesmo estado e ano. Tal visualização combinada mostra que no início de 2020, internações por esse grupo CID eram frequentes em crianças e, a partir do meio do ano, as internações por esse motivo cresceu na população adulta masculina.

6. Conclusão

Na área da saúde pública, técnicas de visualização de dados já servem como ferramentas para auxiliar nos estudos epidemiológicos há muito tempo. Com o advento da era da informação, onde dados são gerados, processados e armazenados a todo momento, a visualização de informações tornou-se ainda mais importante para auxiliar na descoberta e comunicação de conhecimentos. Sendo assim foi desenvolvida uma ferramenta focada em internações hospitalares do SUS, a partir de dados abertos do DATASUS, por meio de técnicas e ferramentas de processamento de *Big Data*.

O principal objetivo dessa ferramenta foi criar visualizações intuitivas e fáceis de serem exploradas, uma vez que as ferramentas disponibilizadas hoje pelo DATASUS são muitas vezes complexas de serem utilizadas por qualquer pessoa que não tenha conhecimentos especializados previamente, tanto sobre técnicas de visualização quanto sobre os dados abertos disponibilizados. As técnicas adotadas na criação da ferramenta foram escolhidas a partir de um estudo de ferramentas e artigos anteriores referentes à visualização de dados na área da

saúde pública. A maior parte delas tratou de explorar o comportamento epidemiológico dos grupos de doença, ao longo do tempo e/ou localização. A partir dessas visualizações criadas é possível comparar o perfil de internações em cada ano, em cada estado brasileiro. Alguns dos exemplos mostrados trazem dados do ano de 2020 e mostram as alterações no comportamento das internações em função da pandemia de Covid-19.

Essa versão inicial desenvolvida ainda será demonstrada e avaliada por representantes da Quádrupla Hélice, em ciclos da etapa Avaliação do método DSR, para fins de refinamento quanto aos objetivos da solução e aprimoramento do projeto da ferramenta proposta. Ademais, com o conhecimento aprofundado da base de dados, uma possível implementação futura seria a inclusão de *chatbot,* para auxiliar o cidadão a construir um *dashboard* personalizado de acordo com dados de interesse em visualizar, tirando dúvidas sobre as visualizações formadas, aumentando ainda mais a autonomia do usuário na análise dos dados disponibilizados.

Além de futuros trabalhos relacionados às visualizações por níveis mais específicos do CID, a análise de padrões a respeito das internações, podendo servir como insumo para a predição de uso de recursos públicos, inclusive, conforme a época do ano e/ou localização. Um estudo de correlação entre outras variáveis e a classificação de CID, a exibição de visualizações referentes aos outros campos da tabela SIH, a possibilidade de comparar visualizações de anos diferentes em uma mesma tela, entre outras pesquisas futuras.

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14. How Social Capital Facilitates Absorptive Capacity in a High-Growth Environment

Fieke van Telgen
Open Universiteit Nederland
Fieke.vanTelgen@ou.nl

Rachelle Bosua
Open Universiteit Nederland
Rachelle.Bosua@ou.nl

Laury Bollen
Open Universiteit Nederland
Laury.Bollen@ou.nl

Abstract

As High Growth Firms (HGFs) are considered to be main contributors to job creation, researches have tried to uncover factors that contribute to high growth. Although a number of relevant antecedents were identified, a holistic perspective on the growth process is lacking. Hence, this research in progress aims to construct an integrated conceptual model on high growth in order to better understand the growth process and also to provide valuable insights and guidelines on how organizations can realize high growth. The conceptual model will be based on Social Capital theory and Absorptive Capacity theory, as existing research has shown that both social capital and absorptive capacity seem to play an important role in overcoming challenges during phases of growth. The initial conceptual model and corresponding propositions to be tested are presented in this paper. The proposed research methodology, a mixed method approach consisting of an extended literature review combined with a multiple case study, is provided as well.

Keywords: absorptive capacity, high growth, knowledge, social capital

1. Introduction

For years researchers have been focusing on the growth of organizations, especially High Growth Firms (HGFs). HGFs are organizations that realize an annual growth of 20% for at least three years and have started their business with at least ten employees (Eurostat-OECD, 2007). Since HGFs are main contributors to job creation all over the world (Henrekson & Johansson, 2010), researchers have tried to determine the main factors that contribute to high growth. Previous research on growth identified different growth antecedents such as growth orientation, availability of resources and advantageous macro-economic circumstances (Župič & Giudici, 2017). Other research relates more to the growth *process* and possible consequences of growth (Phelps, Adams, & Bessant, 2007). However, despite academic interest in high growth, researchers are struggling to conceptualize growth, the interaction between growth antecedents and the growth process in general (Župič & Giudici, 2017).

The variety of measures used to conceptualize growth leads to fragmentation of research, resulting in conflicting findings and low generalizability (Coad, Daunfeldt, Holzl, Johansson, & Nightingale, 2014; Župič & Giudici, 2017). In addition, growth is a dynamic, context-dependent and complex concept, resulting in the need for a holistic, multidimensional, process-oriented and longitudinal approach (Coad et al., 2014; Župič & Giudici, 2017).

One way to consider growth holistically, is to focus on the role of *knowledge*. Most studies that connect knowledge to the growth of an organization, view knowledge as a transferable asset

(Ganguly, Talukdar, & Chatterjee, 2019; Lee, 2018). Macpherson and Holt (2007) view knowledge as a *relational construct* that has to be examined within the context of social interactions. Hence, there is a need to examine the role of knowledge in the context of firm growth from a more relational perspective, for example by looking at the *absorptive capacity* of an organization. Another topic within growth research that has received wide attention, is the notion of *social capital*. The creation of social capital is seen as a way to compensate for the lack of resources that firms might face (Nahapiet & Ghoshal, 1998; Župič & Giudici, 2017) and is positively linked to the creation of absorptive capacity (Maurer, Bartsch, & Ebers, 2011). Similar to knowledge, social capital is a multidimensional, dynamic concept (van Dijk, Hendriks, & Romo-Leroux, 2016) and thus has to be examined from a relational perspective.

This paper aims to fill the research gap providing a holistic view on high growth by constructing a conceptual model based on Absorptive Capacity theory and Social Capital theory. Hence, previous research on HGFs is examined and interpreted using both theories. These theories provide a structured approach to consider high growth from a process-oriented perspective that suits the context-dependent nature of high growth. The main research question to be answered is: *"How does social capital facilitate absorptive capacity in a high-growth environment?"*.

2. Literature review

A systematic, iterative approach inspired by the grounded theory of Wolfswinkel, Furtmueller, and Wilderom (2013) was used to select and analyze relevant literature. Relevant articles were sourced from EBSCO and Web of Science databases. An open search was conducted combining the key terms 'high growth', 'absorptive capacity and 'social capital', using the NEAR, AND and OR operators. Relevant synonyms were identified and added, namely 'HGF', 'rapid growth', 'social network' and 'knowledge' (E.g. TS = (high growth) NEAR/5 ("absorptive capacity" OR knowledge OR "social capital" OR network* OR HGF). All searches included only English and academic articles with no time-frame restrictions to include theoretical papers by founders of the theories used. After selecting relevant articles based on title and abstract, additional sources were identified e.g., highly cited articles omitted from the initial search. These were added to the core literature, resulting in 16 empirical articles used to frame the initial conceptual model. Selected articles were coded using open coding followed with clustering and finally selective coding, as proposed by Wolfswinkel et al. (2013). The main themes are discussed next.

3. Literature analysis

3.1 Challenges of a growing organization

Because of the dynamics of growth, the challenges that organizations face during a phase of high growth vary over time. Phelps et al. (2007) describe these challenges as six 'tipping points' that need to be overcome: people management, strategic orientation, formalized systems, new market entry, obtaining finance and operational improvement. According to Phelps et al. (2007), during growth, the structural and contextual dimensions of an organization need to be changed in order to successfully resolve these tipping points.

3.2 Absorptive capacity as a means to overcome growth challenges

Based on the notion of overcoming growth challenges that organizations face during phases of growth, Phelps et al. (2007) focus on the role of *knowledge* as a means to survive these dynamic phases. Most studies that connect knowledge to firm growth, treat knowledge as a transferable asset (Ganguly et al., 2019; Lee, 2018). However, Macpherson and Holt (2007) describe knowledge as a relational construct which has to be examined within the context of social

interactions. Hence, there is a need to examine the role of knowledge from a more relational perspective, for example by looking at the *capability* of recognizing and acquiring valuable knowledge instead of looking at the acquired knowledge itself (Macpherson & Holt, 2007).

Phelps et al. (2007) propose a framework to examine growing organizations. In their view all tipping points might need to be addressed in different ways but can be overcome by applying new and requisite knowledge. In order to do so, organizations that aim to grow, need to be able to recognize, assimilate and apply current as well as new valuable knowledge within the context of the organization. This so-called *absorptive capacity* of an organization thus influences successful growth (Phelps et al., 2007). Absorptive capacity can be divided into two types. The acquisition and assimilation of external knowledge is defined as *potential absorptive capa*city, whereas the transformation and exploitation of knowledge is defined as *realized absorptive capacity* (Zahra & George, 2002). Both types of absorptive capacity play an important role in a high-growth environment, as organizations need to pass different levels of absorptive capacity in order to overcome the main challenges (Phelps et al., 2007). As follows, differences in growth rates between organizations might be explained by differences in the capability of acquiring, assimilating, transforming and exploiting knowledge.

3.3 The importance of social capital
The growth process is partly determined by the constant matching of resources to opportunities (Župič & Giudici, 2017). Social capital in particular has received a lot of academic attention, as the creation of social capital is seen as a way to compensate for the potential lack of other relevant resources (Nahapiet & Ghoshal, 1998; Župič & Giudici, 2017).

Nahapiet and Ghoshal (1998) define social capital formally as *"The sum of the actual and potential resources embedded within, available through, and derived from the network of relationships possessed by an individual or social unit"* (p. 243). The network of connections between people, organizations and other social units is described as the *structural dimension* of social capital, whereas the *cognitive dimension* describes the existence of a shared understanding between the actors within networks. The type or value of network ties are described as the *relational dimension* of social capital (Nahapiet & Ghoshal, 1998). In addition, relationships where the focus lies on homogeneity are defined as *bonding ties*, whereas *bridging ties* are relationships between actors of different social backgrounds (Putnam, 2001).

Various studies focus on the role of social capital within growing organizations, as social networks, i.e., the structural dimension of social capital, provide access to valuable resources (Ganguly et al., 2019; van Dijk et al., 2016; Župič & Giudici, 2017). However, as growth is a dynamic process, the social capital that an organization needs during phases of growth changes according to the resources needed (Hite & Hesterly, 2001; Partanen, Möller, Westerlund, Rajala, & Rajala, 2008).

3.4 .The relationship between social capital and absorptive capacity
Although the positive impact of social capital on growth is recognized in the growth-orientated literature (Hite & Hesterly, 2001; Partanen et al., 2008; Župič & Giudici, 2017), some researchers argue that only the *interaction* between social capital and absorptive capacity leads to growth. E.g., Yli-Renko, Autio, and Sapienza (2001) found a positive relationship between firm growth and the internal and external relationships of the organization but only through the mediating effect of knowledge acquisition. Maurer et al. (2011) also found that social capital is essential to the growth of an organization, but only through knowledge transfer. As both studies show, the potential as well as realized absorptive capacity of an organization mediates

the relationship of social capital with firm growth. Consequently, the influence of social capital on high growth can only be understood by including the role of absorptive capacity.

4. Conceptual model of high growth

Prior research shows, there is an important link between social capital, absorptive capacity and high growth. Various researchers found that social capital increases access to the valuable resources needed to achieve high growth (Hite & Hesterly, 2001; Partanen et al., 2008; van Dijk et al., 2016; Župič & Giudici, 2017). In addition, the type of social capital varies depending on the phase of growth (Hite & Hesterly, 2001; Partanen et al., 2008; Župič & Giudici, 2017). This leads to the first two propositions:

- H1a: Social capital contributes directly to high growth.
- H1b: The social capital needed in order to grow, varies per different phases of growth.

Social capital is not only expected to facilitate growth directly, but also through the creation of absorptive capacity (Maurer et al., 2011; Yli-Renko et al., 2001). Hence, this leads to:

- H2: Absorptive capacity is facilitated by different dimensions of social capital.

Through the creation of absorptive capacity, various growth challenges can be overcome (Macpherson & Holt, 2007; Phelps et al., 2007). Hence, the third proposition is as follows:

- H3: Absorptive capacity facilitates high growth.

And finally, through the combination of propositions, an overall contribution of social capital, in combination with absorptive capacity is expected to facilitate growth, leading to proposition:

- H4: The development of social capital in combination with absorptive capacity facilitates high growth.

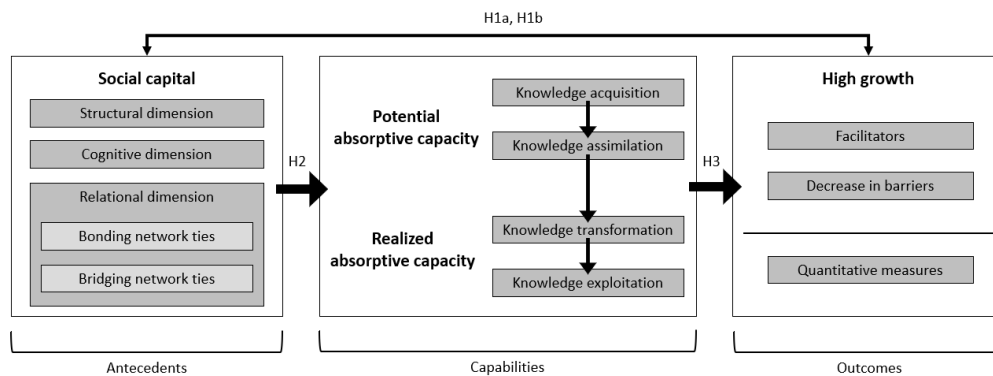These propositions are integrated in the proposed conceptual model provided in Figure 1.

Figure 1: Proposed Conceptual Model of the Relationship between Social Capital, Absorptive Capacity and High Growth

5. Research method

In order to test the proposed conceptual model empirically, this study will follow a mixed method research approach consisting of an extended qualitative research study and a quantitative research study. A mixed method is particularly valuable when looking at complex phenomena and social constructs through multiple lenses (Creswell, 1999). As this research

aims to look at knowledge and social capital as relational constructs in relationship to the dynamics of high growth, a mixed method seems most appropriate.

5.1 Stage 1: Extended literature review
As differences in the conceptualization of high growth have led to a fragmentation of growth research (Župič & Giudici, 2017), the creation of an inclusive conceptual model based on an extended literature review is necessary to interpret existing findings. Conceptual models function as a mediator between existing theories and empirical phenomena (Morgan & Morrison, 1999). When a phenomena cannot be analyzed from a single theory, existing views have to be synthesized in light of the specific situation, creating an integrated view on the phenomena (Imenda, 2014). As this research aims to integrate various findings into a holistic view and then test it within the dynamics of a high-growth environment, the qualitative study will focus on the extension of the proposed model. To do so, a more extensive literature review will be conducted based on the principles of the grounded theory (Wolfswinkel et al., 2013).

5.2 Stage 2: Multiple case study
To test the extended conceptual model of stage 1 and address the current qualitative research gaps, a qualitative multiple case study will be conducted. Research questions that aim to understand *how* and *wh*y phenomena occur are best answered by conducting qualitative research (Creswell, 1999). Especially case studies allow to investigate phenomena in a real-word setting (Saunders, Lewis, & Thornhill, 2016). As both social capital and absorptive capacity need to be examined from a relational view, a multiple case study seems most suitable. The multiple case study will consist of conducting a thorough document analysis in order to collect qualitative background information, supplemented with semi-structured interviews within two different organizations that faced multiple phases of high growth. The first case study concerns a managed business process outsourcing organization active in the domain of financial services. This organization has realized a growth in turnover of roughly 100% and a growth in employees of roughly 400% in 2020. The second case study is selected within the same sector. This organization is seen as one of the main competitors of the first organization, as this organization offers secondment of financial professionals. In 2018, it realized a turnover growth of 43% and an employee growth of 20%. Both cases express clear growth ambitions.

5.3 Stage 3: Quantitative study
Finally, the research will be complemented with a quantitative study based on the outcomes of stage 1, as some findings will ask for a quantitative approach. Hence, at the end of stage 1 all the findings will be integrated into a theoretical framework that will be used to develop a complementary survey with the propositions from the framework guiding this process. For example, results might indicate that a sound measurement tool of social capital or absorptive capacity within the context of HGFs might be lacking. The creation and testing of such a tool might not only be a valuable addition to current research but also guide practitioners in evaluating and acting on challenges they face during phases of high growth. However, results might uncover other valuable propositions that need to be addressed. Hence, the final research approach will be based on earlier findings. The proposed research design is given in Figure 2.

6. Conclusion
This research in progress, as part of a PhD, study attempts to uncover the contribution of social capital and absorptive capacity in a high-growth environment. The results of this research will increase our understanding of the growth process in general and guide organizations in achieving high growth through social relationships and knowledge, instead of financial capital. This research will also provide practitioners new insights in how to design support programs

for organizations that aim to grow, based on the presence or absence of social capital and absorptive capacity. Finally, this research will act as an example to scholars that aim to examine relational constructs in dynamic contexts by using a process-orientated, holistic approach.
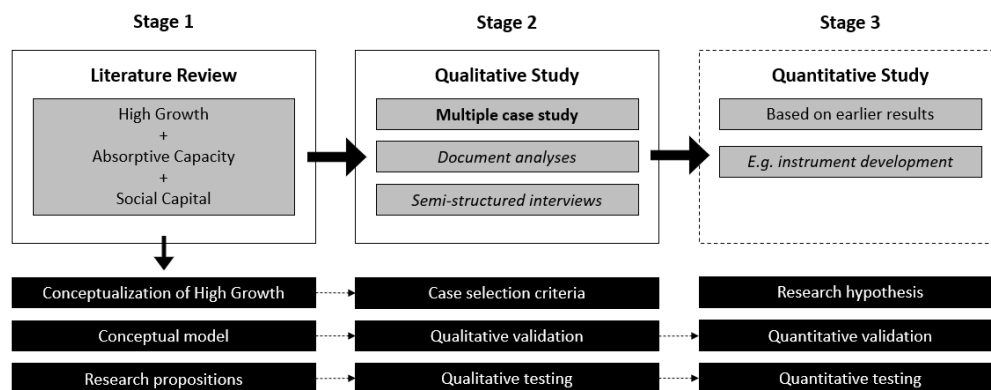

Figure 2: Proposed Research Design

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15. Inclusive Innovation Based on ICT: Lessons from the Maker Movement in Brazil

Cecilia Burtet
Unisinos University
cecilia.burtet@gmail.com

Amarolinda Zanela Klein
Unisinos University
aczanela@unisinos.br

Abstract

This research explores the concept of inclusive innovation based on ICT, examining collective practices and creations from the Maker Movement (MM) in Brazil. The research results show that this Movement, which exists as a network of overlapping practices based on the principle of 'making', tries to break through the black box around manufacturing items and open it up to look at innovation differently. However, although the main actors promote inclusiveness to the public, who, due to maker spaces, now have access to endless creative options, other actors, who have historically been ignored when discussing innovation, are still excluded from this Movement. Therefore, the very concept of inclusive innovation needs to be reconsidered.

Keywords: *Inclusive Innovation; ICT; Maker Movement*

1. Introduction

The majority of existing studies on innovation tend to conform to the "mainstream". They focus on technical, strategic, and management aspects of innovation, set within a formal organizational context (R&D laboratories, multinational businesses), for profitable purposes (Heeks, 2014; Patnaik & Bhowmick, 2020), leaving historical and political aspects related to innovation to other areas, and ignoring the population at the base of the pyramid (Prahalad, 2009) and who work informally. When the poor and excluded people are considered in the mainstream approach, the rhetoric for their inclusion and involvement in innovation is depoliticized, and this fails to address the power relations inherent in the processes of technological change and innovation. Also, it does not discuss the socioeconomic causes of inequality and exclusion (Pansera & Owen, 2018), preferring instead a supposed global economic development approach that does not meet local social developmental needs (Klochikhin 2012; OECD, 2013; Heeks et al., 2014).

In order to bridge the gaps in mainstream innovation, researchers have tried to develop a concept of inclusive innovation (George et al., 2012; Heeks et al., 2013; Foster & Heeks, 2013; Heeks et al., 2014; Foster, 2014; Smith et al., 2014; Sengupta, 2016; Smith et al., 2016; Pansera & Owen, 2018; Patnaik & Bhowmick, 2020; Pinzón-Camargo et al., 2020). This concept regards "the development and implementation of new ideas which aspire to create opportunities that enhance social and economic well-being for disenfranchised members of society" (George et al., 2012: 663). The groups who are seen as marginalized include women, young people, people with disabilities, ethnic minorities, informal entrepreneurs and the poor in general (OECD, 2013; Heeks et al., 2014). Inclusive innovation tries to encourage marginalized communities to empower them (Pinzón-Camargo et al., 2020). The aim is to create innovative solutions for low-income communities, including them in innovation to achieve positive results by, for example, creating qualified, relevant products and services that are economically, socially, and environmentally sustainable, with equitable profits and growth. However, it is questionable how much this exists in reality (Patnaik & Bhowmick, 2020). We also do not

understand the role that new technology can play in inclusive innovation very well (Harsh et al., 2018). There are few empirical studies on inclusive innovation to support the development of evidence-based policies (Pansera & Owen, 2018; Patnaik & Bhowmick, 2020).

In order to bridge this gap, some researchers have focused on the study of inclusive innovation in grassroots movements (Smith et al., 2016) - typically those that encourage socially inclusive innovation in terms of the knowledge, processes, and results involved for local communities (Smith et al., 2014; Fressoli, 2015). One example of it is the Maker Movement. It is a decentralized and globally diffuse collective, based on the idea that ordinary people can build, repair, modify or manufacture any type of object or create any type of project themselves, working together, learning and sharing resources among themselves (Anderson, 2012; Dougherty, 2013; Lindtner et al., 2014; Lindtner, 2015). The MM has its origins in the hacker community (Lindtner & Li, 2012; Lindtner, 2015) and is an extension of the 'do-it-yourself' principle and has been supported by the vast proliferation of collective spaces, such as hackerspaces, maker spaces, and fab labs (digital manufacturing labs), by the advent of crowdfunding through collective funding websites and by the growth of open hardware platforms (like Arduino, for example). It is spread by various publications, such as Make magazine, websites, and maker events (maker Fairs, Arduino Day, Hackathons, among others), held worldwide (Lindtner et al., 2014).

Several of the collectives developed out of the digital revolution, many linked to the MM, have explored new approaches to innovation and technology. As a result, new ways of thinking about the dynamics of innovation and the concept of inclusive innovation must be studied empirically now, as there are many different interpretations and frames of reference (Pansera & Owen, 2018). Therefore, this article aims to contribute to developing the concept of inclusive innovation based on ICT by answering the following question: How does ICT-based innovation take place in the Maker Movement in Brazil, and to what extent does this Movement encourage inclusive innovation?

2. Method

The research method was inspired by the ANT- Actor-Network Theory (Law, 1992; Latour, 2005), which invites us to look at the material effect of innovation, both social and technological. The focus of the analysis is on the relationships and networks consisting of humans and non-humans. A study of the MM in Brazil was carried out, based on the principles of ANT, through three instances of field immersion. In all, the data collected involved 112 hours of observations by participants (77 pages recorded in a field diary) and 35 formal interviews (recorded and transcribed) with key actors in the MM in Brazil. Several informal interviews were also carried out at two maker spaces (POA Lab and Olabi) and during MM-related events - see Figure 1.

The 1st field immersion (exploratory) provided an opportunity to meet some of the prominent participants in the MM in Brazil, to talk with them informally, to take part in events, and to see how the Movement operated in Brazil, in general. The 2nd immersion consisted of observing participants at POA Lab, an active fab lab located in the south of the country, and taking part in another of the Movement's events. A semi-structured interview script was applied to 08 individuals who regularly attended the shared space, and each interviewee was asked to identify one or more people that they considered to be important in the MM in this country and any ideas or projects that they thought were particularly noteworthy. The actors and projects cited for the MM in Brazil, as a result, led to the 3rd field immersion. In this third and final stage of collecting data, another 21 semi-structured interviews were carried out, followed by taking part

in two more maker events and a visit to a maker space (Olabi), located in Rio de Janeiro, southeastern Brazil.

On the basis that the Movement is made up of different actors who play different roles in the network, we identified four distinct but complementary roles: *users* (regular users of POA Lab and Olabi); *supporters* (actors who publicized the Movement, provided workshops and shared projects via social networks or in person at the maker spaces), *entrepreneurs* (actors who dedicated themselves to creating MM-related ventures, such as creating private or for-profit maker spaces and providing consultancy) and *authors* (creators of projects cited by other actors in the network as significant to the MM in Brazil). This classification was created for analytical purposes and only describes each actor's main role; each of them may undertake more than one role, and there may be other roles than these. In total, 35 interviews have been conducted with 33 people (two informants were interviewed twice): 6 users, 13 supporters, 6 entrepreneurs, and 8 authors. The participants will be described using their primary role when presenting results.
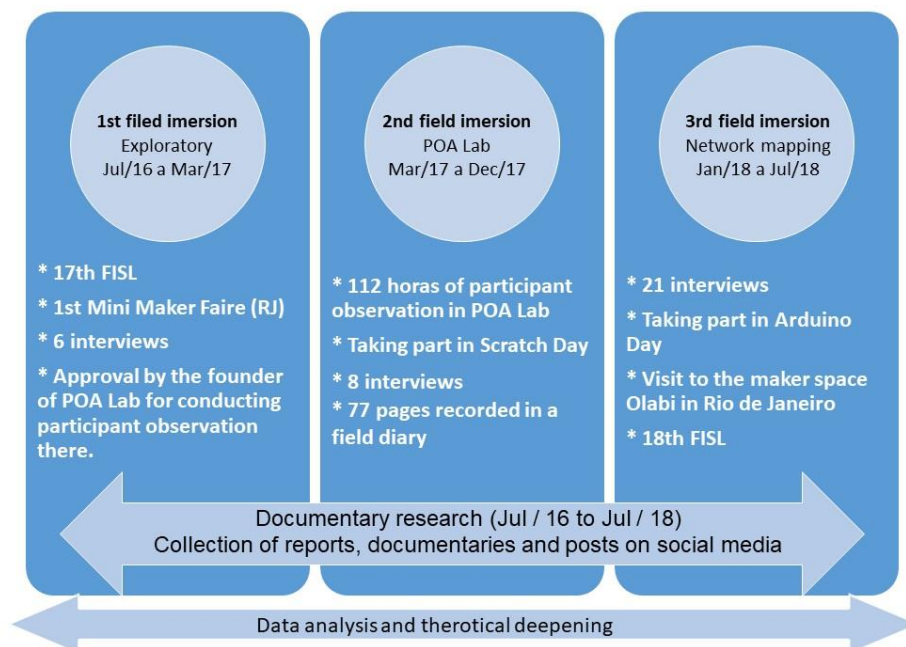

Figure 1: Research Method - Field immersion phases - Source: Research Data

The data collected from interviews, documents, social media and recorded in field diary notes were saved in a single database using NVIVO software. The content was coded inductively, i.e., based on the data and not the theory (Saldaña, 2015). It was possible to identify common themes by creating the codes from the large amount of data collected. In the first cycle of coding, 93 codes were generated, which resulted in a need for a second cycle (Saldaña, 2015), in which some codes were merged because they were similar in concept. Infrequent codes were assessed for their usefulness as part of the general coding scheme, and some codes were discarded; the entire body of data was reviewed, resulting in a total of seven primary and twenty-one secondary categories. All of them were registered in a codebook, which recorded the analysis process and identified the main themes, actors, and projects for the MM. The use of multiple sources of data and informants, and also the use of the codebook to guide the data

analysis helped us to handle validity issues regarding researcher and respondent bias. The research results are described in the next section.

3. The Maker Movement in Brazil: the "Gourmet" and the "Grassroots" versions

According to Supporter16, the term "Maker Movement" first appeared in Brazil in the middle of 2009, when Neil Gershenfeld (a professor at MIT and one of the creators of the fab lab concept) visited the Faculty of Architecture and Urban Design at the University of São Paulo (FAU-USP), where he gave a lecture and visited the Laboratory of Experimental Models, which had digital manufacturing machines, and therefore was a type of *fab lab*. Although it was created partly to interest the MIT professor, the FAU-USP *fab lab* brought together a group of people who wanted to develop a network of laboratories throughout the country. In 2012, some members of this group created the Fab Lab Brazil Association, a non-profit organization, whose objective was to help establish *fab labs* in Brazil, spread the network's ideology, publish material in Portuguese on the subject of digital manufacturing and link together the different laboratories nationally and internationally, acting as a connection between the Brazilian *fab lab* community and the *Center for Bits and Atoms* at MIT, also called 'Fab Central'.

According to Supporter16, disagreements among the Association members led to it shutting down after a few years. In 2011, Supporter16 and other actors in the Movement created the Fab Lab Brazil Network, a non-profit organization that tried to join up the *fab labs*, promote events, and support new *fab labs* to open in the country. In 2016, the creation of the Free Fab Labs of São Paulo and other independent *fab labs* began to attract the media's attention, which started to report about "maker spaces" and the promises of the MM in Brazil. As you can see, when the term arrived in this country, it was closely connected to the *fab lab* network and *maker spaces* of North America.

A characteristic of the MM in Brazil is that it is concentrated in the fab labs and maker spaces, which are generally part of universities or business locations, and are used by people with a higher level of education and income: "Like everything in Brazil, while it isn't a feature of MM, it's not universally available. We joke a lot that the future has arrived, but it is not everywhere" (Author23). Entrepreneur17 backs up this statement. They recognize that the media attention and large corporations' interest in the so-called 'maker culture', maked people think that the Movement is expanding in Brazil. Supporter4 criticized this apparent expansion: "We continue to exclude people who are already doing it, because doing something for yourself, doing it together, solving problems with whatever you have at hand, that is something that is part of Brazilian culture everywhere. So, suddenly, we are building an elitist place, and now we think these things are worth doing before they were frowned upon, right? (Supporter4).

The public *fab labs* of São Paulo are mentioned by some of the actors as an important attempt to bring digital manufacturing knowledge to the periphery, "where people are already well used to doing things off their own initiative" (Supporter26). Still, this is not enough to make the Movement in this country less elitist. The expansion of the Movement often seems to be leaving Brazilians on the margins, those who could and would benefit from it, as Author31 suggests. "The MM is really only talking to itself. This isn't just the MM's issue, it is an issue for the whole movement for innovation, entrepreneurship, technology ..." (Author31).

Entrepreneur27, when talking about a visit to the Sustainable Periphery Institute (a space located on a favela of São Paulo that aims to introduce renewable energy generation and distribution systems to communities in São Paulo), emphasizes that making the MM inclusive does not mean, or at least it shouldn't mean, a posture of 'taking' knowledge to those who 'don't have it'. Instead, it is about getting to know and discuss and learn with the actors from the diverse range of communities that exist in this country: "It always has to be an exchange. I listen to academics and companies saying that solar power energy is expensive, but then I come here, somewhere extremely poor in São Paulo, and I see what some guy is doing, and we have to get together with the **grassroots makers** (...). I think the main point here is to realize that we are not providing something ... we may have something new, but it is an exchange, we are exchanging all the time with the people who are already doing it here" (Entrepreneur27).

The elitist form of the MM in Brazil has caused some actors to refer to it as '**gourmet**': "We end up importing things in a hollow way, leaving only the shell, the name, the mystique, but it ends up losing its content. In Brazil, the MM is almost completely taken over by what I call **gourmet** craftsmen, who are craftsmen only, a '*DIYer*', but who isn't connected to the MM, doesn't pass on the knowledge from what they are doing. The product is much more than an elaborate craft, or a mini creation, more than a product maker, which provides access to something. The *fab labs* are mainly in the universities, unavailable to the general public, making it difficult (Entrepreneur1). In the words of Author31: "What I see in these places is people thinking about issues that are no use to normal Brazilians and that are not really innovative because people do not understand the Brazilian people (...). I see a lot of people creating products and services for people who already have products and services, you know? So, the market is saturated with applications, for what, I don't know, with solar energy projects, but if you're not talking about solar energy for those who can't afford a solar energy panel, you're thinking about solar energy for practically no-one in Brazil!" (Author31).

In contrast to the *gourmet* MM of Brazil, there is what some call the **grassroots** MM (Entrepreneur27), which is based on doing things in ways that have been shared among Brazilians for a long time; those people are "born makers", and therefore "natural makers" (Author32). The grassroots MM can be seen in projects for communities in the city periphery, which, being 'peripheral' to the 'center' of the network - in other words, marginal compared to the gourmet movement - makes up the 'periphery' of the MM. In this 'periphery', digital technology does not have any more importance over other technologies, which are referred to by Author32 as "low technologies" or improvisations, which are any solution designed to solve a local problem. In the grassroots MM, the practice of improvisation is treated the same way as "that which is cutting edge in the Brazilian maker culture" (Supporter30). It is considered much more inventive, creative and better related to solving real problems than imported maker culture (Supporter4). Popular knowledge is not treated as an indication of ignorance, nor as inferior, but as a different type of knowledge that, when articulated technically and scientifically, can create some mutual learning points. This is the case for solar energy, which Entrepreneur27 thought of as something costly until they came across Author28 - whom he acknowledged as a "grassroots maker" - who develops such technology, at low cost, in one of the most impoverished communities in São Paulo.

When talking about the real situation in the favelas of Rio de Janeiro, Author32 points out: "The favela is by nature a maker. Most of the places where they talk about innovation, creation,

and creativity at the moment are basically full of white, middle class, men mainly, right? Whereas what poor people create, their innovation, is not recognized as such, but just as 'you know... the Brazilian way', but not as something innovative, right? And the poor; they have always been makers, because they have always had to come up with their own solutions, think of creative answers when things are scarce or there is no support from the State; they are born makers" (Author32).

The consensus is that the MM's potential for innovation lies in democratization, providing access to specific machines, tools, and knowledge. What is new is not digital manufacturing: "I always like to say that MM is a Movement to democratize access and knowledge" (Supporter5). Next, we analyze this Movement's innovation through four projects, which were cited by the research participants as significant projects for the Brazilian MM. The first two projects were developed in a university or business context, and represent the people usually included in the MM; the second two projects were developed in the context of the favelas, representing people usually excluded from the MM. These projects help us to get a better understanding of the practices and contrasts that exist in the MM in Brazil.

The PLUVI.ON Project - Pluvi.On was the most mentioned project by the interviewees. It turned into a startup and received international recognition and awards. The startup, which has the same name as the product, was run by five partners - including Author23, who graduated in civil engineering from USP - and created a range of low-cost rain gauges, which collect data and help the technicians and the community interact (https://cutt.ly/5jsbcXh). The Pluvi.On system records the amount of rainfall in millimeters so that, in the future, it will be possible to calculate the likelihood of flooding in a region based on the data from a connected network of rain gauges. The community can access this data through various interfaces that take the data from the nearest station. Author 23, one of the creators of PLUVI.ON, attended the *open days* at Insper's *fab lab* (a higher education institution in Brazil). The first prototype, made from a plastic bottle in 2016, began its development at the Red Bull Basement, a corporate *maker space* that provides a base to develop promising ideas. Once they joined the program, the prototyping phase sped up rapidly with the support of mentors from the areas of electronics, design, hardware, and software, who helped develop the project; 'Pluvi.Ons' were now made from laser-cut acrylic, with parts printed on a 3D printer. It took two months of intense work on several versions of the product to produce the *open-source* version, available on Instructables website, with more than 1,500 views. Besides, Red Bull helped to promote the project, including to public agencies: "Thanks to the exhibition there, we were approached by Climatempo and the Regional Government of Lapa (SP) in 2016 (...). So, we set up a pilot project for a network of 110 sensors in São Paulo" (Author23). Between 2016 and 2018, the startup developed into a business. By 2018 they were developing the seventh version of the meteorological station, which had more sensors and was more linked to the new IoT protocols. "Our dream is to be able to have *open-source* hardware that can distribute the data collected in a more democratic way (...) we have never intended to kill off this branch, and we will always dedicate some of our efforts to it (...) it's what the company is about" (Author23). A version of Pluvi.On was developed using funding provided by Embrapii (The Brazilian Industrial Research and Innovation Company), which was a patented version: "The patented version was only because of an intellectual property issue relating to the Embrapii project, which is where we got the funding from. It meant that we needed to establish intellectual property rights. (...). In reality, what is the point of a patent? It is there to cover various bits of bureaucracy and it supports the company's *valuation*, because when you say you have a patent, you have an

intangible asset that increases the value of your company, that's all" (Author23). The company's innovation is the rain gauge, which according to Author23, is more economical, practical and accessible than imported equipment: "Because the project has been developed commercially, on a larger scale, it means that the price is lower and we can make more people aware of it".

Project "Connected Drains" - Connected Drains began in mid-2013, as a result of the research of Author24, who was a design student at USP at the time. One day, while watching the building of the gutters at the University Campus, the sidewalks and culverts, he had an idea: "My God! Drains! It's not something digital, it's from Roman times, the aqueduct, all run by gravity (...). I was thinking about the floods, and that was the moment I thought about mixing digital technology with archaic technology". (Author24). Thus, the idea of Connected Drains was born. It is a service, a product, and a digital application, which links citizens with the city's drainage system in order to prevent flooding or accidents caused by poorly maintained drains. The idea was developed along the lines of a research project in the design course. Author24 created the visual identity, developed the prototype of what would be the application and a prototype for the hardware, "which I made with Arduino, with the help of a friend of mine at the time, because I was not that proficient in Arduino" (Author24). With a prototype of a navigable application, the prototype of the hardware printed in 3D and with the electronics (Arduino), he presented the research work, and it was approved, but according to him, from a practical point of view, Connected Drains (https: // cutt.ly/BjsbEqa) never made it past that stage. The project received an award in the area of design and became well known, which led to interviews with the media, contact with accelerators, involvement in a challenge promoted by Cisco, during a Startup Weekend, where it featured among the finalists for the contest. However, Author24 comments that: "Then it ended up like this ... I started to get the idea, due to all the conversations that I had and with all the connections I was making and such, that I felt that I needed to treat it as a startup. Well, a startup comes as a package, you need to have investment, you need to have investors and each investor needs to have an angle, and whatever it is here, business model, make a PITCH there, fill in the boxes they want you to, and that's when I started to distance myself from what was the original idea, which was: "I'm going to take this here, I'll put it there and I'll see what happens". The initial idea was to make an open-source solution available for everyone to make. "But what assurance do I have that each one will get built? None. Who'll invest money? Who'll pay for it? I began to think really seriously about this. So, it had to be low-cost, but what about hidden costs, which we don't know about yet?" (Author24). When his research was complete, Author24 started making his idea public, and many people advised him:" 'You have to find a partner', 'you have to get the government to pay for this '... then I started to go away from the maker's way of doing things" (Author24). "Man, I would like to create all this (...), but do I want to deal with councilors, with deputies? (...) It was from that moment I began to distance myself from the Drains project".

The "Gato Midia" (Cat Media) Project - The Gato Midia project (https://gatomidia.com/) is a media and technology learning space for young people who live in the favela. The idea started in 2013, in the Alemão favela complex in Rio de Janeiro, as a way of giving residents a voice, through telling stories about what the favela is like and who lives there. Initially, the focus was on providing free open courses to encourage people to use new media to talk about important topics within the favela, such as human rights, the democratization of information, urban mobility, and how to use Facebook, YouTube, and Twitter to put these issues on the table. Over time, Author32, whose project it was, realized that it was more important to train young people to create digital platforms than to teach them how to use the tools. "So, it's not just about understanding how I can make a video to put on YouTube, it's that I have the knowledge to be able to make a YouTube, make a mobile app, etc." (Author32). With that in mind, Gato Mídia

adopted a residency model: intensive courses that aimed at producing a project by the end of the course. For example, the Residência Favelados 2.0 teaches not only how to make videos for YouTube (write scripts, film, edit and publish), but also teaches them how to create blogs and websites. The final result of one of the classes was a joint production of a documentary, 'Who Are the Makers in the Favela?', which was a debate about innovation from community spaces. Another product was the Wagikisa Residency course. In northeastern Angola, *Mutwo Wagikisa* refers to a strong person, with a strong body. The use of the term in the course title was because its objective was to think about "how to make the most of the bodies of women, black people, LGBT and marginalized people during a military intervention? How to use technology to subvert logic?". This training focused on learning programming. During the residency, participants were encouraged to create games and apps that dealt with the challenges they experienced daily in the favela. The last class, for example, developed a Transphobia Game, where the game aimed to find a way for the (transgender) character to manage to exceed their life expectancy "of only 35 years" (Author29). In this, the player had to use the arrows to get past obstacles such as prejudice, stray bullets, shootings, religious oppression, and having to collect coins along the way. Author31, who develops and teaches some of the classes for Gato Mídia, spoke about the dynamics of the training: "It's a job that is about the creative process, which I think is very important. Our residency courses start with this type of content (...) because it is something that seems quite intangible, something that doesn't seem connected to life in the favelas, because it seems like such a destructive, unfertile world, from the point of view of those who see themselves as creators. This lack of self-esteem... Usually the young people who come to us, they don't understand how to be creators, they don't understand themselves what power they have around them. So, first we try to work on their creativity, by making these young people see themselves as creative (...), then we start on more technical content" (Author31). The project raises funds from companies and foundations to carry out the training without having to charge students. The bureaucracy involved in trying to raise money from the government means that the State is not a viable partner: "Often we can't wait for the State to authorize anything, so we prefer to get it where we can, where we have contacts, where people recommend us, we even go and knock on the doors". (Author31). To provide young people from the favela with the chance to work in the media and technology, Gato Mídia has a partnership with an agency that hires these young people as interns or *freelancers* depending on demand. According to the interviewees, this is an opportunity for them to get into a job market dominated by middle / upper-class people in this country.

"Afro Engenharia no Mundo do Cinema" (Afro Engineering in the World of Cinema) Project - "Making audiovisual equipment with low-cost materials to help the black population, who have always been at a disadvantage when working in the film and television industry"; this is the mission of the Afro Engineering project, from Author29 (https://cutt.ly/njsnv1G). Author29 is an electronics technician and computer engineering student who, in 2015, started working in the film and television industry on the back of recording an award-winning documentary. He wanted to improve the quality of his videos, but soon faced the problem of high cost, which gave him the idea of building his own equipment: "All of this equipment here works on principles that I have already used on other projects, this is very simple to replicate, the electronics for this design here, cost BRL 15,000.00 ... man, if I have BRL 50.00 I can put it together and develop all the smart part of it myself" (Author29). That way, he was able to produce equipment of similar quality to that sold on the market for twenty times less, and he could share this knowledge with the community. As a result, the demand increased. Colleagues who had the same requirements started to order equipment to buy or rent, which created a business opportunity. Soon, I started worrying about the aesthetics: "The first equipment was made in PVC, which made me think about coloring it black because inside the film industry

everything is black to give it that air of standardization and to help things sort of disappear into the shadows because if anything is very colorful, they say that it distracts the actor, or takes people's attention away etc. But black items have different effects in different contexts. For example, I am a black guy, who lives in the favela, but if I am making a film, if I have a shoulder rig (...), if I am with that and I run into a police officer in the favela, I could get shot because of that. I don't even need to be in the favela, I can be in the middle of the street, in the city with that thing on the street, running, doing a tracking shot and, unfortunately, they might think I'm a robber, mistake it for a gun, and, unfortunately, there is plenty of data showing that this is not just something in my head, right?" (AuthorE29). His concern reflects the growing rates of violence in Rio de Janeiro's communities - shootings, confrontations, and deaths of innocent civilians - including children - in Rio's communities. "So, there is this whole black body dynamic working in different situations, so I thought: "Man, I can't color this thing black", it was a natural reaction, "man, I can't walk around with this because it could be mistaken for a gun", so then I had the idea of covering the equipment with African fabric." In parallel with developing and producing equipment like the Rig, Author29 also holds workshops where he teaches how to produce simpler equipment, which he no longer produces himself, these are dedicated to research and the development of more elaborate projects. His production is based on work and research in electronics, 3D modeling and printing, mechanics, embedded electronics, and programming. For this reason, he makes a point of making it clear that his projects "are far from being 'improvisations'". When talking about his products' innovative nature, he points out that "empowering black people to create their own environment, tell their own stories, this is innovative, this is revolutionary" (Author29).

4. Discussion and Final Remarks

Since there is no consensus on what inclusive innovation is, the existence of different interpretations (Pansera & Owen, 2018) indicates a lack of empirical studies that would allow us to understand better how it works in practice (Pansera & Owen, 2018; Patnaik & Bhowmick, 2020) and what is the role that emerging technology plays in inclusive innovation (Harsh et al., 2018). The study of the MM in Brazil provides a number of ideas and thoughts on how this concept has been developed.

First, it is worth considering that even a movement that, in principle, supports autonomous creation ("doing it yourself") and advocates for technology and innovation to be open and shared (Lindtner, 2015), it still retains many of the features of so-called "mainstream innovation" (Heeks *et al.*, 2014) when it comes to Brazil. For example, the assumption that technology-based innovation is synonymous with economic development predominates (Schumpeter, 1934); that innovation refers to its successful commercial application (Schumpeter & Fels, 1939; O'Sullivan & Dooley, 2008), carried out within the influence of traditional formal organizations (Schumpeter, 1934; Teece, 1996). It has led some authors of innovative projects within the MM to try to develop them through the startup model: sometimes successfully - like the Pluvi.On project - and other times not so successfully, such as the Connected Drains project, which failed to become a product because its author could not identify with the business and institutional dynamics involved in the mainstream development model.

Although the "*gourmet*" MM encourages the public to be included through *fab labs*, *makerspaces* and *hackerspaces*, which provide access to countless creative options, based on people's connections and the material resources that these places provide, it still leaves out other actors, those who have been historically excluded from debates on innovation in Brazil. According to our research data, we identified as excluded mainly people from favelas and low-income communities, especially black people, and people that do not have contact with

Universities and other spaces dedicated to entrepreunership endeavors, such as incubators and technology centers. Even a movement that aims to innovate through the way we create, make and relate to technology is still blind when it comes to some of the actors and settings excluded from the Movement, and consequently this significantly reduces its potential for social transformation in Brazil.

When studying the MM in China, Lindtner (2015) examined how Chinese makers were moving away from the western idea of innovation (which physically separates the idea conception phase from its materialization/manufacturing phase, based on the assumption that only the first phase is innovative). They were beginning to adopt a new ontological and political approach, which assumes that China's technological innovation is based not just on its technological *know-how* but also on the country's cultural methods of production. Therefore, the term "maker" has become a term for new entrepreneurs who are looking to move from "*made in China*" to "*made with China*" or "*created in China*", in order to make the country a center of technological innovation (Lindtner *et al*., 2014; Lindtner, 2015). Such potential for the MM could act as an inspiration to create unique technological methods, more inclusive and based on specific challenges, environments, and objectives, especially concerning developing countries, which tend to follow the technology and innovation paths set by developed countries (Medina et al., 2014; Dias & Smith, 2018).

Our research suggests the MM's potential to be transformed, as evidenced when the interviewed actors share a common criterion to which they attributed the innovative nature of the projects in this research. They unanimously refer to **access** as the main criterion to identify relevant innovations. The projects that were highlighted as significant were recognized as innovative solutions, not because they used sophisticated ICT, or because they generated immediate economic results, but because they provided access to something: knowledge, technology, information, empowerment, for a **community**. Once innovation begins to depend on the level and type of access and how inclusive it is, its political dimension can then be considered as part of its process. It constitutes an alternative way of looking at the mainframe of reference in which innovation takes place, instead of something that takes place within the sphere of traditional formal organizations, which are concerned with economic profit and intellectual property and their competitiveness in the global market (Schumpeter, 1934; Teece, 1996; Tidd & Bessant, 2015). However, while access and production of technology are limited to a select group, most Brazilian people are not represented, the dominant frame of reference will be reinforced and the *gourmet* MM and the innovation it produces will continue to maintain and worsen the inequalities.

Carrying out innovation based on access means that we consider the relations that exist as a result of the local conditions or situations. When we examine innovation taking place locally, in a less generalized way, we can look at the various environments (diverse and unequal) that surround us and that enables us to reconsider innovation based on these relationships. The literature review shows that the studies already carried out on the concept of inclusive innovation have approached inclusion from different perspectives (George et al., 2012; Heeks et al., 2014; Pinzón-Camargo et al., 2020), the most common of these are: (a) exploring the potential for the low-income population to be a potential market; (b) multinationals directing the focus to meet the needs of people at the base of the pyramid; (c) the poor as citizens who should be included in the process of developing local technology, as "co-creators"; (d) innovation as something that provides a positive impact for certain communities.

Our research suggests a more mature and refined version of this concept. It points out the need to go beyond the notion of inclusion in these works and to do more to overcome the unequal relationships, beginning with the inclusion of different actors (not just low-income ones) in

creating alternative ways to develop technology and innovation. We need to take into account and involve the local community and its knowledge to develop solutions that are relevant to them and accessible, but, above all, which will help to redefine what it is to innovate and to include. This is similar to the highest levels of inclusion, in other words, those that involve epistemological and discursive aspects (Heeks et al., 2014; Harsh et al., 2018; Pinzón-Camargo et al., 2020).

The contribution of this article to the concept of inclusive innovation is based on the argument that inclusive innovation is not about involving people in the dominant frame of reference. The discussions woven throughout this article suggest that this idea is much more than this: inclusive innovation means providing the right conditions for actors excluded from the 'center', and enable them to have an impact on naturalized practices, considered 'truths', contesting or changing *mainstream*/imported frames of reference, by bringing their knowledge, methods, and ideas to the table, which are based on different frames of reference, in order to discuss and take part in the process of innovation and making.

This research empirically shows what several authors, such as Schumacher (2011), Klochikhin (2012), George *et al.* (2012), and Heeks *et al.* (2014) have already stated: that the promise that economic growth would bring development and social well-being is no longer supported, therefore it is necessary to develop new ideas, and new approaches to (re)think innovation and technological development. It opens up the question of how inclusive the concept of inclusive innovation is. Who can be part of developing this concept? By whom and from whom is it being created? We suggest that future studies dedicated to problematizing the literature on inclusive innovation are invited to rethink it from other perspectives that try to take into account its political dimension from a critical approach. We need to provide advances that are significant and relevant not just for academic debate but also for the development of government policies, especially in so-called less developed countries.

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16. Internal IT Control Systems and Global Regulation of Organizations: The Rise of Control Assemblages

Edward W.N. Bernroider
Vienna University of Economics and Business
edward.bernroider@wu.ac.at

Abstract

The encounter between global regulation and IT offers a challenging environment in organizations to investigate how internal control systems (ICS) emerge and social orders are changed. In this research paper, I used the opportunity to investigate assemblages that have coded and territorialized IT in a large organization. Based on a case study, the paper emphasizes that ICS are composed of loosely structured, ever evolving heterogeneous components and systems, which are involved in constant re-conceptualization. In particular, processes leading to the creation of control assemblages, resulting tensions and conflicts, and the roles of the installed base and exteriorized relations are shortly discussed.

Keywords: Internal Control Systems, Assemblages, Case Study; Information Technology Regulation, Accounting Information Systems.

1. Introduction

The increasing dependence of organizations on Information Technologies (ITs) generates configuration and control phenomena that invite us to reframe our ways of understanding organizational structures and management control (Dechow, Granlund, & Mouritsen, 2006). ITs have not only become critical business enablers, e.g., allowing for enterprise resource planning in both developing and developed economies (Bernroider, Sudzina, & Pucihar, 2011), but also political objects themselves, where their organizational adoption becomes a matter of socio-political controversy (Barry, 2001). Disruptions of business services due to IT related incidents have become common, especially in organizations which are complex, large, growing rapidly, or undergoing restructuring (Doyle, Ge, & McVay, 2007), or among organizations that heavily rely on IT such as banks, which need to explicitly cover associated operational risks (Bauer & Bernroider, 2013; Jobst, 2007).

As response to this problem, international laws and regulations together with supporting standards are constantly emerging, which require constant changes in governance and work routines, and record-keeping control and test procedures to allow for the production of information that can be appraised by management and auditors. For example, the Sarbanes Oxley Act (SOX) requires the design and operation of a broad range of IT controls to protect shareholders from corporate fraud (US-Congress, 2002). It triggered a wave of worldwide adaptations and derivations of SOX with similar compliance requirements, e.g., the European version publicly known as EUROSOX (EU, 2006). Or, more recently, the General Data Protection Regulation (GDPR) was introduced, which has wide implications on how data is governed and controlled across the organization (Tikkinen-Piri, Rohunen, & Markkula, 2018). These laws require organizations to develop and maintain effective internal control over IT services, and constantly strive for achieving regulatory compliance, e.g., in terms of compliant information security behaviors (Bauer & Bernroider, 2015; Bauer & Bernroider, 2017). It is worth noting that these efforts are generally costly and complex. For example, in terms of achieving SOX compliance, organizations reported high control system expenditures and major audit delays (Ettredge, Li, & Sun, 2006).

IT control system configurations, which includes various relationships among diverse actors, artefacts and organizational units, need to continously adapt and change to meet the requirements of evolving external regulations, standards and frameworks, and dynamic IT risk landscapes (Krumay, Bernroider, & Walser, 2018, 2020). This research study applies assemblages, a conceptual apparatus also inherently unstable and infused with movement (Marcus & Saka, 2006). Assemblages in general terms can be seen as dynamic entities under constant reconfiguration, including changing contexts and territories (Deleuze & Guattari, 1987). Consequently, I apply this dual attention of assemblages to structure and change to the practical problem of how IT is controlled in a large case organization driven by laws and standardization. First, I seek to provide an analysis of processes and components of an IT control assemblage in the given context. I am interested in shedding some light upon the processes through which these heterogeneous, unstable and ephemeral components of such an assemblage are recursively created, and in its movement from a recent past toward a near future, which is the temporal span of emergence I am observing. Second, I seek to discuss the emergence of internal IT control configurations from these processes, the role of tensions and conflicts between material actors, and components in the space of assemblage theory. By doing so, I will explore social construction processes and how these are entwined with IT's material properties, and intentionally move away from isolated techno-centric or human-centered views on control system designs or matters related to control configurations or performance. In methodological terms, I draw on a case study of a large Information and Communication Technology organization on the basis of a cyclic action research design. Next, I will attempt a short overview of what I mean by referring to global forms and assemblages, and IT regulation. However, since there is ambiguity in the referential frames of assemblages in literature and due to the space limitations of this paper, I need to point to other resources for a more informed introduction (e.g. Collier & Ong, 2005; DeLanda, 2006; Harman, 2008; Lanzara, 2009; Marcus & Saka, 2006). Next, an overview of data collection and analysis, and the main results are presented. The following discussion positions these results more clearly in prior literature and selected conceptual elements within the frame of assemblages. The last section concludes the article.

2. Research Background

2.1. Global Forms and Assemblages

The analysis provided in this paper draws on the body of literature using the concept of global forms and assemblage in social and organizational research (Marcus & Saka, 2006; Mennicken & Miller, 2012). Assemblage theory is rooted in the works of Gilles Deleuze and Felix Guattari (1987), but was more fully developed by DeLanda (2006). For the use in this study, we define an assemblage as follows (Collier & Ong, 2005, p.12): *"An assemblage is the product of multiple determinations that are not reducible to a single logic. The temporality of an assemblage is emergent. It does not always involve new forms, but forms that are shifting, in formation, or at stake."*

Underlying the understanding of such a composite concept is the mapping of exteriorized parts characterized by properties and capacities. When considering exteriorized relations, the properties of single parts cannot explain the relations which constitute the whole. The properties of the whole are dynamic and result from the actual exercise of capacities, which not only make use of a component's properties, but also involve properties of other interacting entities (DeLanda, 2006). Central to mapping these exteriorized relations of assemblages are two axes (Deleuze & Guattari, 1987). The first axis determines the levels of materiality to

expression and the second travels from territorialization to deterritorialization. The latter can be understood as processes in which components are involved that can either stabilize or destabilize the assemblage. Stabilizing usually means to increase internal homogeneity and/or sharpen boundaries (Harman, 2008). A third axis added by DeLanda (2006) invites the investigation of linguistic expressions shifting from codings to decodings, which may either work towards consolidation or flexibilization of the identity of the assemblage.

Still drawing on DeLanda (2006), the resulting components of an assemblage are heterogeneous and can be characterized by either a material or expressive role (or both). While material components are usually resources and reflect the content, expressive components can be seen as the descriptive elements and can include triggers and signals for behavioral responses. Territorialization processes can be connected with components that play a material role and coding processes with components taking expressive roles.

2.2 Global IT Regulation and IT Control Frameworks

Organizations worldwide are affected by laws and regulations (Luthy & Forcht, 2006), which acknowledge the critical role of ITs to ensure the effectiveness and efficiency of business processes, the accuracy of data processing, and security and privacy objectives (e.g. Bauer & Bernroider, 2017; Tikkinen-Piri et al., 2018). Organizations seeking compliance with these laws an regulations need to effectively control risks related to these ITs. It is often suggested to use publicly available standards for such internal control design by public bodies. For example, The Public Company Accounting Oversight Board (PCAOB) was charged with overseeing, regulating, inspecting and disciplining accounting firms in the context of SOX (US-Congress, 2002). As another important actor it releases auditing standards which organizations acknowledge. Their specific standards numbers 2 and 4 consider the importance of IT in the arena of internal control (PCAOB, 2004, 2007).

One well established control framework is the Control Objectives for IT and related Technology (CobiT) framework (ISACA, 2008) which is extensively used in IT management and control (Bernroider & Ivanov, 2011; Tuttle & Vandervelde, 2007) and seeks to support legal compliance with regulative requirements such given by the SOX or Basel 2 (Hardy, 2006; Kordel, 2004). CobiT was developed by the Information Technology Governance Institute (ITGI) and its associated Information Systems Audit and Control Association (ISACA). CobiT as well as other systems for management control refer to best practice guidelines with limited empirical and theoretical support. It is used by used by auditors, IT managers and consultants to evaluate the state of internal control and to manage the IT related risks in the enterprise.

3. Data Collection and Analysis

3.1. Case Description

In considering what kind of practices emerge when facilitating internal IT control in an organization, it is useful to first consider the type of organization and actors involved. The analysis in this paper applies to a large Information and Communication Technology organization with over 5000 employees. The organization needed to develop and certify a SOX compliant internal control system (ICS) especially to account for their heavy reliance on ITs for conducting business. Among the used ITs were hundreds of different artefacts, which potentially had to be considered in the configuration of the ICS. These artefacts were operating on a complex IT infrastructure and connected with numerous extensive data bases and extensive data volumes. IT users and service providers, testers and auditors needed to execute routines and maintain these ITs.

3.2. Data Collection and Analysis

The aim of the two-staged data collection process was to review and support developing the strategy, design and operating effectiveness of the general IT controls used in the organization's internal control system over IT. In both stages I was directly involved in field activities including interviews, presentations, audits, meetings and workshops. Table 1 shows an overview of contact sessions and data collection durations.

The field research strategy followed a cyclic action research design (McKay & Marshall, 2001), where results from the first stage were inputs for the second. The action approach allowed for overcoming the passivity of research found in many traditional case studies. Especially when organisational change is involved, the active role of the action researcher allows achieving a more in depth understanding of the complex multi-dimensional transformations and their socio-technical dynamics. Additionally, informal gatherings provided important sources of information. These multiple data collection sources allowed for a sustained consideration of events with data needing to converge in a triangulating fashion (Wynn & Williams, 2012).

	Research cycle 1	Research cycle 2	Main contact group(s)
Briefings	5	5	Control owners
Operational control tests	28	95	Control owners & executors
De-briefings	0	3	Control owners
Intermediate reporting	1	4	Quality management
General meetings	8	2	Program Managers
Workshops/presentations	1(ex-post)	1 (a priori)	All main stakeholders
Total field sessions	**43**	**110**	
Scoping (framework and risks)	1 week	2 day	
Scoping (systems)	2 weeks	2 days	
Design tests	2 weeks	2.5 days	
Operational tests	5 weeks	5 weeks	
Reporting	2 weeks	Concurrent	
Total durations	**12 weeks**	**~6.5 weeks**	

Table 1: Overview of field research contact sessions and durations

The early activities during the first three-month research cycle (i) were dedicated to reviewing the legal requirements for IT control in the organizational context, followed by testing the current and desired states of their internal control system, before reflecting upon the findings and suggesting ways to improve the configurations. The second research cycle (ii) followed three months later and took almost 2 months. It placed a stronger emphasis on testing the achieved progress in institutionalizing the ICS and the further collaborative changes needed to remediate identified control problems. The field work was supported by research assistants who helped to coordinate the schedules, prepare documents, and perform repetitive tests with organizational actors such as control executors in relation to specific systems with clear instructions and forms. Almost all exchanges were transcribed into a common format by the testers or interviewers, and used for quantitative and qualitative analysis. Quantitative analysis provided summary statistics on control design and operating effectiveness per area. Ex-post meetings with managers or the auditors allowed for discussing the main themes pertaining to problems, such as conflicts, and make better sense of the rich data collected (Cresswell, 2003).

In addition, the use of further data collection methods at different research stages allowed for data source triangulations to ensure a comprehensive view and increased validity of findings

(Denzin, 1984; Yin, 2003). A large volume of business and technical documentation in particular including prior testing results, control and process definitions, roles and responsibility assignments, and related presentations was analysed. Most importantly, work processes and meetings were not only passively observed but also actively conducted by the researcher in an auditor's capacity.

4. Main Results

In this section, I firstly give the identified main assemblage components before describing the specific processes producing assemblages, which were enacted based on the capacities of the given components. The following discussion in more detail explains how these findings relate to assemblages and the roles of regulation and standards in their dynamic creation.

4.1. Main Assemblage Components

The main components identified in the assemblages are summarized in Table 3. They are heterogeneous, can be material (e.g. software applications) or take on an expressive role (e.g. control owners). Material components are resources and can be interpreted as the content of the assemblage. While expressive components are actively engaged in coding processes, the material components can be connected with territorialization.

	Research cycle 1	Research cycle 2
Professional auditors	4	3
IT processes	14	13
Control owners	21	17
Control executors	>50	>50
Process owners	>100	>100
Systems (applications only)	16 (out of >50)	10 (out of >50)
Core networks	10	(not considered)
User developed applications	11	8
IT general controls (incl. system instances of abstract controls)	>100	>100

Table 3: Selection of assemblage components

4.2. Main Processes

The first set of processes includs scoping and designing activities sought to harmonize the global standards and adapt a configuration suiting the context of the organization. Linking into the assemblage theory, these processes exhibit territorialization and codification characteristics which were guided by global standards (see Figure 1). These were prescribed by the SOX act and their regulative bodies (such as the PCAOB) as external legislation, and framework recommendations, which in our case relates to the CobiT framework. The product of territorialization and codification at one point of time included 14 IT processes with cross-referenced control objectives, links with 16 application systems, 10 core networks, 11 user-developed applications and large sets of testable controls designs, which were all linked to internal and external people with associated responsibilities. In addition to scoping these components, common measurement systems including sampling procedures were established. The second set of processes is related to operational tests and reporting, which can be conceptually related to aims of qualification, where the qualities of business processes are assessed by means of past control executions and operational tests in order to show if they meet the criteria laid out in effective design documents.
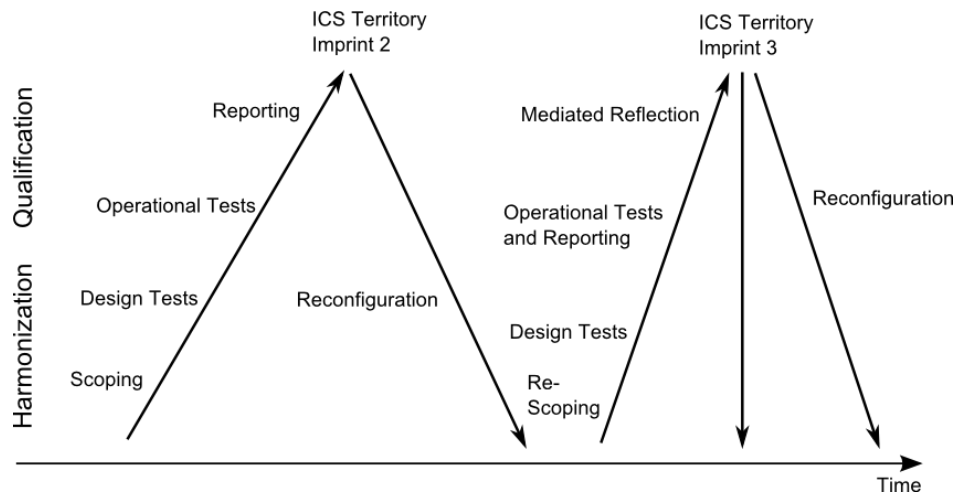
Figure 1: Harmonization and qualification processes in constant ICS re-creation

5. Discussion

5.1. The Emergence of Control Assemblages

The identity of an assemblage as noted by DeLanda (2006, p.28), *"at any level of scale is always the product of a process and it is always precarious, since other processes can destabilize it."*. The identified processes were also recursive, emergent and contingent, while the created identities of assemblages can become almost stable. Aiming at accountability is inherently territorializing (Mennicken & Miller, 2012). The continuous and shifting assemblage always has a territory while the borders, which define "zones of control" (Lemos, 2010), change over time as they are challenged by regulative and social forces outside of and within the organization. Drawing on the case, different types of (de-)territorialization processes struggled with these often opposing forces in what was called scoping the IT process and ITs landscapes, and control objectives which guided the further design of effective IT general controls to be used for calculative practices.

The control objectives should account for risks, which, however, were mainly derived from the standards through mediation processes including external consultants, internal quality management and revision. This again demonstrates the strong impact of global forms. Drawing on the concept of an "global variable" (Collier & Ong, 2005), the used CobiT framework was available to all components in particular the actors of the assemblage, and offered universally accepted best-practice content, which, however, was modified or overwritten if conflicts emerged with other local variables or views. We can extend the concept of the "global variable" to reflect the situational multiple outcomes of standards (Timmermans & Epstein, 2010), by interpreting these as "abstract global variables", which may be overwritten in specific sociomaterial contexts.

The established measurement systems in the first set of identified processes can be conceptually linked with an assemblage as a metrological zone (Barry, 2001). According to this concept, differences in measurement approaches are minimized to allow for performance comparisons across components of the assemblage. Once the process reaches testing and reporting activities, the assemblage moves to a zone of qualification (Barry, 2001). Once the reports were officially delivered to upper management, a new "official" ICS imprint with clearly outlined borders denoting zones of control was established, which, however, gets instantly outdated through its constant re-creation by continuous process and control executions or failures.

5.2. The Tension of Creation

The notion of global forms in the context of control assemblage suggests an inherent tension in (re-)creation. The term global implies the existence and institutional relevance of broadly encompassing, seamless and mobile norms or structures which need to be imposed on assemblages, which imply heterogeneous, fluid, partial, contingent and situated components (Collier & Ong, 2005). This inherent conflict was clearly observable in the case.

The above sketched (re-)creation processes iterated in short or long cycles, and each iteration synthesized a new population of assemblages. The capacities of internal and external experts as material components worked together to identify and codify the IT processes and activities, the central systems and self-developed applications. New expressive components, e.g., design documents and control instructions, and material components, e.g., workflow systems and internalized consultants, were created and existing ones changed. However, the interaction with standards (e.g. CobiT) was always partial and uneasy as attempts were made to align the broadly encompassing norms with existing heterogeneous and contingent elements. The tension of creation derives from the ongoing struggle between these processes, the unstable interrelationships with global forms, and the direction of territorialization or codification (re-)creation processes generate. However, the processes were framework-mediated, and framework-supported institutional arrangements emerged as a result.

Multiple conflicting logics emerged in the organization as control-based imperatives derived from global forms entered established institutional domains, which caused low perceptions of legitimacy through individual cognitions. For example, formal control requirements for certain tasks were partly at odds with existing routines and legitimacy principles of autonomy and fairness. Low perceptions of both aspects of legitimacy have been linked with low control compliance intentions in the context of IS development (Walser, Cram, Bernroider, & Wiener, 2020). Middle management's attempts of coercive methods of influence partly failed to mobilize human agents expected to provide essential control capacities. It is suggested that resulting partial or situated circumventions of control requirements and their effects are as much part of the assemblage as the global form is itself (Dunn, 2005). In this context the study of global control assemblages offers how actors reflect upon global forms and call them into question. Failure to account for control requirements may require actors to accept these as unavoidable conditions for which, however, new or alternative modes of rational action can be used as an intervention (Holmes & Marcus, 2005). In this case for example, failure to automatically produce testable information on user accounts for certain systems may result in providing alternative ways of book-keeping users profiles and accounts, or alternatively, deterritorialization processes changing boundaries.

Moreover, legal and cultural forms of accountability interact with each other. It is therefore difficult to obtain fully functional, formalized and well-integrated configurations. What is achieved instead are incomplete, semi-automated and incompatible components such as "abstract" controls, which need to be instantiated and changed according to contextual requirements. Moreover, other institutional components, which were created in the past and are now partially or fully incomplete, cannot not be easily discarded or replaced. They have distinct identities and remain part of constantly changing assemblages.

5.3. The Role of the Installed Base

As institutions can become wired into IT-topologies and infra-structures, the installed base is critical for organizational change and control requirements (Chae and Lanzara, 2006; Ciborra

2000). In the sense of the sum of history, the installed base summarizes the current technologies and systems the organization dominantly uses. In the case study, the installed base included over 50 centrally registered systems and even more de-central and self-developed applications supporting various business processes (see Table 3). Systems reside on heterogeneous IT infrastructure and are operating with extensive data volumes. The classic views on the technical dimensions of the installed base, however, do not account for the concept of assemblages, where one equally needs to consider interrelated heterogeneous components and exteriorized relations. Moreover, within assemblages technical objects and systems can become institutional and constitutive (Lanzara, 2009). These material components thus become equally critical for their capacities for execution as well as for the roles they play in the configuration of relationships among heterogeneous components, such as risks, control objectives, controls and human actors. This can lead to a better understanding of a competitive situation, where, e.g., ITs and regulation, or IT owners and (human or artificial) actors with control responsibilities strive to "harmonize" one another, each trying to impose views, principles or norms.

In the case, this phenomenon was clearly observed through conflicts between systems and rules, e.g., when unintentional changes of legacy systems could not be automatically identified due to a lack of logging capacities which opposed the standard requirement of being able to back-track any system changes. One central implication arising from this situation is about the question of design. If the installed base is dynamic and dominates business routines, and is an independently given ex ante context, can the requirements of global norms be applied to freely design system-related controls? The more general question is whether the underlying assemblage can be designed (Lanzara, 2009). With regard to the case study, the answer seems to be no. Actors had to cope with the properties of the installed base and design feasible and innovative workarounds termed compensatory controls especially related to legacy systems and self-developed applications.

5.4. The Importance of Exteriorized Relations

Components through exteriorized relations affect each other, in particular the historic components of the organization. The idea of exposure to the exteriority of relations within control assemblages is largely neglected in IS accounting literature. Conventional literature views components of control systems as largely internalized, self-presented subjects, which can be independently used as inputs for control activities, assessments or audits. Either techno-centric or human-centered perspectives dominate, while constitutively entangled social and material views are largely missing (Orlikowski, 2007; Orlikowski & Scott, 2008).

In assemblage theory, however, the properties of the whole are not "the result of an aggregation of the components' own properties but of the actual exercise of their capacities" (DeLanda, 2006, p. 11). While these capacities depend on the components' properties, they cannot be reduced to them since they involve reference to the properties of other interacting components. To illustrate this situation, the effectiveness of the control assemblage cannot be determined through aggregating control effectiveness for each material component, e.g., a particular software application, or expressive component, e.g., a IT general control description, in isolation. Only through understanding the actual exercise of capacities involving a number of heterogeneous components in a sociomaterial process, insightful estimates of control effectiveness levels can be attempted. In sum, it is essential to consider externalizing the component as opposed to thinking of self-containing individual elements in an attempt to simplify the analysis. This in particular applies to IT risks which have complex externalized exposures effectively guiding the territorialization of IT control assemblages.

Deterritorialization through exteriorized relations can disrupt spatial boundaries or increase heterogeneity. For example, in the case study the introduction of new global standard or framework revisions (CobiT version 3 to 4 by ISACA) or new guidelines from the oversight body (audit guidelines issued by PCAOB) have potential deterritorization effects and may lead to shift of boundaries and the exclusion or inclusion of new components within the assemblage.

6. Conclusions

This paper refers to the idea of control assemblages with which to address the problem of introducing broadly encompassing and seamless global forms for internal control, while accounting for the history and dynamics of the organization, and heterogeneity within the ephemeral (Marcus & Saka, 2006). While the global prescription derived from norms and standards are reasonably well covered in prior literature, their constant socio-material re-conceptualization with effects, contradictions, and changing relationships is not. The mix of both, the global and structural with the unpredictable and contingent, is usually not considered within the classical traditions of social or computer science based IS research. A number of interesting observations were made in the case study deemed to offer interesting options for further analysis in future research.

I can reasonably speak of control-mediated institutional arrangements which emerged from sociomaterial practices within an assemblage involving global rules and the regulatory regime exemplified by the case analysis. The organizational setting provided a rich field of problems and resistances in control assemblages driven by IT related risks and the attempt to impose control-imperatives on social practices and material elements. The identified standardization and harmonization processes enacted by the capacities provided by material and expressive components aimed at achieving accepted commonalities and establish assemblages as zones of control, measurement and qualification. However, a number of tensions, conflicts and conflicting logics emerged in ongoing struggles between components, in particular based on the uneasy relationship with global forms. Observed partial or temporary circumventions of controls are suggested to be part of the assemblage as much as the global form itself. Furthermore, exteriorized relations in particular linked with the global form can disrupt spatial boundaries and trigger new de-territorialization processes.

The formation, development and sub-sequent evolution of control assemblages were clearly path-dependent. The complexity of current conditions and previously made decisions including non-human components (such as the installed base), and human components and capacities (such as their tacit knowledge) imposed given constraints limiting free-designs derived from global forms. In relation to research cycle one, the organizational stakeholders and external auditors alike accepted with sufficient reasoning and compensating processes that certain elements of global forms had to be "overwritten". Thus, the global form was accepted as "abstract global variable", which instances are context-specific temporally territorialized assemblages.

In the context of global assemblages for internal control over IT, further research is warranted to extend upon these issues or develop other potentially rewarding avenues in space of assemblage theory. One empirically overlooked issue is that organizational actors are offered capacities from emerging assemblages through relations of exteriority with new potentials for quality control, which may go beyond compliance and its view of "only" satisfying legal control requirements.

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17. Learning from Security Failures:
The Roles of Psychological Safety and Mild Fear
Research-in-Progress

Chengqi (John) Guo
College of Business
James Madison University
guocx@jmu.edu

Abstract

Learning from mistakes and failures is of paramount importance to today's information workers and cybersecurity task force members when they confront ever-growing signs of cyber foes. However, Information Systems (IS) security literature offers limited insights into this phenomenon. Few studies, either theoretical or empirical, shed light on the mechanism of learning from security failures at the individual level. Moreover, the existing research has primarily focused on the deterrent effect of fear and overlooked the promoting effect of mild fear that could augment human cognitive functions, thereby enhancing their learning efficacy. Informed by cross-paradigmatic underpinnings, this study proposes a research model elucidating how the presence of moderate fear stimuli, in conjunction with psychological safety, may boost learning performance and thus positively affect the security coping intention and behavior of information workers. The model also juxtaposes individual factors with environmental factors to leverage cross-level viewpoints. Research methods and expected contributions are discussed.

Keywords: learning from failure, security coping, information security, fear, psychological safety.

1. Introduction

The gravity of security threats these days is staggering (Burns et al. 2019; Liang et al. 2019). Not only do new variants of malware keep emerging, but the past-its-prime attacks continuously find their ways, using the old backdoor, to cripple and befuddle victims. According to a threat intelligence report spanning from 2007 to 2017, organizations still get compromised by the same old tricks, the same old vulnerabilities (F5 Labs, 2017), highlighting the needs to learn better from security failures. In terms of academia, behavioral security has enjoyed significant advancements that strive toward better understandings of the IS security nomologies (e.g., Boss et al., 2015; Johnston et al. 2015; Moody et al. 2018; Burns et al. 2019; Liang et al. 2019), but the phenomenon of learning from security failures remains unexplored (e.g., the basket of top IS journals).

Learning from Failures (LFF) is an enduring research topic in personal psychology, organizational behavior, public administration, entrepreneurship, and others (Edmondson and Lei, 2014; Carmeli and Gittell, 2009). Specifically, leadership and organizational learning theorists have argued that psychological safety is associated with LFF at all three levels - individual, group, and organization (Edmondson & Lei, 2014). Carmeli et al. (2012) suggest that high-quality leader-subordinate relationships engender psychological safety, which positively leads to failure-based learning in an organization. At the individual level, Detert & Burris (2007) examined relationships between psychological safety and the "extra-role" improvement behaviors such as speaking up – an indispensable behavior associated with LFF.

These insights, however, do not explain how LFF unfolds in the IS security paradigm where fear plays a key role in exerting impacts on individuals' emotional state and subsequent behavioral manifestations, thus calling for research that provides new orienting points and re-contextualizes classic nomologies to attain new discoveries. Moreover, little is known about the combinative effects of psychological safety and fear on LFF because these two factors often undergo analysis in separate contexts. Busato et al. (2000) found that learning style has a positive correlation with fear of failure negative, but a negative correlation with fear of failure positive, hinting the paradoxical effects of fear. Their findings resonate with those of neurobiological studies that suggest an inverted U-shaped function of fear arousal and cognitive performance, implying a positive effect brought by fear that is mild and could enhance individuals' sensory acquisition (e.g., memory, attention span; Susskind et al. 2008; Sussman et al. 2013).

Situating our research at the intersection of neurobiology, organizational learning, behavioral IS security, and personal psychology, we explore how the presence of moderate fear stimuli, in conjunction with psychological safety, may augment learning performance and thus positively affect the security coping intention and behavior of information workers.

2. Theoretical Background & Research Model

2.1 The Promoting Effect of Mild Fear
Drives, such as fears, play an essential role in human behavior (Miller, 1948). Drawing upon a meta-analysis investigation by Burke et al. (2011) on safety training literature, this study suggests that fear, if presented in a mild form, plays a promoting role in the prediction of the learning from security failures behavior, especially when acting agents handle hazardous situations. Interestingly, research in neurobiology indicates that mild fear can positively affect the physiological and cognitive functions such as sensory exposure and attentional processing (Susskind et al. 2008), suggesting an inverted U-shaped correlation between fear and enhanced cognitive performance tied to learning efficacy (Sussmanet al. 2013; Vermeulen et al. 2009). Meanwhile, the leading security research indicates that perceived threat vulnerability and perceived threat severity predict fear (Floyd et al. 2000; Rogers and Prentice-Dunn, 1997). However, Protection Motivation Theory (PMT), same with other baseline lenses, does not consider the connections between mild fear and failure-based security learning behavior in its core or full nomologies, creating a research gap. Hence, this study makes the following proposition:

H1: To what extent for information workers mild fear will serve as a drive to learn from security failure when perceived threat severity and perceived threat vulnerability are present.

2.2 The Effects of Psychological Safety on Learning from Failure
Psychological safety describes individuals' perceptions of the consequences of taking interpersonal risks in a particular context such as a workspace (Edmonson, 2004). This is important because learning situations such as reflecting on mistakes and errors in organizations where people are in a position to judge skills and performance involve personal risk (Edmondson, 2004). It refers to a belief that one is able to express his or her self "without fear of negative consequences to self-image, status, or career" (Kahn, 1990 p. 708). A central theme of research on psychological safety helps to explain - across levels of analysis such as individual, group, and organization - the willing contribution of ideas and actions to an organized body of people with a particular purpose (Edmonson & Lei, 2014). Furthermore, Edmonson (2004) proposes a theoretical model of five learning-oriented behaviors arguably

enabled by psychological safety. These findings show that psychological safety and learning from failure are two correlated factors capable of exerting impacts on performance at different levels. Of particular interest to this study, however, are the manifestations and effects of psychological safety on key indicators of learning from failure relating to information workers' IT security-based coping behaviors.

H2: Perceived psychological safety is positively associated with learning from security failure such that greater perceived psychological safety will support information workers to engage more actively in failure-based learning behavior about IT security.

2.3 The Effects of Leadership on Psychological Safety

Keeping up with the rapidly increasing rate of security risks is a daunting challenge for today's firms (Burns et al. 2019). In light of this, scholars suggest that people with diverse backgrounds must work effectively in a cross-disciplinary manner by leveraging complementary skills and experiences to confront on-going foes (Edmondson and Lei, 2014). To achieve this strategy, change-oriented leadership is indispensable. A transformational leader encourages information workers to explore failure-driven, innovative, and sometimes high-risk gambits without worrying about negative consequences of self-interest (Detert and Burris, 2007). These endeavors require a milieu where one-on-one attention is readily available and cross-boundary collaboration regularly takes place, thus fostering workers' psychological safety.

H3a: Transformational leadership is positively associated with psychological safety so that information workers will have higher psychological safety under the influence of strong transformational leadership.

The literature considers managerial openness as the employees' perceptions that their upper-level managers listen to them, give fair consideration to their ideas, and sometimes take actions to address their concerns (McCartt and Rohrbaugh, 1995). Moreover, openness is more consistently related to improvement-oriented voice – a behavior often associated with failure-based learning, mediated by subordinate perceptions of psychological safety (Detert & Burris, 2007). The contemporary literature on leader-member relationships cheers the importance of managerial openness to change, evidenced by its broad exposure in research on technology adoption (e.g., McCartt and J. Rohrbaugh, 1995), organizational behavior (e.g., Nadler & Tushman, 1980), and individual-level employee voice (e.g., Detert & Burris, 2007).

H3b: Managerial openness is positively associated with psychological safety so that information workers will have higher psychological safety under the influence of strong managerial openness.

When investigating the relationship between psychological safety and subordinate discretionary improvement behavior (i.e., voice their opinions), Detert & Burris (2007) revealed that change-oriented leadership exerts more influence on high-performance subordinates than it does on low-performance subordinates. Our proposition then suggests that better performers will be more active in providing constructive inputs, which will engender better outcomes from learning. The literature has noted that speaking-up is a key indicator of learning from failure (Carmeli & Gittell, 2009) and contributes to learning effectiveness by enabling and fostering first-hand based and vicarious learning experience. For change-oriented leaders, they need to leverage strong performers' influence as an important resource to galvanize more followers into active learning from mistakes to accomplish a shared goal.

H3c: Job performance moderates the impact of change-oriented leadership style on learning from failure in such a way that stronger performers will be more active in learning.

2.4 The Effects of Learning from Failure on Response Efficacy & Self-Efficacy
An in-depth look into the IS security literature exposes several studies where the researchers have re-conceptualized the response efficacy construct from various perspectives (e.g., Jensen et al. 2017; Johnston et al., 2015). In our context, security response efficacy means that information workers believe what they have learned from the past, especially negative experience including failures and mistakes, is effective in laying the groundwork for a better security posture of their workspace. Notably, neither the core or full PMT nomologies evaluated what may enable or enhance individuals' perceptions of response efficacy (Boss et al., 2015, Figure 1, p. 4). Because of this gap, some researchers shed light on the effects of individuals' learning experience on response efficacy by theorizing learning activities and their relationships with people's attitudinal representation of whether a security measure is efficacious. For example, Silici & Lowry (2019) suggest that intrinsic and extrinsic motivations can positively generate influence on behavioral change through security learning, setting the stage for our proposition that learning from failure is positively associated with response efficacy.

H4: Learning from security failure is positively associated with security response efficacy in such a way that more effective learning will lead to increased perception of response efficacy.

Security-based learning fosters coping abilities (Silici & Lowry, 2019), and self-efficacy serves as an inextricable component of individuals' coping appraisal (Moody et al., 2018). Educational psychology studies accentuate the connections between self-efficacy and simulation-oriented learning experience (Busato et al. 2000). Additionally, management-research publications revealed a significant relationship from learning to self-efficacy. Gong et al. (2009) examined employee creative self-efficacy as a mediator of the influence of employee learning orientation on creativity, on top of its mediator role between transformational leadership and creativity. Informed by these theoretical developments, we then argue that a person's past performance, lessons learned, and vicarious experience constitute a valuable learning mechanism, which impacts efficacy development. Our research model (Figure 1) recaps the hypotheses.

H5: Learning from security failure endeavor is positively related to information worker self-efficacy in such a way that increased learning will lead to heightened self-efficacy.

3. Research Method
We plan to utilize a triple-study research design that aims to accomplish the following purposes: complementary, developmental, corroboration, and expansion (Venkatesh et al. 2013). The interview study consists of three sections: (1) the pre-interview reiterates the study's goals and reorients participants to the process; (2) the main section explores how information workers deal with security failures at work, leader-subordinate interactions, and the promoting effects of mild fear in the IS security context; (3) the post-interview provides closure on the experience by offering both researchers and participants an opportunity to clarify and refine outcomes of the interview. In the second study quasi-experiment, we will assign students to groups of four in a capstone course where they collaborate to devise a Minimum Viable Product (MVP) solution for a security consulting company. As course instructors, we will observe how the unpleasant emotion (fear), which is caused by the presence of security threats jeopardizing their mission/grades, manifests in conjunction with the influence of psychological safety on subjects' failure-based learning behaviors in a dichotomous working milieu - high and low

transformational leadership and managerial openness. The treatments afforded by a 2X2 full factorial design allow us to gather data that, once analyzed, may reveal hidden gaps and discoveries, thereby providing hypotheses to be tested in the last study. In the third study (survey), we will draw on Edmondson (2004) and Carmeli et al. (2012) to use six items with a five-point response scale to measure LFF. We will measure fear by drawing upon Boss et al. (2015), who devised and empirically tested the indicators of the fear motive. We measure psychological safety (Edmonson, 1999), transformational leadership (Detert and Burris, 2007), and managerial openness (McCartt and J. Rohrbaugh, 1995) using items informed by Detert & Burris (2007), where the authors tapped the individual-level estimate of independent variable coefficients.
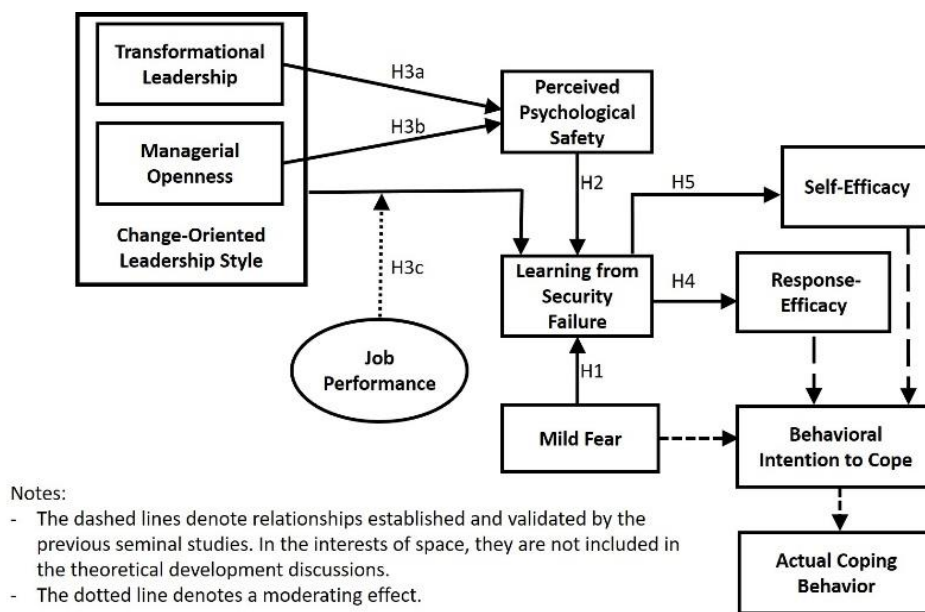

Figure 1: Research Model

4. Expected Contributions
The present study renders multiple contributions. First, our cross-disciplinary research sheds light on the interplays of fear and psychological safety on learning from failure, explaining how decision-makers can utilize leadership roles to mitigate the barriers associated with employees' attempts to acquire knowledge that is new to them, with the use and reflection of their failures and mistakes. Second, we introduced a new perspective about the promoting role of fear that has not received much attention in the IS security literature. Our review suggests that nearly all behavioral security studies emphasize the deterrent effects of fear, primarily when associated with fear appeal and threat appraisal. The present study taps the inverted U-shape of fear to unveil a hidden research gap. Third, the conceptual model dovetails the individual psychological factors and environmental factors that jointly influence information workers' security-related behaviors, leveraging a cross-level integration of viewpoints. Lastly, fear-induced learning from failure can display effects that are more potent for some individuals (e.g., high performance employees) than others, offering managerial implications to security professionals.

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18. Mensuração de desempenho em Smart Government: análise da Estratégia de Governança Digital do Governo Federal do Brasil

Mariane Santiago de Souza
Universidade de São Paulo
marianesantiago@usp.br

Daielly Melina Nassif Mantovani Ribeiro
Universidade de São Paulo
daielly@usp.br

Abstract

A evolução tecnológica e de telecomunicações tem causado transformações significativas no modo como os cidadãos interagem com os seus pares, buscam e obtém informação, gastam suas horas de lazer, trabalham, consomem e se relacionam com os interlocutores, inclusive com os governos. A busca por soluções rápidas, convenientes e com padrão alto de qualidade se intensificou também no que diz respeito aos serviços públicos. Com o objetivo de se modernizarem para atenderem a esses novos padrões, os governos têm procurado adotar práticas baseadas em inovação e em tecnologias da informação, que sob o conceito de Smart Government pretendem repensar, fundamentalmente, o modo como a administração pública funciona. Norteando as iniciativas alinhadas com esta premissa, encontram-se a Estratégia Brasileira para a Transformação Digital, E-digital, e a Estratégia de Governança Digital – EGD. Este trabalho tenciona analisar a metodologia proposta pela EGD para mensuração e avaliação do desempenho das ações de smart government no Governo Federal do Brasil à luz da literatura acadêmica existente a respeito do tema, bem como levantar opções para a proposição de uma versão aprimorada do modelo atual.

Keywords: Smart government, E-government, Smart cities, Indicadores de desempenho, KPI's

1. Introdução

O advento de novas e sofisticadas tecnologias relacionadas a inteligência artificial, big data, sistemas de sensores e internet das coisas tem feito com que os Governos busquem implementar práticas inteligentes na prestação de serviços públicos e nos seus próprios processos de trabalho (Schedler, Guenduez & Frischknecht, 2019). O desenvolvimento de um novo modelo de gestão pública baseado na utilização dessas tecnologias da informação com o intuito de disponibilizar serviços de maneira mais transparente, eficiente e integrada é conhecido por Smart Government. Para assegurar que as ações propostas nos governos estejam aderentes aos objetivos traçados bem como estejam contribuindo para tornar a administração pública mais inteligente, torna-se mister implementar sistemas de mensuração de desempenho efetivos.

Na busca por subsidiar a mensuração de desempenho da inteligência em cidades diversos padrões internacionais foram desenvolvidos (ETSI 2017a; ISO, 2018a, 2018b; ITU, 2016b, 2016c, 2016d). Todos esses conjuntos de indicadores consideram, em alguma extensão, a governança como aspecto chave para que uma cidade possa ser considerada inteligente. Estudos voltados especificamente para o âmbito da governança identificaram inúmeras dimensões que podem ser consideradas para caracterizar o nível de inteligência nos governos, como inovação, integração, sustentabilidade, criatividade, efetividade, eficiência, igualdade,

empreendedorismo, engajamento cidadão, abertura, resiliência e conhecimento tecnológico (Gil-Garcia, Zhang & Puron-Cid, 2016); eficiência, efetividade, transparência e colaboração (Nam & Pardo, 2014).

Com o objetivo de propor soluções para essa questão, inúmeras pesquisas têm procurado sintetizar indicadores existentes em conjuntos que possam melhor se adequarem às especificidades da estratégia do poder público (Huovila, Bosch, & Airaksinen, 2019). Entretanto, a escolha decisiva de quais indicadores utilizar para avaliar o desempenho da administração requer uma forte compreensão do contexto em que as iniciativas de smart government surgem e são implementadas, dos modelos de governança vigentes e do valor público que se pretende gerar, do contrário há um risco real de serem obtidas informações incapazes de refletir a situação concreta e que levarão ao desenvolvimento de estratégias irrealistas.

Em outras palavras, o "smart" que se deseja alcançar em cada situação é um estado ímpar que dependerá do contexto específico (situação política e geográfica, difusão tecnológica, por exemplo) em que uma determinada sociedade se encontra, do modo como o governo administra e implementa políticas públicas para melhoria da qualidade de vida dos cidadãos (âmbito da governança) e da maneira como trata a medição do valor público, como aspecto principal do produto entregue para os cidadãos (Meijer, Gil-Garcia & Bolivar, 2015). A complexidade dos aspectos envolvidos na transformação de um governo em "smart" é de notável relevância e inclui tanto a necessidade de definição clara do que se pretende com cada ação e a demonstração de como medir, controlar e aprimorar ações vigentes (viés objetivo) mas ainda atenção especial à percepção dos cidadãos do valor que lhes é gerado (viés subjetivo). A interligação entre esses aspectos demonstra que o smart government possui caráter transcendental que rompe os limites da plataforma digital de oferecimento de serviços e se propõe, em alguns casos, a revolucionar a governança pública.

Considerando esses aspectos, este trabalho irá analisar com base em revisão teórica, a Estratégia de Governança Digital – EGD lançada pelo Governo Federal do Brasil em 2016 conforme os conceitos constantes na literatura acadêmica vigente. A EGD surge como um arcabouço da intenção da administração pública brasileira em se alinhar a práticas de smart government e além de índices elaborados por organizações internacionais (ONU e World Wide Web), há a fixação de objetivos estratégicos, metas e alguns indicadores para medir o desempenho do Governo Federal no andamento de ações que se encontram divididas em três eixos, quais sejam, acesso à informação, prestação de serviços e participação social.

Levando em conta os avanços do Governo Federal Brasileiro na elaboração de uma estratégia em smart government em um contexto de limitações políticas, econômicas e de infraestrutura inerentes à sua condição de país em desenvolvimento, estas são as perguntas de pesquisa levantadas neste trabalho: Q1: De que modo está sendo medido o desempenho das iniciativas de smart government no Governo Federal Brasileiro? Q2: Quais os indicadores utilizados na mensuração de desempenho e como eles se relacionam com as dimensões-chave de smart government apontadas na literatura? Q3: Como a mensuração de desempenho proposta pela EGD avalia o valor público e a eficiência? Q4: Que modelo propor para um aprimoramento na mensuração de desempenho de Smart government vigente na EGD? Com o resultado desta pesquisa, objetiva-se fornecer dados relevantes para agentes públicos na avaliação de ações de smart government e tomada de decisão no sentido de adaptar e melhorar estas inciativas. Do ponto de vista acadêmico este trabalho pretende trazer luz a importantes aspectos a respeito do modo em que o desempenho de ações de smart government vem sendo medido no Governo

federal brasileiro e em que extensão eles se alinham ao conhecimento já consolidado na literatura.

2. Base teórica

Um governo se torna mais inteligente quando passa a ter uma visão de futuro voltada para a utilização e integração de informação, tecnologia e inovação nas atividades governamentais (Gil-Garcia, Helbig & Ojo, 2014). Essa abordagem envolve uma modernização completa na administração pública, que vai além da mera disponibilização de serviços em meios digitais, pois implica uma mudança de paradigma em relação aos objetivos institucionais, estruturas organizacionais e culturais vigentes. Na realidade, os aspectos institucionais são tão decisivos para o sucesso na implementação de ações de smart government que, em alguns governos, seu êxito já se mostrou substancialmente prejudicado por barreiras institucionais e políticas (Schedler, Guenduez & Frischknecht, 2019).

A implementação de inciativas de smart government não deve ser um fim em si mesmo, mas sim um meio para atender aos anseios da sociedade. O objetivo principal de modernizar a administração pública consiste em oferecer uma prestação de serviços otimizada e mais eficiente, na visão do cidadão. O valor público corresponde à expectativa coletiva que os cidadãos possuem em relação ao governo e aos serviços públicos (Moore, 1995). Este conceito envolve, portanto, a percepção de valor criado pelo poder público e recebido pelos cidadãos. Há, deste modo, uma expectativa que os cidadãos possuem a respeito do governo e dos serviços públicos. Medir o desempenho em smart government não é uma tarefa simples, uma vez que se pretende mensurar uma entrega que é intangível por natureza, o valor público. Atingir maior valor público em uma iniciativa de smart government envolve que a entrega do serviço ocorra com a melhoria de eficiência e serviços esperada pelo uso intensivo de tecnologia e ainda que esta entrega ocorra de forma associada a valores sociais como inclusão, transparência, democracia e participação (Twizeyimana e Andersson, 2019). Destarte, o valor público é conceito central que deve nortear a definição de quaisquer indicadores para medição de desempenho em smart government. Por outro lado, é importante ressaltar que os resultados dessas ações nem sempre estão claramente delineados e visíveis o que torna bastante difícil definir modelos de avaliação capazes de cobrir todas as áreas abrangidas por esse conceito (Salvodelli, Misuraca e Codagnone, 2013).

A medição de performance tem origem na administração de empresas e busca quantificar o quão bem o negócio vai, se os objetivos estão sendo atingidos, se os clientes estão satisfeitos, se os processos estão sob controle e se/quando melhorias são necessárias. A medição de desempenho fornece as informações para tomada de decisão inteligente em um negócio quanto ao estabelecimento de metas e padrões, detecção e correção de problemas, gerenciamento e melhoria de processos, demonstração do progresso no atingimento dos objetivos e da efetividade e eficiência de programas, processos e pessoas. Para levantar esses dados, a medição de desempenho comumente foca em seis categorias: Efetividade, eficiência, qualidade, produtividade, segurança e tempo (Artley e Stroh, 2001). Ao buscar medir o desempenho de ações de smart government o principal foco deve ser detectar em que nível essas ações impactam no atingimento dos objetivos estratégicos estabelecidos pela administração pública, levando em consideração o fator-chave do valor público já mencionado. Para fins desta pesquisa, será utilizada a seguinte tipologia de indicadores-chave de desempenho (Bosch e outros, 2017): Indicadores de entrada (Input), Indicadores de processo (Process), Indicadores de saída (Output), Indicadores de resultado (Outcome), Indicadores de impacto (Impact).

O maior ou menor foco em um outro tipo de indicador dependerá das prioridades estabelecidas pelo poder público em um determinado intervalo de tempo. Os indicadores de entrada, por exemplo, serão bastante críticos em cenários austeros em que haja necessidade de otimizar recursos, aumentar a eficiência organizacional, contingenciar gastos ou lidar com escassez de pessoal. Indicadores de saídas e resultados, por sua vez, podem terão aplicação mais intensivo para quantificar as entregas à sociedade. Já os indicadores de processos serão decisivos para fornecer dados à própria administração pública quanto ao modo como tem desempenhado suas atividades e as oportunidades de melhoria, adaptações e correções possíveis. Em quaisquer cenários, entretanto, os indicadores de impacto devem ser objeto de atenção especial por parte do poder público, pois estão ligados ao resultado obtido no longo prazo, ou seja, aos objetivos estratégicos da administração pública no que se refere à sua modernização e alinhamento ao smart government.

Por fim, sistemas robustos de mensuração de desempenho requerem investimento expressivo em recursos, treinamento de pessoal, suporte e recompensas por melhorias (Marr, 2009). Por isso, é tão importante que os dados obtidos com a medição de performance levantem questionamentos a respeito de quais fatores influenciam no desempenho e busquem a compreensão do valor dessa mensuração para o aprendizado organizacional, ou seja os resultados da medição devem se integrar com a elaboração das estratégias e transformar o comportamento da administração pública como um todo (Sanger, 2013).

3. Resultados da Pesquisa

A pesquisa pode ser classificada como revisão exploratória de literatura. Os indicadores de desempenho descritos na Estratégia de Governança Digital dos períodos de 2016-2019 e de 2020-2022 foram classificados de acordo com a tipologia de Bosch e outros (2007) com o intuito é identificar o nível de alinhamento com os objetivos estratégicos definidos para ambos os períodos e se os indicadores definidos são eficazes para apontar a evolução das iniciativas propostas inicialmente. Na sequência prosseguiu-se com um breve comparativo entre as estratégias de 2016-2019 e 2020-2022 com o objetivo de identificar elementos evolutivos na abordagem utilizada para mensurar o desempenho do smart government no âmbito do Governo Federal nesses períodos. Na sua primeira versão, a EGD apresentava uma visível predominância dos ditos indicadores de saídas (outputs) que representavam quase a metade (47%) de todo o conjunto de indicadores utilizados para acompanhamento do desempenho da estratégia. Este resultado mostra a priorização de métricas que visam quantificar as entregas mais imediatas, no curto prazo. Trata-se de uma abordagem coerente com os objetivos que haviam sido estabelecidos para atingimento na EGD que por sua vez tinha uma vigência breve de três anos.

Cerca de dois terços dos indicadores neste conjunto estão voltados para os processos e os resultados intermediários. Chama atenção a inexistência de indicadores de entradas (inputs) e impacto. No que se refere aos indicadores de entradas, a sua ausência demonstra que não há preocupação específica na mensuração de eficiência ou melhoria dos recursos nas iniciativas de modernização da administração pública, ou ao menos que essa preocupação existe, não é objeto de acompanhamento na implementação da estratégia. De acordo com o relatório de acompanhamento da EGD divulgado pelo Governo Federal, a estratégia encerrou sua vigência em 2019 com 85,35% da execução planejada.

Na versão subsequente da EGD há uma mudança perceptível no peso dos indicadores de resultado (outcome) que passam a ser majoritários em relação aos demais, compondo 41% do conjunto de indicadores. Vale ressaltar, que na nova estratégia houve uma considerável

expansão na quantidade de indicadores utilizados e na própria abordagem que se optou por adotar a partir de então. Os eixos orientadores dos objetivos estratégicos estão sobremaneira alinhados com as dimensões de valor público definidas no estudo de Twizeyimana e Andersson (2019). Listamos na tabela abaixo como cada eixo na EGD de 2020 se alinha às dimensões definidas pelos autores como chave para aferição do valor público nas iniciativas de smart government:

Dimensões de valor público (Twizeyimana e Andersson, 2019)	Eixos orientadores EGD/2020
Serviços públicos aprimorados	Governo centrado no cidadão
	Governo integrado
	Governo inteligente
Confiança e segurança no governo	Governo confiável
Governo aberto	Governo transparente e aberto
Eficiência administrativa	Governo eficiente
Comportamento ético e profissional	

Tabela 1: Dimensões de valor público Vs Eixos Orientadores EGD/2020

A dimensão 'Valores sociais e bem-estar' não pode ser associada a nenhum dos eixos definidos na EGD. Trata-se justamente de uma dimensão que compreende efeitos na sociedade no longo prazo e atuam impactando a qualidade de vida e bem estar social. Assim como sua antecessora a EGD 2020 não possui nenhum indicador que possa ser classificado como de impacto. Sendo assim, faz sentido que não haja eixos que se apresentem aspectos dessa dimensão específica do estudo de Twizeyimana e Andersson (2019). Um aspecto positivo e que pode ser considerado uma relevante evolução na nova estratégia, diz respeito à inclusão de indicadores de entradas (inputs). Apesar de tímida (apenas 11% dos indicadores são de entradas), essa mudança mostra a Administração Pública começando a se debruçar sobre as necessidades de aperfeiçoamento e otimização dos recursos para o atingimento dos objetivos estratégicos estabelecidos.

4. Discussões e considerações finais

Os dados coletados mostraram uma evolução significativa no modo como a Administração Pública Federal trata da modernização da sua atividade e como vem se esforçando não somente para implementar iniciativas consideradas de *smart govermen,t* mas também para mensurar seus resultados e acompanhar ao alcance das metas. Além do aumento notável na quantidade de indicadores usados, a EGD/2020 que foi lançada durante a execução dessa pesquisa, apresenta eixos alinhados com a literatura atual sobre o tema. Isso mostra que há empenho por parte Administração em manter-se atualizada e de acordo com o que há de mais recente e inovador também no meio acadêmico. Os resultados apresentados no item anterior, respondem sobremaneira as questões de pesquisa Q1 a Q3. Considerando a base teórica utilizada neste trabalho para responder a "Q4: Que modelo propor para um aprimoramento na mensuração de desempenho de *Smart government* vigente na EGD?", entende-se que deve haver a busca por um set de indicadores que possua equilíbrio entre as cinco dimensões a seguir: aplicação de recursos, efetividade dos processos, saídas de curto prazo, resultados alcançados e valor público agregado. No quadro resumo abaixo (ver Tabela 2) é possível verificar quais aspectos devem ser considerados na definição dos indicadores para cada uma das categorias. O quadro (Ver Tabela 2) mostra também os eixos da EGD/2020 que mais se relacionam com cada tipo de indicador. O principal elemento que deve ser considerado é a inclusão de indicadores de

impacto para o acompanhamento das ações. Estes se relacionam com todas as dimensões da EGD/2020 uma vez que se propõem a medir de que maneira as iniciativas, quaisquer sejam, impactam a vida dos cidadãos. É, portanto, o elemento-chave para mensurar os efeitos no longo prazo dessas medidas.

Grupos de Indicadores (Para cada eixo)	Aspectos a serem considerados	Eixos relacionados (EGD/2020)
Aplicação dos recursos	Quantidade de recursos necessários Eficiência da utilização dos recursos, aproveitamento e desperdício Relação custo-benefício	Governo eficiente Governo Transparente e aberto
Efetividade dos processos	Aderência das atividades ao planejado Cumprimento de cronogramas e prazos Aprimoramento dos processos de trabalho	Governo eficiente Governo integrado
Saídas de curto prazo	Produtos entregues; A saída esperada no curto prazo;	Governo eficiente Governo inteligente Governo centrado no cidadão
Resultados alcançados	Resultados intermediários; Em que medida as saídas atendem às metas traçadas;	Governo eficiente
Valor público agregado	Impacto das medidas na sociedade no longo prazo; Métricas capazes de dimensionar a melhoria na qualidade de vida dos cidadãos em decorrência das iniciativas definidas na estratégia; A mudança percebida pelos cidadãos;	Todos

Tabela 2: Conjunto de indicadores proposto.

Do ponto de vista teórico explorado neste trabalho, foi possível concluir que o balanceamento das cinco categorias de indicadores sugeridas oferece um bom parâmetro para que a administração pública efetive uma mensuração de desempenho satisfatória, uma vez que o modelo proposto abrange desde os recursos e processos (perspectiva interna) bem como produtos, resultados e impactos profundos na vida do cidadão. Um conjunto que abranja esses eixos balizadores cobrirá toda a abrangência da estratégia sob pontos de vista diversos e capazes de subsidiar os gestores com informações valiosas tanto para a avaliação em si dos resultados, quanto para redefinição e laboração de novas metas e objetivos. Uma vez conceituados os tipos de indicadores desejáveis, pretende-se em um segundo momento prosseguir com uma pesquisa mais aprofundada, na qual será possível ir além e estudar os mecanismos e tecnologias utilizadas na operacionalização da medição do desempenho do *smart government* no contexto da Administração Pública Federal e de que maneira esses processos podem se tornar mais integrados, velozes, assertivos e inteligentes.

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19.   Micromobility challenges in the city of São Paulo: The impact of shared economy services of electric scooters

Luis Hernan Contreras Pinochet
Universidade Federal de São Paulo
luis.hernan@unifesp.br

Vanessa Itacaramby Pardim
Universidade Nove de Julho
vanessa.itacaramby@gmail.com

Heloisa Mangini
Universidade Federal de São Paulo
heloisa.mangini18@gmail.com

Cesar Alexandre de Souza
Universidade de São Paulo
calesou@usp.br

Abstract

The purpose of this paper is to understand the impact of shared economy services of electric scooters on micromobility in the city of São Paulo, based on the proposal of a theoretical model that sought to analyze antecedent factors of continuance intention. For that, descriptive research was carried out with a quantitative approach. The data were collected from a survey (n=190) with the structural equation modeling technique (PLS-SEM). After analyzing the data, all hypotheses were accepted. The results indicated that the user understands that the electric scooter service is useful. Its benefits were perceived as part of diversifying the possibility of getting around the city in short distances. On the other hand, it is noteworthy that, probably, users who already had low satisfaction, when exposed to the reality of costs, after a period of initial euphoria, tend over time to reduce interest. Despite the slight drop, those who showed high satisfaction tend to continue using the service. Finally, the research results corroborated the understanding of the slow evolution of micromobility in São Paulo, which caused companies to leave the country or restrict the number of cities served by the service.

Keywords: intelligent mobility, micromobility, electric scooters, structural equation modeling.

1. Introduction

Transport is one of the basic needs of any individual. It allows people to experience the possibilities that life in society offers, such as going to work, school, and walking. Even though it is recognized as necessary, mobility has its disadvantages, emphasizing urban environments that demand different yet complementary transport options.

In this context, electric scooters appear part of a micromobility market (Brunner et al., 2018), a trend of diversification of urban transport that includes a variety of small vehicles for individual users to travel short distances (McKenzie, 2019).

The growth in the use of electric scooters, as a new vision of transport for large cities, comes when the world demands the development of new technologies for the transport sector. In Brazil, this also occurred in the main metropolises from 2018, as is São Paulo's case.

In this way, micromobility has become a very popular movement, leading specialized companies that invested in the segment in São Paulo due to the high population density; strong penetration of mobile telephony; public transport and underdeveloped infrastructure; and the presence of an ecosystem, culture and friendly climate for the use of these services (Gössling, 2020).

In this sense, few studies have examined the usage patterns of shared electric scooters, although the literature is growing (Bai and Jiao, 2020; Caspi et al., 2020; Hardt & Bogenberger, 2019). In general, use is considered more flexible than bicycles, as they do not require physical effort or specific skills (Fitt & Curl, 2020). The emerging literature on electric scooters seeks to understand user behavior and what drives them to continue using this service.

This article expands the scope of studying a user group from acceptance in the continuance intention (Cheng et al., 2015) of e-scooters, analyzing a series of factors that influence among them trust (Lai, 2015), perceived usefulness (Wang et al., 2018), confirmation and satisfaction. Perceived cost (Chong, 2013) was used as a moderating variable to verify whether it would affect the behavior between the construct satisfaction about the continuance intention using e-scooters. Therefore, this article aims to understand the impact of shared economy services of electric scooters on micromobility in the city of São Paulo, based on the proposal of a theoretical model that seeks to analyze antecedent factors of continuance intention.

2. Theoretical Background, Research Model and Hypothesis

2.1 Smart Mobility
Smart mobility is one of the dimensions of smart cities that address accessibility, international and local, modern and sustainable transport systems, and the availability of resources provided by information and communication technology (Giffinger et al., 2007; Stolfi & Alba, 2014). In this dimension, the important initiatives identified by Dewalska-Opitek (2014) are

- reduction in congestion levels resulting from the promotion of efficient and low-cost public transport,
- commercialization of transport services through mobile devices (electronic tickets, applications for smartphones, among others), and
- reducing the negative impacts of transport on citizens' lives.

In this sense, mobility is seen as one of the critical and critical services of smart cities. There are countless social and economic challenges resulting from its growing demand and the impacts arising from the use of space and the environment. Thus, it is possible to understand that initiatives related to smart mobility in urban centers are an alternative to improving citizens' quality of life and smart cities' sustainability (Caragliu et al., 2011; Batty et al., 2012).

In this context, alternatives should be sought to the modes of transport already routinely used, such as buses, trains, and subways, including self-propelled vehicles, for example, bicycles and scooters. It must be done considering the different types of special needs and integrating all areas of the city. Logistics in smart cities must be designed to prioritize the public, ecological, and efficient transport, which meets the demands of the internal population and external. Also, they make connections with other areas around them and promote greater social inclusion (Zygiaris, 2013) and connect neighborhoods and cities. In this study, mobility is a crucial factor, as the shared electric scooter service is a relatively recent technology that is still developing. Citizens are adapting to this new way of individual locomotion and the main benefit, in addition to those focused on the environment and technology, is the collective awareness (Giffinger et al., 2007). Information and Communication Technologies (ICTs) tools can optimize access to public transport to be fast, safe, and sustainable (Batty et al., 2012). The information must be passed on to citizens in real-time, making mobility efficient.

2.2 Micromobility and Electric Scooter Services in São Paulo

The integration of information and communication technologies in everyday life through different devices and interactive systems is called ubiquitous computing or environmental intelligence. In this model, the user has a variety of devices at his disposal, including the smartphone, that facilitate his access to information in a simplified and immediate way.

In this sense, the emergence of applications that suggest an inflection in the travel modalities themselves, as is the case with electric scooter rental services, act directly in the micromobility (Brunner et al., 2018; Gössling, 2020), being used for short routes. This model is based on digital location technologies, inserted in the most complex communicational and informational context, marked by the diffusion of applications, and characterized by mobility, portability, and connectivity.

In 2019, many companies, whether in rental or application sharing and equipment sales, invested in the electric scooter segment. This study focused efforts on rental and sharing services through an application.

The city of São Paulo, with a population of 12.33 million inhabitants, is representative for this research because it has road infrastructure projects and transportation services, generating urban mobility that justifies its classification as the most intelligent city in Brazil in the ranking Connected Smart Cities from Urban Systems (Urban Systems, 2020) and in 42nd position worldwide by the Global Power City Index (GPCI Index 2020). However, when analyzed by the IESE Cities in Motion Index (2020), in the classification of Mobility and Transport, it appears only in 126th position among the main smart cities.

Electric scooter services in the city of São Paulo increased considerably in 2019. This event highlights the changes that are taking place in the means of transportation in the urban centers of the capitals, a fact that is explained by the change in the behavior of citizens. Changes in urban centers are part of the term smart city, a theme that several authors are studying and increasingly gaining visibility in academic and political circles. It addresses the adverse effects of urban growth (Mahbub et al., 2011).

Brazilian legislation adapting to this new transport model, with Law No. 13,640, of March 26, 2018, changed the wording of Article 4, item X, of Law No. 12,587, of January 3, 2012, now considering individual private paid passenger transport that performed through digital platforms, using a geolocation system. In addition to Artificial Intelligence and Big Data (data from users that are available to the company, allowing greater market control through the surveillance system) (Brazil, 2012). Companies that operate in the sector work with a "lease agreement" with their users, with payment for the transport time.

Table 1 shows the market for electric scooters that worked in the city of São Paulo in 2019. This refers to a process of connectivity on digital platforms that fits within a perspective of 'smart city', whose techno communicational. Techno-informational is explained, in turn, by the ubiquity and environmental intelligence, at the same time that the urban geography of the localities is considered as a central element in the process.

The city of São Paulo was a pioneer in regulation in Brazil, after publishing Decree nº 58.750, of May 13, 2019, which required companies to do a previous accreditation to operate in the activity of sharing electric scooters through an application, after also, the accreditation at the Municipal Mobility and Transport Secretariat (São Paulo, 2019).

At the national level, the Bill of Law (PL) seeks, among others, to eliminate the impasse that exists today between several Brazilian cities that use self-propelled vehicles, such as electric scooters, when establishing decrees that deal with the matter differently. PL 4135/2019 alters the Brazilian Traffic Code (CTB) and also the National Urban Mobility Policy (PNMU) and aims to regulate the service for sharing personal self-propelled equipment in order to allow harmonious coexistence with other vehicles and pedestrians (Brazil, 2019).

Company	Logo	Historic
Yellow		Originally a Brazilian company, it was founded in 2017. In January 2019, after the merger with Grin, it was renamed Grow Mobility (the largest company in the Latin American continent).
Grin		Originally a Mexican company, it was founded in 2018. In July 2020, Grow Mobility filed for bankruptcy to avoid bankruptcy due to the context of the Covid-19 pandemic.
Scoo		100% Brazilian company, founded in 2018, Scoo operated, among others, in technological innovation projects and was responsible for creating the first Brazilian application for the rental of shared electric scooters.
Lime		Lime was founded in 2017 in the United States. The American operator, which had Uber as one of the investors, stayed in Brazil for only six months.

Table 1: Electric Scooters Market in the city of São Paulo in 2019

The challenges of these companies do not stop there, as they need, among others, to deal with the imprudence and/or malpractice of their users, which ends up resulting in fines by the inspection bodies and, also, the need to hire personal accident insurance and liability.

2.3. Research model and hypotheses

For the construction of the research model - presented in Figure 3 - applications of models for accepting the use of technology were analyzed to understand behavioral interactions of e-scooters, concentrating efforts on using the models of Cheng et al. (2015), Chong (2013), Lai (2015) and Wang et al. (2018). Other references were also incorporated in the literature review to support the constructs that make up the model.

2.3.1 Confirmation

The Expectation Confirmation Model (ECM), adaptable to the service area, proposes that an individual's intention to continue using a technology depends on three variables: the level of user satisfaction with the technology, the degree of confirmation of the user expectations, and post-adoption expectations, in the form of perceived usefulness. Thus, the confirmation construct can be understood in this research as the initial expectations about the electric scooter services being confirmed during its use (Bhattacherjee, 2001). Before using a service, the user develops expectations about it. After using it, the user has experiences and develops perceptions about its performance, and this results in the confirmation or disconfirmation of the expectations that existed before use. In turn, the level of trust and user satisfaction with the application service is determined by this confirmation (Chong, 2013; Yuan et al., 2014).

Given that the experience of using the service would confirm or not the expectation, users are led to update their post-adoption beliefs, corroborated by the technology acceptance models (Davis, 1989), and the level of confirmation will also have an influence direct at perceived usefulness (Wang et al., 2018). Based on these studies, adapted to the use of electric scooters, the following hypotheses are presented:

       H1a: Confirmation positively affects trust.
       H1b: Confirmation positively affects satisfaction.
       H1c: Confirmation positively affects perceived usefulness.

2.3.2 Trust

Trust is a determining factor about economic activities, as it influences users' decision-making when hiring a service, causing it to be shaped by rational assessments involving the cost-benefit ratio. Lai (2015) investigated the factors that affect consumers' intention to use an intelligent bicycle sharing system, employing a technology acceptance model (TAM) adapted to the trust construct - consequently - relating it to the perceived usefulness. Besides, it is admitted that one of the consequences of trust is satisfaction (Chong, 2013). Trust is a determining factor as an antecedent of continuance intention in the use of electric scooters (Chong, 2013; Lai, 2015). This allows the elaboration of the following hypotheses:

H2a: Trust positively affects satisfaction.
H2b: Trust positively affects perceived usefulness.
H2c: Trust positively affects continuance intention.

2.3.3 Satisfaction

Satisfaction refers to a general assessment of an information or service system, reflecting a response based on emotion or assessment (Bhattacherjee, 2001; Lam et al., 2004; Kim, 2010). In this way, satisfaction has been understood as an essential element in changing the attitude based on experience. According to Yuan et al. (2014), there are numerous studies related to continuance intention that understand that satisfaction is an essential factor determining it. The electric scooters continuance intention is expected to be positively determined by user satisfaction. Therefore, the following hypothesis is formulated:

H3: Satisfaction positively affects continuance intention.

2.3.4 Perceived Usefulness

Perceived usefulness refers to the extent to which a consumer thinks that using a sharing service is useful for achieving goals, such as reducing travel expenses, increasing travel experience and convenience, reducing greenhouse gas emissions and energy consumption and mitigate traffic that generates congestion (Wang et al., 2018). When consumers are deciding whether to use innovative technology, they are more willing to try it if it is easy to use and beneficial for a purpose that is advantageous and, above all, that can bring Satisfaction (Park et al., 2014; Chong, 2013). In many studies applied in different contexts, perceived usefulness is positively associated with continuance intention (Cheng & Huang 2013; Chong, 2013; Park et al. 2014; Dong et al., 2017; Wang et al., 2018). Thus, based on the same logic, in the context of using electric scooter services, the following hypotheses are proposed:

H4a: Perceived Usefulness positively affects satisfaction.
H4b: Perceived Usefulness positively affects continuance intention.

2.3.5 Perceived Cost

In this study, perceived cost can be understood as the value that consumers of electric scooters expect to incur to evaluate, obtain, use, and dispose of a product or service per kilometer traveled. In their study, Wei et al. (2009) found that cost is among the main factors that affect decisions to adopt a service. Because of the above, we sought to analyze perceived cost as a moderating variable to see if there is an impact on the direct relationship between satisfaction and continuance intention, considering that several public news reports indicated that costs were higher than other modes, depending on, for example, of companies having to pass on operating costs to users due to regulation, short equipment life, taxation on scooter imports, among others (Balago, 2021). Thus, the following hypothesis is formulated:

H5: Satisfaction negatively affects continuance intention when it is moderated by perceived cost.

2.3.6 Continuance Intention

Bhattacherjee (2001) suggested that continuance intention is used when consumers are committed to spending maximum efforts to continue the relationship with a given product or service (Cheng et al., 2015). It is also possible to observe the consumer's effect when using a specific company regularly (Jambulingam, Kathuria & Nevin, 2011). In other words, the continuance intention of a relationship is a fundamental result of the relational effort between companies and consumers, as it plays a central role in the service delivery process. Therefore, in this study, continuance intention is related so that users of electric scooters can maintain the service's credibility as a means of integration with the micromobility transport system in the city.

3. Method

In this research, a survey was used to collect data, and the method for selecting respondents was convenience sampling, which is a non-probabilistic technique (Malhotra, 2014). In all, 215 people participated in the survey. However, after data purification (identifying multivariate outliers using Mahalanobis distance), the valid sample was represented by 190 users of electric scooters who were approached in this survey in various public places across the city of São Paulo, among them: parks, main circulation avenues and in partner companies. Thus, an attempt was made to identify a diversified sample with multiple service users in public spaces (Gössling, 2020).

About the research instrument, it was divided into three sections: sociodemographic information, perception about the use of electric scooters in São Paulo, and a psychometric scale that had 19 items for measurement that were designed to understand the research model developed, organized on a Likert scale with endpoints anchored at 1=strongly disagree and 5=strongly agree for all statements. It is worth noting that, before conducting the research, a pre-test was carried out with 25 individuals to verify the effectiveness of the elaborated research instrument. After this stage, the research was carried out personally by the researchers involved with the individuals to collect the data necessary to test the hypotheses.

In the phase of analysis of sociodemographic data, we sought to incorporate questions to cover aspects of using the e-scooters. Multivariate data analysis was also used through structural equation modeling, with partial least squares estimation (PLS-SEM). The moderating effect was analyzed using the PROCESS v.3.4 macro (Hayes, 2017).

4. Analysis and Discussion of Results

4.1 Analysis of the structural model

The largest group of respondents are men, n=114/60%, and are between 26 and 35 years old, n =96/50.5%. The normality of the data was verified by the Kolmogorov-Smirnov test (K-S) and the respective p value of each variable. This procedure was necessary to limit the possibility of using some statistical analysis techniques that have the normal distribution of data as a characteristic. All individual p-values of the K-S test referring to the indicators were "very significant" with $p < .001$ (Hair, Hult & Ringle, 2016). Regarding the predictor variables related to the latent variable "continuance intention", it was possible to accommodate multicollinearity in the model - all values of the Variance Inflation Factors (VIFs) were below 5, with the lowest being TR3=1.149, and the largest, SAT4=2.644.

After the first interaction, the results of the factor load obtained by the variables were presented and it was possible to verify that only two variables, SAT3 and PU3 had to be excluded to

adjust the model. After the adjustment, the convergent validity was verified, which demonstrates the extent to which the latent variable correlates with the items chosen to measure that variable, and the discriminant validity that involved the correlation between the constructs of the research model were accommodated (Table 3).

The analysis of the measurement model must precede the analysis of the relationships between the constructs or latent variables. The next step was to examine the measurement model (Table 2), which involved: Composite Reliability (CR), Average Variance Extracted (AVE), determination coefficients (R^2) (Hair, Hult & Ringle, 2016).

Construct	Convergent Validity			Discriminant Validity				
	CR	AVE	Items	(1)	(2)	(3)	(4)	(5)
(1) Confirmation	.842	.641	3	*.801*				
(2) Continuance Intention	.824	.611	3	.583	*.782*			
(3) Perceived Usefulness	.862	.611	4	.714	.565	*.782*		
(4) Satisfaction	.921	.795	3	.783	.553	.742	*.892*	
(5) Trust	.771	.532	3	.630	.522	.649	.713	*.729*

Table 2: Convergent and discriminant validity

The CR coefficients indicated high internal consistency of the scales used, as well as the AVEs (Chin, 1998) to indicate the existence of convergent validity. The R² value measures the predictive accuracy of the model, which demonstrated that in this study the model has an accuracy and predictive relevance in all constructs (Satisfaction=.722; Perceived usefulness=.575; Trust=.397 and Continuance intention=.375). In line with the previously presented validities, the SRMR=.083 indicated adjustment in the model after confirmatory factor analysis (AFC).

In the practical application of the structural equation modeling for the Proposed Theoretical Model - Figure 1 -, the measurements performed, individually for each construct, are observed, seeking to verify its internal and external validity and consistency, as well as the results obtained in its paths and hypotheses.

When analyzing the formulated hypotheses is observed that all paths were accepted within the cut-off point of p<.05 for the significance. When individually analyzing the direct relationships proposed in the model, it is possible to observe that the Confirmation construct paths as antecedent had the highest β (all p<.001). In other words, this is explained by being an antecedent construct that, according to Bhattacherjje (2001), demonstrates that the individual understands that the electric scooter service is useful. Its benefits were perceived as part of diversifying the possibility of getting around the city. over short distances (McKenzie, 2019). Among others, more speed and relieving mass public transport that today is no longer able to cope with the existing demand, especially during business hours.

The **H₁ₐ** with the path "Confirmation → Trust" (β =.630; p<.001) was the one with the most significant effect. This is probably because people see electric scooters as a micromobility tool with the potential, among others, to reduce congestion levels in the city, which negatively impact citizens' quality of life (Dewalska-Opitek, 2014), in addition to contributing to the environment as it is a self-propelled vehicle that uses renewable energy to be able to circulate (Giffinger et al., 2007). This indicates that people understand that the shared electric scooter service is reliable and will meet their initial expectations (Yuan, 2014) satisfactorily. Likewise, the paths "Confirmation → Perceived Usefulness" (β=.505; p<.001) and "Confirmation →

Satisfaction" (β=.421; p<.001), respectively **H₁b** and **H₁c,** brought indications that when the adoption occurred in the city, many individuals showed interest in being a "novelty", but there were also expectations regarding its use and the potential to improve mobility as an advantage of urban mobility, in addition to serving the purpose of leisure on weekends, thus showing that confirmation has a significant influence on variables after the adoption of electric scooters (Chong, 2013).
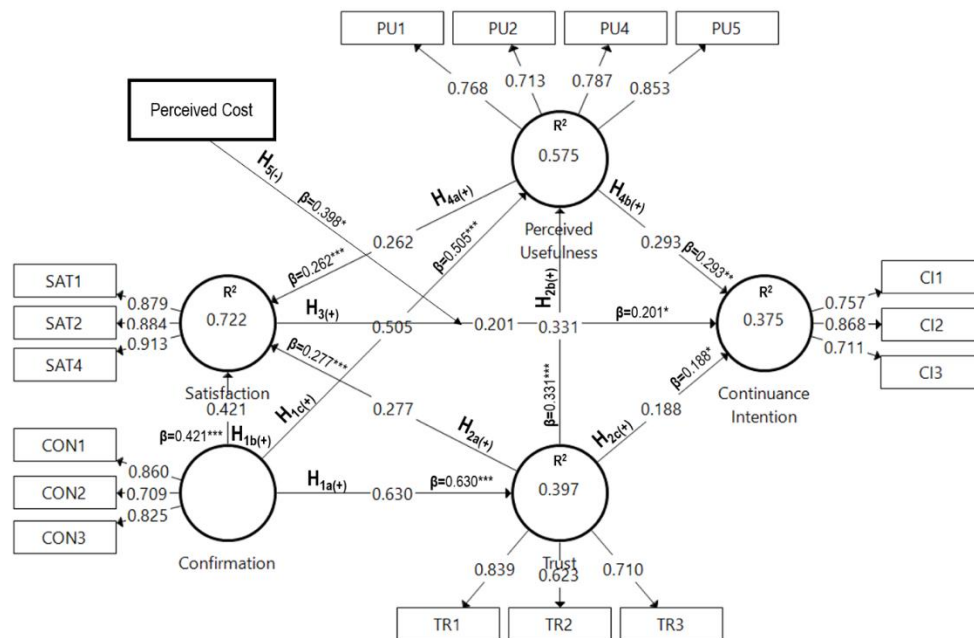

Figure 1: Proposed Theoretical Model
Note: Significance: * p <0.05; ** p <0.01; *** p <0.001.

On the other hand, **H₃** represented by the causal relationship "Satisfaction → Continuance Intention" (β=.201; p<.043), despite being accepted, was the one that presented a level of significance closer to the cutoff point (p<.05) and this indicates that, despite the expectations of consumers of this service, the level of Satisfaction in relation to Continuance Intention tends to decrease. This can be explained by the initiative of the agents responsible for handling the matter, which legislate excessively to regulate the use and offer of this type of service. Which has resulted, among others, in a high number of fines for companies, for example, due to the mandatory use of a helmet, to walk on the sidewalks and to exceed the speed limit (Brazil, 2019), responsible agents had no option but to pass on the part of these costs to users, which raised the service price (Balago, 2021).

Other aspects also constituted challenges and affected this shared business model, for example, equipment vandalism. In several situations, the user was faced with damaged and inoperable equipment, conflict, and/or accidents between users of electric scooters and pedestrians or with users of other vehicles. Showing an evident difficulty in establishing a harmonious coexistence between the different existing subjects; slow evolution of infrastructure aimed at micromobility expressed, for example, by the irregularity of the pavements (holes and/or lack of adequate signage) and debris in the cycle paths and cycle lanes. Therefore, even if they have Continuance Intention due to the positive aspects they see in this type of service, Satisfaction ends up being affected by the factors mentioned. As it results from the general assessment of electric scooters' shared service, affecting the decision to repurchase the service (Kim, 2010; Chong, 2013).

H5 was proposed to understand whether the electric scooter service's perceived cost would be a moderating variable for the Satisfaction and Continuance Intention relationship. Still, this moderation allows a better understanding of **H3**.

The analysis of moderation involving **H5** (response variable [Continuance Intention]; predictive variable [Satisfaction]; and moderator [Perceived Cost]), was developed using the macro-PROCESS v3.5. The graph indicates that when the cost perception rises above 3.634 - indicated by the Johnson-Neyman (JN) region of significance, and high satisfaction users tend to maintain the Continuance Intention. Despite the slight drop for the low satisfaction group, users who belong to the low satisfaction group reduce the continuance intention of use of electric scooters. This is explained by an R^2=.418 of the Continuance Intention with a negative effect on the perceived cost (β=-. 917, SE=.243, 95% CI [-1.397; -.437], p<.001) and Negative effect of satisfaction (β=-1,182, SE=.569, 95% CI [.0392; -2,306], p=.003).

It is noteworthy that, probably, users who already had low Satisfaction, when exposed to the reality of costs, after a period of initial euphoria, tend over time to reduce interest. On the other hand, for those who showed high Satisfaction, there is a tendency to continue using the service despite the slight drop. It should be noted that, in addition to cost, other inhibiting aspects of use must be considered, such as the safety of users. From the point of view of equipment quality and public safety, it is an aspect beyond the control of companies. It is a matter of public management, an essential element to improve a smart city's mobility and transport indicators.

5. Conclusions

The study's focus falls on its general objective, which was to understand the impact of shared economy services of electric scooters on micromobility in the city of São Paulo, based on the proposal of a theoretical model that sought to analyze antecedent factors of Continuance Intention.

The results obtained in the analysis of the significance of the paths indicated that all the hypotheses were supported in their formulations and the moderation, Perceived Cost, which measured the effect of Satisfaction on Continuance Intention. The fit of the model - the coefficient of determination of the dependent variable Continuance Intention - was R^2=.375 (37.5%), indicating an acceptable result considering the discussions presented in the analysis and discussion the results.

The path traced by the city of São Paulo in search of alternatives that, among others, guarantee social welfare, protection of the environment, and the development of the market in a balanced way, brought the need to face legal issues in several branches. However, in the context of urban mobility, more specifically of micromobility, the city still faces numerous challenges, mainly to create a harmonious coexistence between the different actors, as is the case with electric scooters.

The slow evolution of micromobility in the country has caused self-propelled vehicle sharing companies to leave or restrict the number of cities served by the service. These challenges are not only faced by Brazil but also by other countries.

In this context, the technology for sharing electric scooters through digital platforms has become a worldwide reality. It has attracted many national and international companies that have started to provide the service. On the other hand, the crisis's main reasons were greater regulation, increased competition, decreased profit margins, and a constant need to update products. With the Covid-19 pandemic, most sharing services were paralyzed, and the collapse

of this business model was present. The social isolation and the new prevention rules imposed by the pandemic inhibited the contracting of the service, impacting the sector at that time and doubting whether this business model will make sense in the future for São Paulo.

5.1 Practical and Social Implications

The article argues that electric scooters can be characterized as a radical micromobility innovation, with the potential to challenge the existing mobility system in cities. Moreover, the dynamic growth of micromobility presents itself in a favorable way for implementing this type of technology.

On the other hand, electric scooters compete for pedestrians, cyclists, and motorized transport, adding complexity to the transport systems. Therefore, it is often divided on its suitability, and there is uncertainty about the appropriate rules and policies. In this sense, to regulate this new form of micromobility, many cities adopt ad hoc policies, sometimes incurring substantial fines for operators or users or even seizure of equipment from those who do not comply with current rules (Gössling, 2020).

Public managers must be aware of the forms of social and cultural resistance that citizens can transmit as a result of living with electric scooter services and infrastructure and technical challenges. From a theoretical point of view, the main barriers to electric scooter systems have focused on the lack of charging infrastructure, reduced subjective safety for other traffic participants, adverse weather conditions, or limited luggage transport capacity (Hardt & Bogenberger, 2019).

Thus, the implementation of mobility applications and the presence of electric scooters in the urban space unthinkable a few years ago makes us question the extent to which these digital technologies and services encourage. Thus, the use of new modes of transportation around the city, contributing to the occupation and redefinition of urban space.

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20. Pequenos Negócios e Inclusão no Pós-Covid-19 Desafios de nova plataforma em Ecossistema em Rede

Rodrigo Rubens da Silva
FGV EAESP
rodrigorubens@newroad.com.br

RESUMO

Dentre inúmeros efeitos nocivos, a pandemia do Covid-19 demonstrou sua face cruel também quanto à sobrevivência das pequenas e médias empresas (PMEs) brasileiras. Para lidar com o isolamento social, tecnologias digitais precisaram ser rapidamente assimiladas por gestores de empresas cuja estrutura tecnológica muitas vezes era embrionária ou mesmo inexistente. De forma emergencial, uma importante instituição representativa do comércio varejista de um estado brasileiro, para digitalizar as vendas das mais de 35.000 empresas associadas, optou pelo desenvolvimento de negócio digital organizando-o na forma de um ecossistema em rede. O projeto do marketplace regional, sem fins econômicos e com relevantes incentivos para lojistas concorreria, porém, em segmento dominado por grandes grupos. Este estudo aprofunda-se na aplicação de estratégias orientadas à estruturação de negócios no modelo de ecossistema em rede, usando evidências qualitativas coletadas em entrevistas com executivos da instituição, realizadas à luz de teorias de economia da informação e ecossistemas de mercados. Seguindo o modelo de negócios para organizações em rede, foi estruturado projeto de marketplace, identificando características para formulação estratégica. O estudo complementa literatura que tem apresentado exemplos de aplicação do modelo a grandes companhias de tecnologia e indica alternativas gerenciais para fomentar a digitalização de PMEs de países em desenvolvimento.

Keywords: Digital Transformation, SMEs, Marketplace, Network Ecosystem, Business Model.

1. Introdução

Expostos à maior crise de saúde do século, gestores têm sido desafiados a realizar com celeridade a digitalização em seus negócios, em direção ao efervescente, processo de transformação digital. Para lidar com o distanciamento físico, estão à disposição tecnologias digitais cujos benefícios têm o potencial de habilitar a empresa na descoberta de novos meios para a criação de valor (Vial, 2019). Porém, assimilá-las mostra-se um desafio constante.

A retração no consumo, ocasionada pela pandemia, fez de abril de 2020 o mês com pior resultado do varejo brasileiro em dez anos (IBGE, 2020a). Até julho, a crise promoveu o encerramento de 486,1 pequenas e médias empresas (PMEs) (IBGE, 2020b). Em março de 2021, o país contava com 14,3 milhões de desempregados, 2,5 milhões a mais, em comparação ao mesmo período do ano anterior, antes de medidas de *lockdown* (IBGE, 2020c). O efeito da pandemia sobre as PMEs pode influenciar a própria economia do país, uma vez que o segmento representa em geral 90% das empresas e gera 70% dos empregos nas economias emergentes (WorldBank, 2020). No Brasil, são 17,2 milhões os pequenos negócios, que contribuem com 27% do Produto Interno Bruto brasileiro e empregam 22,3 milhões de pessoas, cuja massa salarial movimenta 46,7 trilhões de reais (Data Sebrae, 2021).

Enquanto acelerava a mortalidade de PMEs, o *lockdown* ampliava o consumo digital de bens, levando o *e-commerce* brasileiro ao recorde histórico de faturamento no primeiro semestre de

2020, atingindo 38,8 bilhões de reais, com 90,8 milhões de pedidos e 7,3 milhões de novos compradores. Desse total, 78% de todos os pedidos digitais aconteceram em *marketplaces* (64 milhões), gerando 30 bilhões de reais, 56% maior do que em 2019. (Ebit Nielsen, 2020). No Brasil, o segmento é dominado por grandes grupos, como a empresa mais valiosa da América Latina, Mercado Livre (CNN Brasil, 2020); da B2W, responsável por Submarino, Americanas.com e Shoptime (B2W, 2021); da Via Varejo, das plataformas Casas Bahia, Ponto Frio e Extra (Via Varejo, 2021); da Magazine Luíza, da plataforma homônima e Netshoes (Magazine Luiza, 2021).

Dado o impacto positivo do modelo *marketplace* como canal de venda no pós-Covid-19, este estudo parte da premissa de que a bem sucedida implantação de um novo negócio digital, genuinamente destinado a favorecer a competitividade de PMEs pode impactar positivamente a realidade de países em desenvolvimento. O estudo complementa literatura que apresenta exemplos de estruturação de negócios no modelo de ecossistema em rede, voltado a grandes companhias de tecnologia, mas que pouco indica sua aplicação às PMEs de países em desenvolvimento. O trabalho visa responder à seguinte pergunta: Como deve ser estruturado o modelo de negócios de um novo *marketplace* genuinamente destinado a potencializar as vendas de PMEs de um estado brasileiro? A seguir, o artigo apresenta revisão de literatura, estratégia metodológica, contexto, desafios, proposta de solução e contribuições iniciais da pesquisa.

2. Revisão de Literatura
Esta seção apresenta uma visão geral de alguns dos principais conceitos relacionados à economia da informação e ecossistema de mercados, que servirão de bases teóricas para o estudo e favorecerão compreensão do desafio e proposição de solução posteriormente apresentadas.

2.1. Ecossistemas em Rede
A definição dos ecossistemas focados em mercados traz a percepção quanto à criação e adição de valor sobre os bens comercializados e podem ser organizados em Ecossistema em *Pipeline* e Ecossistema em Rede. O primeiro tipo, representa modelo predominante no último século, com cadeia de valor linear, bem definida e cujo valor unitário é agregado pelos participantes ao longo do processo (Sambamurthhy & Zmud, 2017).

O segundo tipo tem crescido nas últimas década, fomentado por tecnologias digitais. Nele, o valor produzido e consumido é trazido de forma unificada pelo orquestrador de redes, que cria e administra o ambiente do mercado e a natureza das transações, mas não determina os valores praticados e tampouco tem propriedade sobre os itens comercializados (Sambamurthhy & Zmud, 2017). Como exemplo pode ser citado o *marketplace*, plataforma intermediária que facilita a descoberta de mercado, lida com transações e fornecem infraestruturas institucionais (Bakos, 1998). Em essência, o Ecossistema em Rede envolve mercado de dois (*two-sided market*) ou mais lados (*multi-sided market*), que realizam troca de valores por meio de uma *market platform,* hospeda conteúdo e funcionalidades e estabelece, opera e administra o mercado do ecossistema (Tan et al, 2015).

2.2. Efeitos de Rede
A literatura sinaliza a existências de efeitos que acontecem nos negócios em rede e podem se referir ao valor gerado para um participante a partir da adesão à plataforma por outro participante (Tan et al, 2015). Se o valor percebido é aumentado, são entendidos como efeitos positivos e se o valor é reduzido, entende-se como negativos. Tais efeitos, ocorrem entre

membros da comunidade dispostos do mesmo lado da rede, (*same-side effect*) ou entre participantes de lados opostos (*cross-side effects*) (Sambamurthhy & Zmud, 2017).

Observa-se ainda o fenômeno de *aprisionamento,* que ocorre quando o usuário investe suficientemente em ativos no consumo, de forma que o *custo de troca* para um concorrente seja alto, o mantendo aprisionado. E ainda, o movimento de *feedback que* tem forte influência no crescimento e solidificação das redes, fazendo as redes amplamente maiores quando positivo, ou impedindo o seu crescimento, quando negativo (Shapiro & Varian, 1999).

2.3. Modelos de Negócios para Ecossistemas em Rede

Um modelo de negócios consiste em arquitetura pela qual uma companhia cria e entrega valor para seus clientes. Os mecanismos empregados para captura e compartilhamento de valor envolve uma série de fluxos, custos, receitas e lucratividade (Teece, 2018). No contexto de um Ecossistema em Rede, a múltipla existência de participantes, disposta em diferentes lados, expõe desafio ao orquestrador que, no intuito de fomentar o ecossistema, deve criar e envolver propostas de valor atrativas para cada comunidade participante. Além disso, uma vez identificados as características da rede, deve otimizar os efeitos positivos e minimizar os efeitos negativos. Neste contexto, a complexidade de orquestração da rede cresce, conforme o número de lados que ela possui (Sambamurthhy & Zmud, 2017).

Dadas as peculiaridades do Ecossistemas em Rede, os autores Sambamurthhy e ZMud (2017) propõem a existência de Modelo de Negócios específico para essas organizações que deve levar em consideração a entrega de valor e modelos de lucratividade, por meio de capacidades dinâmicas e capacidades centrais. O modelo considera: Número de Comunidades participantes da rede; Proposta de Valor para as comunidades; Definição de Modelos de Receita para as comunidades; Capacidades Centrais oferecidas pela rede à comunidade; e Capacidades Dinâmicas, consistindo em habilidade para detecção, apreensão e transformação para projetar e implementar um modelo de negócios (Sambamurthhy & Zmud, 2017, Teece, 2018). A Figura 01 demonstra modelo de organização de Negócios em Ecossistema em Rede.
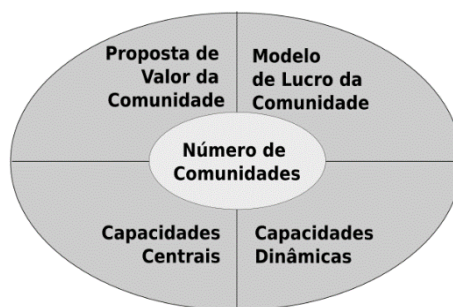

Figura 01: Modelo de Negócios para Ecossistema em Rede
(Fonte: Adaptada de Sambamurthhy & Zmud, 2017)

3. Estratégia Metodológica

Este estudo tem natureza exploratória e visa aplicar a teoria de Modelo de Negócios para Organizações em Ecossistema em Rede, proposto por Sambamurthhy e Zmud (2017) em novo negócio digital da Federação da Câmara de Dirigentes Lojistas do estado Espírito Santo (FCDL-ES). Seguindo a configuração proposta pelos autores, o propósito é configurar o modelo de negócio de empreendimento digital para fomento à digitalização de PMEs sediadas no estado brasileiro de Espírito Santo. Para isso, a pesquisa utiliza método qualitativo a fim de

explorar processos e características da instituição e do projeto para que possam ser aplicáveis à teoria.

Foram realizadas coleta de dados a partir de entrevistas semiestruturadas realizadas em grupo com 05 executivos da diretoria da FCDL-ES, responsáveis pela região metropolitana mais populosa do estado composta pelos municípios, Vitória, Vila Velha, Serra, Cariacica e Guarapari. Somados os municípios têm juntos 1.643.732 de habitantes, 40,5% da população do estado (IBGE,2021d), e são sede de 224.080 empresas, 54% de todas empresas do estado, das quais 93% são PMEs (DataSebrae, 2021).

As entrevistas foram realizadas em 04 encontros presenciais de aproximadamente 3 horas cada, realizadas entre julho e dezembro de 2020. Os roteiros para entrevistas foram previamente desenvolvidos baseados na determinação de critérios descritos por Sambamurthy & Zmud (2017) para análise de plataformas em Ecossistema em Rede. Com base nessas características, as entrevistas foram conduzidas, visando mapeá-las para construção de modelo de negócio da FCDL-ES. Complementarmente às entrevistas, a pesquisa contou com análise de dados secundários, envolvendo informações de fontes múltiplas, disponibilizadas pela instituição, tais como perfis, porte, segmento e geolocalização dos associados.

4. Contexto Câmaras de Dirigentes Lojistas

As Federações das Câmaras de Dirigentes Lojistas (FCDLs) são entidades de classe do setor varejista, presentes nas 27 unidades federativas brasileiras (FCDL-ES, 2021). Sem fins lucrativos e com representação em âmbito estadual, respondem à Confederação Nacional de Dirigentes Lojistas (CNDL), maior entidade representativa do comércio lojista nacional (CNDL, 2021), que também é responsável pelo Serviço de Proteção ao Crédito (SPC), o maior banco de dados sobre crédito da América Latina (SPC Brasil, 2021).

Orientada ao fomento de estratégias para melhoria do comércio local, a FCDL do estado brasileiro Espírito Santo (FCDL-ES) presenciou prejuízo da pandemia sobre a maioria de suas cerca de 35.000 PMEs associadas. A fim de favorecer a digitalização de canal de venda de seus lojistas, a instituição optou pelo desenvolvimento de plataforma de *e-commerce*, organizada em modelo *marketplace,* visando facilitar a digitalização de seus associados.

5. Desafio e Proposta de Solução

Apesar da ampla disponibilidade de ferramentas tecnológicas para digitalização dos canais de comunicação e venda, executivos da FCDL-ES identificam que a maioria das PMEs associadas não adotam estratégias *omnichannel*, seja por falta de familiaridade, infraestrutura embrionária, indisponibilidade de recursos, ou pelo alto percentual cobrado por plataformas de *marketplace* existentes. A inércia quanto à abertura de novos canais, reduziu abruptamente o faturamento das empresas durante o *lockdown*, implicando na ameaça à sobrevivência.

O Marketplace da FCDL-ES agrega diferenciais claros para entrada de lojistas, tais como estrutura de suporte integral aos lojistas e menor percentual para transação, possível graças a incentivos fiscais da concepção jurídica de Instituição Sem Fins Econômicos (Planalto, 2021). Os recursos mostram-se como capacidade dinâmica, permitindo e capacitando ao direcionamento de recursos junto a parceiros, para fomento negócios de alto retorno (Teece, 2018). Considerando a alta base de dados instalada, com aproximadamente 35.000 associados, e a volume de clientes por eles atendidos, o negócio digital da FCDL-ES conta com potencial vantagem de favorecer o *feedback* positivo, ao passo que grande redes são mais vantajosas à atratividade de novos membros (Shapiro & Varian, 1999).

No entanto, a *multi-sided platform* proposta deve considerar proposta de valor destinadas a todos os lados da rede, sobretudo aos que são diretamente relacionadas ao *core* do ecossistema, na troca de valores. No *marketplace* da FCDL-ES, identifica-se que essas são as redes de lojistas e de potenciais clientes. A Figura 02 apresenta a composição da rede proposta, contemplando as comunidades participantes e principais diferenciais propostos para cada uma delas.
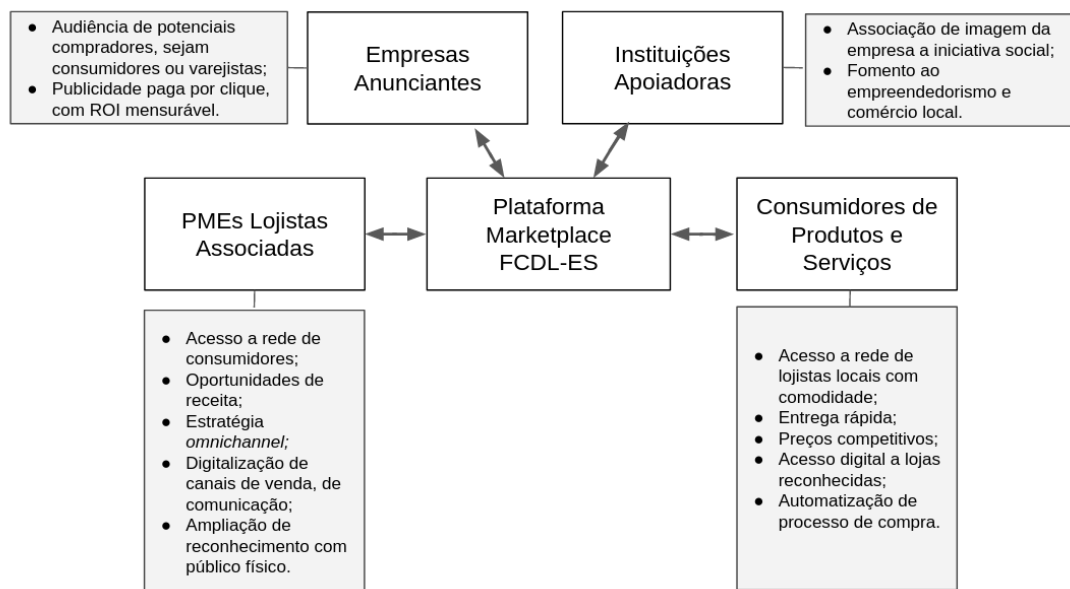

Figura 02: Ecossistema em Rede da Plataforma FCDL-ES
(Fonte: Autoria própria adaptada de Sambamurthhy & Zmud, 2017)

6. Contribuições iniciais

A emancipação e solidificação de novos negócios organizados em Ecossistemas em Rede, fomentados por tecnologias digitais tem nos últimos anos motivado estudiosos a analisarem suas características e particularidades. O Modelo de Negócios para Ecossistema em Rede define critérios a serem estruturados para planejamento de negócio, no intuito de favorecer a competitividade (Sambamurthhy & Zmud, 2017). Ele apresenta a relevância da adoção propostas de valor únicas para os participantes da rede, além de definir capacidades centrais e capacidades dinâmicas.

Este estudo aplica o modelo a um novo empreendimento digital, desenvolvido pela principal instituição representativa de empresas varejistas de um estado brasileiro, cujos associados em sua maioria absoluta são PMEs fortemente impactadas pela pandemia de Covid-19. Mais do que conter os efeitos prejudiciais decorrentes do isolamento social, acredita-se que a digitalização de canais pode promover impacto positivo no desempenho de tais empresas, contribuindo ainda para melhorias na realidade social da região. Além de melhorar a compreensão geral sobre a utilização do modelo, este trabalho apresenta sua aplicabilidade à realidade de *marketplaces* regionais, o que pode servir de base para gestores públicos e privados que pretendam realizar projeto digital com fim social em mercados em desenvolvimento.

Nesta pesquisa foi utilizada, exclusivamente, a experiência executivos das instituições para formulação estratégica. Não foram validadas a aceitação de tais propostas de valor junto às

comunidades participantes da *market platform,* o que limita a pesquisa. Nesse sentido, são adequados estudos futuros que analisem a percepção de potenciais participantes das comunidades do ecossistema de multi lados. O estudo ainda é restrito a um único relato técnico e pode ser aprimorado por estudos que complementem a aplicação de modelo de negócios para Ecossistema em Rede para outros empreendimentos.

Esta pesquisa também pode servir de base para estudos futuros que, por meio de coleta de dados longitudinais, avaliem a melhoria na performance empresarial das empresas impactadas pelo desenvolvimento de *marketplace*, estruturado segundo modelo proposto por Sambamurthhy e Zmud (2017). Em consonância à compreensão de importância socioeconômica das PMEs em países em desenvolvimento, ressalta-se ainda a oportunidade de estudos que analisem efeitos de melhoria na realidade social de região sede das empresas impactadas pela digitalização dos canais, por meio do *marketplace*.

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21. Startups, SMEs and Institutional Arrangements in the Internet of Things Innovation Ecosystem in Brazil

Amarolinda Zanela Klein
Unisinos University
aczanela@unisinos.br

Abstract

Startups and Small and Medium Enterprises (SMEs), despite their importance to the local economy, generally have limited resources and face significant barriers to innovate and grow, such as lack of access to knowledge, human resources, and efficient forms of financing. This paper reports preliminary results of a research project that aims to analyze the institutional arrangements in the Brazilian Internet of Things (IoT) innovation ecosystem and how these arrangements support the innovation by startups and SMEs. The research method is a longitudinal case study. The preliminary research results show the main groups of actors and resources involved in the IoT innovation ecosystem in Brazil. The results also suggest that the institutional arrangements in this ecosystem usually favors the big players; several controversies exist regarding key elements of the institutional pillars elements related to the IoT development in the country. Besides, the knowledge diffusion about the IoT and its potential is still needed.

Keywords: Internet of Things, Innovation Ecosystem, Institutional Theory, Startups and SMEs

1. Introduction

The IoT is a technological platform that allows for countless innovations in products, services, and processes (Barrett et al., 2015; Ben-Daya et al., 2019; Borgia, 2014; Gubbi et al., 2013). It can be applied in the most varied domains, including manufacturing, smart cities, healthcare, agriculture, smart housing, logistics, education, and tourism, among others. (Borgia, 2014). The IoT is also a key technology for the development of Industry 4.0, the new industrial paradigm in which the integration of manufacturing processes and connected products can help companies to achieve higher industrial performance (Dalenogare et al., 2018).

Therefore, creating an innovation ecosystem for the development of innovations based on the IoT is fundamental for the competitiveness of countries around the world (Vermesan & Friess, 2014). The term innovation ecosystem uses a biological metaphor that defines an emerging, self-organizing and self-sustaining system (Thompson et al., 2018). It is defined here as the evolving set of actors, activities, and artifacts, and the institutions and relations that are important for the innovative performance of an actor or a population of actors (Granstrand & Holgersson, 2020:1). An innovation ecosystem is analogous to an organizational field because it has its own institutional arrangements, including its institutional actors (and respective roles), institutional logics, and governance structures (Autio & Thomas, 2014).

The institutional arrangements in an IoT innovation ecosystem should promote the development of all its members, not only large but also small and medium-sized local companies (SME) and startups. Emerging technologies do not necessarily create economic value; they need to be leveraged and exploited by entrepreneurs (Steininger, 2019). In this sense, contextual knowledge from local entrepreneurs is essential to develop innovations based on the IoT considering some of its capabilities, for example, context awareness and

customization (Atzori et al., 2010; Borgia, 2014). These capabilities can be exploited by local SMEs, smaller and more agile, and also by startups.

However, despite their importance to the local economy, startups and SMEs generally have limited resources. They face significant growth barriers, including lack of access to knowledge, human resources, and efficient forms of financing (Steininger, 2019). When seeking to take advantage of innovation opportunities based on new technologies, these smaller companies often fail to succeed in the "institutional game" (North, 1992), following the same rules of the big players.

Considering this context, this paper addresses the following research question: *to what extent does an emerging IoT innovation ecosystem develop institutional arrangements to promote innovation by startups and SMEs, supporting these companies' development*? The research adopts the Institutional Theory (Dimaggio & Powell, 1983; Meyer, 2017; Scott, 2014, 2017) as a theoretical lens that considers the political process as critical to the performance of economies and explains "inefficient" markets. This theoretical lens assumes that institutions and the way they evolve define economies' performance over time (North, 1992). The institutional perspective is prolific to study digital innovation and transformation, examining how organizations gain social approval and interplay with existing institutional arrangements (Hinings et al., 2018).

Therefore, this research takes part in the effort to overcome the following knowledge gaps and research opportunities: (a) to better understand the link between IS/ICT and entrepreneurship (Steininger, 2019); (b) digital innovations require building institutional infrastructures linking different actors in the innovation ecosystem - how this happens in the world of digital innovation is a significant area of research (Hinings et al., 2018); (c) little is known about the relational, cultural, and contextual factors that help explain why some ecosystems develop in ways that support entrepreneurial opportunities while others do not (Thompson et al., 2018); (d) the need of studying ICT innovation and institutionalization at the field level, a level of analysis that is critical for institutional theory (Hinings et al., 2018; Mignerat & Rivard, 2016). Several scholars have suggested that any analysis of innovation and entrepreneurship in an ecosystem should include understanding institutions and institutionalization (Ritala et al., 2018). Besides, the IoT is a strategic issue for any country's development, not only in economic terms but also in its potential use to effectively manage natural resources and public services provision (Vermesan & Friess, 2014). Therefore, the research theme is relevant when addressing a fundamental issue: how the IoT development process can promote local innovation and entrepreneurship.

2. **Institutional arrangements**

Recent studies have addressed the importance of institutional arrangements to create innovation ecosystems; they enable coordination between actors of the ecosystem and have regulative, normative, and cognitive functions related to value creation (Langley et al., 2021). In this sense, institutions are "regulative, normative and cultural-cognitive elements that, together with associated activities and resources, provide stability and meaning to social life" (Scott, 2014:56). Institutions comprise durable (formal or informal) practices, rules, standards, and roles that organizations and individuals must follow (Bruton et al., 2010; Hampel et al., 2017). They generate pressures that force organizations to adopt similar practices or structures to gain legitimacy and support (Dimaggio & Powell, 1983; Seo & Creed, 2002). According to Institutional Theory, institutions are the "rules of the game", while organizations are the "players" - including political bodies, economic agents, and educational agents (North, 1992).

In the field of organizational studies, we can identify institutional pillars (Scott, 2014) that deserve analysis to understand the institutional arrangements in the context of innovation ecosystems:

- Regulative Pillar - include regulations and laws that guide organizational actions and perspectives, such as coercion or threat of governmental sanctions.
- Normative Pillar - The normative aspects of institutions include practical rules, occupational standards, and educational curricula. Its ability to guide organizational actions and beliefs stems largely from social obligations.
- Cultural/Cognitive Pillar - it includes symbols, words, signs, gestures, cultural rules (formal or informal), and structures through which meaning is created. These institutional aspects form a basis of culturally supported legitimacy, which often become taken-for-granted.

In the "institutional game" organizations are continually looking for legitimacy, which corresponds to the right to exist and perform an activity in a certain way (Bruton et al., 2010; Suchman, 1995). An organization is legitimate when its activities are perceived as desirable and appropriate within a system of norms, values, beliefs, and definitions (Suchman, 1995). Established organizations can use their performance record to acquire legitimacy and access resources. In contrast, a new venture (such as startups) or small enterprises cannot easily do so due to their limited or non-existent records (Bruton et al., 2010). Therefore, institutional arrangements and changes must be made to increase the legitimacy of smaller and new ventures and, consequently, their access to resources to innovate.

Considering the institutional pillars, we can identify three types of legitimacy (Bruton et al., 2010): (a) *regulative:* occurs when laws and regulations recognize and help to safeguard the right of the organization to exist and operate in a certain way; (c) *normative:* concerns whether the organization's activities are proper and consistent with influential groups and societal norms; (b) *Cultural/cognitive:* Involves the congruence between the organization and its cultural environment.

The innovations based on the IoT bring new possibilities to develop products, services, and innovative business models, affecting competition in several industries (Langley et al., 2021; M. Porter & Heppelmann, 2014). It may demand changes in current institutions or the creation of new institutions to legitimize and include the new solutions and new entrants that conduct these innovations, especially startups and SMEs. The continuous interaction between institutions and organizations in the economic/competitive setting is the key to institutional change (North, 1992).

One concept that helps us to understand how the human agency shapes institutional changes is the concept of institutional work (Lawrence et al., 2009). This concept describes individual and collective actors' practices that aim to create, maintain or disrupt institutions (Lawrence & Suddaby, 2006). The actors work to interpret, translate, transpose, edit and recombine institutions. These actions lead to unintended adaptations, mutations and other institutional consequences (Lawrence et al., 2011). There are several forms of institutional work, such as: creating normative associations, educating, constructing identities, undermining assumptions and beliefs, among several others (Lawrence & Suddaby, 2006). The actors' institutional work is either "*visible"* (documented) or "invisible". The invisible work includes undocumented work to recruit allies, find resources, negotiate with stakeholders, run experiments, design and test symbols, and coordinate strategies for action (Canales, 2016).

Several institutional studies have documented the ability of actors, particularly those with key

strategic resources and power, to impact on the evolution of institutions and fields (Lawrence & Suddaby, 2006). Therefore, we can consider that the IoT innovation ecosystem's required institutional changes tend to favor big and powerful players. This is justified because, according to North, (2016: 75): "Institutions are not necessarily or, generally, created to be socially efficient; on the contrary, they, or at least the formal rules, are created to serve the interests of those with bargaining power to create new rules". Thus, this research aims to understand these mechanisms and to suggest actions that can be taken so that institutional changes in the IoT innovation ecosystem can confer legitimacy and facilitate access to resources for startups and SMEs and not only favor big companies and technology major providers.

Considering these critical concepts of Institutional Theory (institutional pillars and institutional work), we present the following research propositions and conceptual model of research in Figure 1.
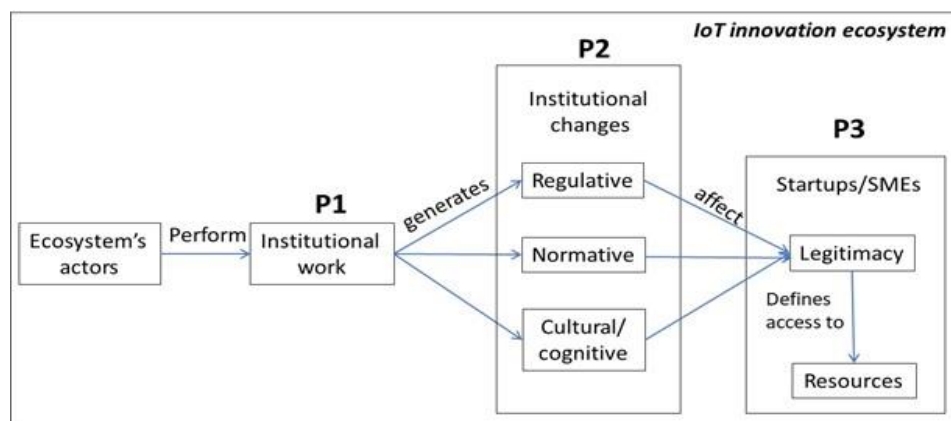

Figure 1. Research framework and propositions

Proposition 1: *Different actors involved in the IoT innovation ecosystem perform different forms of institutional work.* With proposition one, we aim to understand the different types of actors and institutional work (Lawrence et al., 2011; Lawrence & Suddaby, 2006) they perform in the ecosystem and how it affects startups and SMEs' performance. The institutional work performed by different actors can generate changes in the institutional pillars (Scott, 2014): in the regulative pillar (for example, in laws and rules of action), normative (for example, in technological norms and standards), and cultural/cognitive (for example, understanding of technology, its application, and consequences, cultural openness to IoT-based innovations, among others).

Proposition 2: *The institutional work of the different actors leads to regulative, normative, and cultural/cognitive changes that shape the IoT ecosystem.* With proposition 2, we aim to understand the different types of institutional changes and how they affect startups and SMEs' performance in the IoT innovation ecosystem.

Proposition 3: *Institutional changes in the IoT innovation ecosystem affect the legitimacy of startups and SMEs, which, in turn, influences their access to resources to innovate.* Organizational success depends on factors other than technical efficiency; organizations gain legitimacy and needed resources by adjusting themselves to their institutional environments (Seo & Creed, 2002). As already mentioned, nascent and small companies generally have difficulty obtaining legitimacy because they often lack records about their performance history (Bruton et al., 2010). That is why it is necessary to have institutional arrangements to help them build their legitimacy.

3. **Method**

To test and discuss the research propositions, we have been conducting a case study (Eisenhardt, 1989; Flyvbjerg, 2006) in the Brazilian IoT innovation ecosystem. The research is longitudinal (2016-2023); in this paper, we analyze data from 2016 to 2019. It is fundamental because Institutional Theory suggests that institutional changes extend over considerable periods (Hinings et al., 2018). Studying the Brazilian case is adequate to the research goals because emerging markets are characterized by greater informality and less developed government and regulatory infrastructures, educational systems, and financial markets (Canales, 2016; Marquis & Raynard, 2015). Brazil has one of the highest entrepreneurship indexes in the world but, at the same time, one of the worst business environments in the world – e.g., excess of bureaucracy, lack of necessary infrastructure, lack of governmental incentives, many different taxes over businesses (Bosma et al., 2020). Therefore, its institutional environment, as a whole, is particularly adverse for innovation and entrepreneurship, frequently demanding institutional changes to support them.

We collected data through interviews with actors directly involved in defining public policies, technologies and promoting innovation with the use of IoT in Brazil from different entities. We also studied five SMEs and startups that offer innovative products and services based on the IoT from different sectors. In addition to interviews with the main entrepreneurs in these businesses, documents, photos, and videos about the companies' solutions were also accessed. Table 1 presents the details of data collection by interviews. In Table 1, the names of the companies (1 to 5) have been omitted to preserve their anonymity. The position of the interviewees is not informed for the same reason. Four of the companies' interviewees are CEOs and one is a Sales Director. In the other organizations, the interviewees occupy management or senior positions in technical areas, with direct involvement in initiatives related to the development of the IoT at the national level. The interviews were performed from November 2017 until June 2019, face to face or via Skype, and lasted one hour on average (15 hours in total).

ID	Organization	Type
E1	Company 1 - smart public lighting system	SME
E2	Company 2	Startup
E3	Company 3	Startup
E4	Company 4	SME
E5	Company 5	Startup
E6	CPQD	Technology Institute
E7	ABII	Brazilian Association of Industrial Internet
E8	MDIC	Ministry of Industry, Commerce Exterior, and Services
E9	BNDES	National Development Bank
E10	ABINEE	Brazilian electrical and electronics industry association
E11	BPM Consulting Company	Helps companies to implement IoT-based solutions

Table 1: Interviews' details

In addition to the interviews, we collected data at various events related to the development of the IoT and industry 4.0 in Brazil, with approximately 50 hours of participation. At these events, several actors, such as government representatives, companies, universities, research institutes, and industry associations, discussed the actions to develop the IoT ecosystem. Data were collected via a field diary since noisy environments did not allow adequate audio recording during the events. We also collected and analyzed 178 documents created by different actors. One of the main sets was the documents related to the study for generating the

Brazilian national IoT plan. Industry reports, newspapers and magazines, articles, and videos were also collected.

The primary technique adopted in the data analysis was data-driven (inductive) coding (Saldaña, 2009; DeCuir-Gunby et al., 2011). Initially, 136 categories were generated. The content coded in these categories went through a rereading, organization, and grouping of similar categories. From this second reading and understanding of the data, 119 categories were reached, 8 of which are main categories, and the others are secondary. After the codification process, which made it possible to synthesize the main results, a second round of analysis has been carried out, linking the results with the central concepts of the Institutional Theory (the three institutional pillars and the types of institutional work). We present some preliminary results of the analysis next.

4. Preliminary Research Results

4.1 The IoT innovation ecosystem in Brazil

An innovation ecosystem consists of interdependent actors such as firms, governmental and non-governmental organizations (NGOs), and other types of resource providers (Scaringella & Radziwon, 2018). In Figure 2 we present the main types of actors involved in the IoT innovation ecosystem in Brazil and their main relationships, highlighting the SMEs and startups, which are the organizations focused on this research. Only the main direct, indirect, and mutual influences (according to the data collected) are represented to facilitate understanding. In Figure 2, the main types of actors are shown in rectangles. Each group of actors is associated with a type of resource (represented by ellipses) that is essential for companies to innovate based on the IoT. The IoT is highlighted in the center of the figure, comprising a set of related technologies like sensors, networks, devices, applications, among others (Borgia, 2014). The IoT innovation ecosystem is historically connected with the Brazilian National Innovation System (Lundvall, 2016); it is immersed in the country's business environment.

The primary resources for the generation of IoT-based innovations identified were:

- *Qualified human resources, knowledge, and technology* – these are combined resources, as qualified people generate and apply the necessary knowledge for the creation and use of technology.
- *Financial resources* – a crucial factor for innovation and companies' sustainability, especially SMEs and startups in their initial stages.
- *Telecommunications infrastructure* – IoT-based solutions are dependent on that infrastructure. For this reason, telecommunications companies are represented as separate business actors in Figure 2 because they play a strategic role concerning this resource. Consequently, they have significant economic power, being able to pressure, albeit indirectly, the legislation, regulations, and certifications regarding telecommunications.
- *Legislation, regulation, certifications* - these intertwined elements are fundamental for developing innovations based on the IoT, especially those involving certifications of wireless telecommunication devices and hardware quality approvals, and sensitive issues related to IoT applications, such as security and privacy of personal data. Different actors influence these elements directly and indirectly. Although technology changes and evolves quickly, these elements do not change at the same speed.
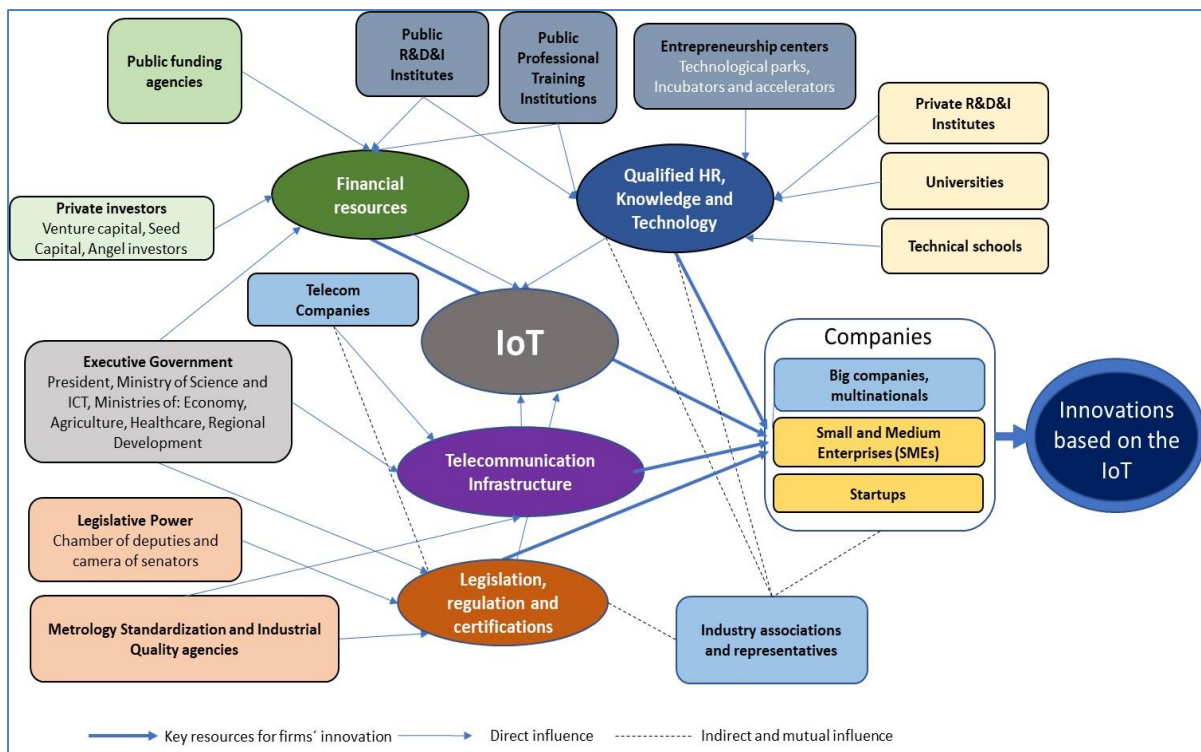
Figure 2: IoT innovation ecosystem in Brazil – main actors, resources, and relationships

Different actors provide each one of the key resources. Mainly, public funding agencies, the executive government, and private investors provide IoT innovation projects´ funds. Public R&D&I institutes also support these projects with public funds. Public professional training institutions, universities, and professional schools provide training for people, technologies (technical and managerial), laboratories, and specialized technicians to help companies develop their IoT innovation projects. Qualified HR, technology, and knowledge are also provided by entrepreneurship centers (tech parks, incubators, accelerators). Private R&D&I institutes stand out in partnerships with industry to develop IoT-based innovations. The trinomial legislation-regulation-certifications are developed under the executive branch's influence, the legislative branch and metrology standardization, and industrial quality agencies. Business associations represent companies (especially big companies) and seek to influence, albeit indirectly, access to various resources, spread knowledge, establish partnerships in R&D&I projects, and support innovation.

Since our research focuses on SMEs and startups in the IoT ecosystem, we show summarized data from the five different companies studied to an overview of how these companies have been innovating with the use of the IoT in the Brazilian context (Table 2).

As shown in Table 2, the innovations generated by the five companies surveyed have several characteristics in common, despite targeting different market segments and clients. The first is the development of "smart products" (Porter & Heppelmann, 2014), based on the IoT technologies: sensors, microprocessors, and actuators, Wi-Fi, cloud computing (Borgia, 2014). All the companies offer applications for accessing data services by the end-user, based on the concept of big data, selling data services associated with their hardware. This is aligned with the concept of servitization, which is common in business models based on the IoT (Frank et al., 2019; Klein et al., 2017). Innovations generated by the companies are innovations in goods and services (hardware plus software) at the local and national levels (firm's market) but not at the global level (OECD/Eurostat, 2018). These firms compete by locally providing simpler

and, in some cases, cheaper solutions, especially via customized projects, based on their knowledge of the local business context. However, the process of innovating both in hardware and in software is complex and, fundamentally, all of them are companies dependent on a high level of technical knowledge.

Company	Solution/value proposition
Company 1 - smart public lighting system	A device attached to lamps, which makes them "smart", connected to a public lighting management software (web/app); a gateway that manages a wireless communication network, to which several IoT devices for smart cities can be connected. The lighting management system monitors, controls, and collects data, allows the lighting scheduling, monitoring, and dimming of lamps. It can serve as an IoT platform, providing other tracking and geo-referencing services.
Company 2 - System for monitoring temperature	An IoT platform solution (SaaS model), with a gateway and temperature sensors, connected via Wi-Fi to the Internet. The solution monitors the temperature of counters, freezers, cold rooms, and greenhouses, sending data to the user via an app. It provides dashboards and alerts by email or Telegram and generates information for presentation to the sanitary inspection. The solution prevents product losses due to inadequate temperatures and reduces errors of manual temperature readings.
Company 3 – Smartcards/ smart readers	Smart card readers and writers for electronic transactions and payment means, with a touch display version for data entry, plus a security solution for industrial IoT networks, with customization.
Company 4 - IoT-based manufacturing automation systems	Smart devices (SaaS model) capable of collecting data and operating various manufacturing equipment safely over the Internet, as well as monitoring the industrial environment (capture of temperature data, humidity, noise levels, light, and CO2 levels) - a gateway of industrial IoT. It allows SMEs and large companies to become smart, data-driven factories.
Company 5 - Smart lighting systems - Home	Smart switches and sockets connected to the Internet via Wi-Fi, allowing monitoring and remote control via a smartphone app. It allows home automation without construction work/breaking walls, generating comfort in the home environment.

Table 2: Examples of IoT-based innovations developed by SMEs and startups

4.2 Key institutional changes and institutional work in the ecosystem

First, regarding the regulative pillar (Scott, 2014), one of the main institutional changes was the creation of the national IoT plan, led by The Ministry of Science, Technology, and Innovation (MCTIC), in partnership with the national development bank (BNDES). They started creating the plan in 2016, based on a broad study, and the plan was made official through decree #9,854, from June 2019. This plan is the main guide for public policies for the development of IoT in Brazil. The decree defined IoT priority application sectors: (1) healthcare, (2) smart cities, (3) manufacturing, and (4) agriculture. It also defined strategic themes linked to the IoT: science, technology, and innovation; international insertion; education and professional training; connectivity and interoperability infrastructure; regulation, security and privacy; and economic viability.

As registered in the study documents for the national plan generation, several actors were heard in its creation via public consultations on the MCTIC website and a series of public events. However, evidence was found that most of the participants in these consultations were industry associations, large companies, especially foreign multinationals, technological institutes, universities, and specialists concentrated in the country's more developed areas (especially the Southeast and Midwest). There was low participation of smaller companies and a lack of representation from all regions of the country. As stated by most interviewees, traditionally, the R&D&I initiatives and innovation public policies in Brazil favor big companies and organizations. Therefore, a first step would be to consider SMEs, startups, and other civil

society groups at the beginning of the process of policies and legislation creation, with greater transparency in these processes.

The national IoT plan guides public funding. In this sense, the lack of funds to innovate affects the SMEs and startups researched. These smaller companies mentioned their difficulties in obtaining public funding, mostly due to the excess of bureaucracy and the guarantees and counterparts demanded. For example: *"For us, it has been difficult to use the BNDES* [national development bank] *because they always ask for guarantees, which is something that I, a startup, do not have. It cannot be one of the partners to take the loan too, so a third party will need to guarantee a loan, even if it is a very good investment in innovation. There are excellent credit lines at BNDES, but we cannot access them, and this is a difficulty that we have"* (E3, Company 3). For example, a public funding program was launched in June 2018 by BNDES called "IoT pilots". However, only technological institutes or universities could submit projects in this program. Although they could include SMEs and startups in their projects' teams (which was encouraged by the BNDES), the values of the demanded counterparts from these companies to their participation were high, making it difficult for them to engage in partnerships with the leading organizations.

Regarding the regulative pillar, a controversy was identified in the research data: the "Create legislation" x "Reduce legislation" debate. On the one hand, there are arguments to "create legislation". Different actors argue that changes and additions to the legislation are needed to contemplate technological advances of the IoT and guarantee fundamental aspects such as access, security, and data privacy. New legislation should also favor developments in telecommunications services, reducing costs, especially the high tax burden, and increasing access to the wireless spectrum to expand networks throughout the national territory. Another aspect highlighted is that the legislation increasingly needs to promote the purchase of solutions based on IoT by the government. It was pointed out by the companies researched and is corroborated by several other actors in the IoT ecosystem. However, on the other side of the controversy is the argument of "reducing legislation". Several actors reinforce that legislation and regulation should be reduced and minimized to avoid hindering the "freedom of the market" to create IoT-based innovations.

Regarding the normative pillar (Scott, 2014), the work performed by the public and private R&D&I institutes – especially the later - technical schools, universities, training institutions and entrepreneurship centers has been essential to generate knowledge that qualified people apply in the development of IoT-based innovations. They also provide normative guidance to professional roles and standards related to the IoT and Industry 4.0 advancements. They also work to propagate the entrepreneurship culture in the country, a role strongly performed by tech parks, incubators and accelerators. Industry associations (such as ABII – Brazilian Association of Industrial Internet) also influence the roles and standards and the culture of innovation among their associates. However, the majority of them are big companies.

A controversy was identified in the normative pillar: the "Open standards" x "Market standards". In this controversy, several actors argue that open standards should be prioritized to democratize access to technology, facilitate systems interoperability, and be preferred when purchasing IoT solutions, especially in purchases by the government and public agencies. One initiative linked to this is the Dojot Platform (http://www.dojot.com.br/), an IoT development open platform whose creation was led by the CPQD (a private telecommunications R&D&I Institute, one of the biggest in Latin America). However, on the other side of the controversy, other actors defend free competition and the choice of the most advanced standards, but not necessarily open. They also defend not to favor local solutions but standards defined by the

global market.

Finally, regarding the cultural/cognitive pillar (Scott, 2014), a barrier for the development of innovations based on the IoT is the lack of knowledge, in the country, about the IoT and Industry 4.0. Since the IoT and the industry 4.0 involves knowledge not of only one, but of diverse connected technologies, several actors commented that there is a lack of knowledge not only about the technologies involved but about the business opportunities, especially concerning new business models, value propositions and return on investment for innovations based on the IoT. "*The problem with the IoT is not technological, but rather the lack of understanding and engagement by society to understand that the segment is important for the country's economic development*" (BNDES representative – Press Document).

Rocha et al. (2019) also pointed out the lack of existing knowledge about industry 4.0 in the country. Many companies fail to realize the value of new digital solutions and the competitive advantages they can offer. The institutional work of educating ("*educating actors in the skills and knowledge necessary to support the new institution*" - Lawrence & Suddaby, 2006:221) has been performed, for example, by organizations such as technical schools, R&D&I institutes and universities, but still they do not reach the majority of the companies and other innovative agents.

5. Final Remarks

The IoT is a strategic theme for any country's development (Vermesan & Fries, 2014). The emergence of the IoT and the new cyber-physical systems (Lee, 2008) challenges current institutions. Despite this new technological platform's generativity, institutional changes are necessary to support innovation based on it by SMEs and startups.

The preliminary research results analysis showed the main groups of actors and resources involved in the IoT innovation ecosystem in Brazil. The data we analyzed so far also suggests that: (1) the institutional arrangements in the IoT ecosystem in Brazil usually favors the big players; (2) several controversies exist regarding critical elements of the institutional pillars related to the IoT development in the country, and (3) the knowledge diffusion about the IoT and industry 4.0 and their potential is still needed.

As research limitations, more data needs to be collected and analyzed via the longitudinal case study. In this paper, only the main findings identified so far have been presented. The careful testing of the research propositions (Figure 1) is still pending. Future research needs to deepen the understanding of the institutional arrangements and institutional work needed to support IoT-based innovation by SMEs and startups in different settings, generating insights for concrete actions and public policies.

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22. Systematic Review of Methodological Approaches for Designing, Assessing and Validating Business Analytics Maturity Models

Wai Yip Freddy Wong
University of Southern Queensland,
Australia
u1065346@umail.usq.edu.au

Michael Lane
University of Southern Queensland,
Australia
Michael.Lane@usq.edu.au

Sophie Cockcroft
University of Southern Queensland, Australia
Sophie.Cockcroft@usq.edu.au

Abstract

Context: Applying maturity models to measure and evaluate Business Analytics (BA) in organisations is challenging. There is a lack of empirical studies on how BA maturity models are designed, assessed and validated to determine how BA contributes to business value.

Objective: To report on state of research on BA maturity models (BAMMs) and identify how BAMMs can be empirically (1) designed, (2) assessed and (3) validated.

Method: Systematic review of BA maturity model studies focuses on methodological approaches used in design, assessment and validation of BA maturity models.

Results: (1) A systematic review resulted in nine papers included for analysis. (2) Within these papers the dominant methodological design approaches for maturity models are Rasch analysis and set theory; (3) assessment approaches are Cluster, Additive Logic, Minimum Constraints using Statistical Squared Distance and Euclidian Distance; and (4) validation approaches are variance techniques using regression, correlation coefficients with tests for statistical significance against self-reported maturity, perceived benefits or performance.

Conclusion: This research contributes to a deeper understanding of how BAMMs can be designed, assessed and validated in a rigorous manner. Future research should involve more empirical studies that demonstrate the validity and usefulness of BAMMs in contributing to business value.

Keywords: Business Analytics, Maturity Model Design, Maturity Model Assessment, Maturity Model Validation, Systematic Literature Review.

1. Introduction

Business intelligence (BI) became a popular term in business and IT communities in the 1990s (H. Chen, Chiang, & Storey, 2012). In the late 2000s, business analytics (BA) was introduced to represent the key analytical component in BI. BA refers to the extensive use of data, statistical, and quantitative analysis, explanatory and predictive models, and fact-based management to drive decisions and actions (Davenport & Harris, 2007). Business intelligence (BI) can be defined as a set of processes and technologies that convert data into meaningful and useful information for business purposes. While some believe that BI is a broad subject that encompasses analytics, business analytics, and information systems (Bartlett, 2013). There are many debates on whether the concept of business analytics (BA) is a subset of BI (Davenport & Harris, 2007) or an advanced discipline within the concept of BI (Laursen, 2010).

In this research, business analytics is viewed as a study of business data using statistical techniques and programming for creating decision support and insights for achieving business goals (Schniederjans, Schniederjans, & Starkey, 2014). Business analytics (BA) can be defined as a process beginning with business-related data collection and consisting of sequential application of descriptive, predictive, and prescriptive analytic components, the outcomes support evidence based decision-making and improved organisational performance (Schniederjans et al., 2014). BA systems involve the use of BA capabilities and technologies to collect, transform, analyse and interpret data to support decision-making (Cosic, Shanks, & Maynard, 2012). Prior empirical studies of BA maturity models (BAMMs) focus on technological and operational aspects. Maturity models (MMs) are a widely accepted instrument for systematically documenting and guiding development and transformation of organisations based on best or common practices (Paulk, Curtis, Chrissis, & Weber, 1993). However, there is relatively little research that considers the methodological approach to designing, assessing and validating of BAMMs. With the increasing diversity and number of published research on MMs, it is necessary to categorise and analyse this field of research in a systematic way (Wendler, 2012). This will enable the construction of an appropriate and methodologically rigorous approach to design, assessment and validation of BAMMs. In this research we undertook a systematic literature review in relation to MMs, BIMMs and more specifically BAMMs to report on the state of research on BAMMs and identify how BAMMs can be empirically (1) designed, (2) assessed and (3) validated.

2. Method

A systematic literature review (SLR) is a means of evaluating and interpreting all available research relevant to a research hypothesis, topic, or phenomenon of particular interest (EBSE, 2007). The following steps were adapted from guidelines for performing SLRs by EBSE (2007) and applied as a procedure to systematically search and select the relevant studies in this research:

1. Define research objective and hypotheses.
2. Define the search string; identify inclusion and exclusion criteria.
3. Conduct initial search.
4. Review the title, abstract, and keywords of the initially retrieved studies.
5. Revise inclusion and exclusion criteria; select potentially relevant studies.
6. Remove duplicate studies.
7. Review potentially relevant studies selected; discuss any issues.
8. Review the entire content of initially selected studies (including the references section to identify any potentially missing studies); identify relevant ones.
9. Review relevant studies selected; discuss any issues.
10. Identify the final set of relevant studies.

Science Direct is a database containing articles from about 1,500 journals in various disciplines. Google Scholar provides an easy way to broadly search for scholarly literature across many disciplines and sources. The search strings for specific terms used in this research are listed in Table 1. Figure 1 shows the refinement steps in the SLR procedure and resulting number of papers between January 2000 and December 2020.

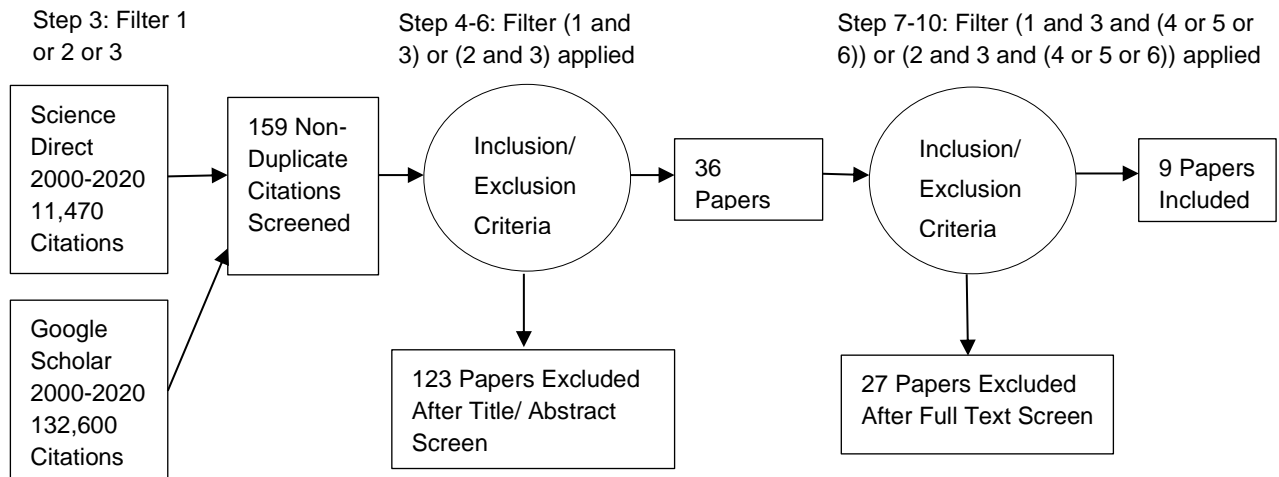| Filter	Term	Search strings
1	Business Intelligence	"business intelligence"
2	Business Analytics	"business analytics"
3	Maturity Model	"maturity model"
4	Design	"design" or "develop" or "create"
5	Assess	"assess" or "measure" or "evaluate"
6	Validate	"validate" or "validation"

Table 1: Search strings for specific terms

Figure 1: The refinement steps in the SLR procedure and resulting number of papers

The papers relevant to the design, assessment and validation of Business Analytics Maturity Models (BAMMs) were downloaded with abstract and results stored in Endnote. These papers were read and removed if (1) not written in English, (2) keynote-related paper editorials, or (3) content did not belong to the field of BI, BA and maturity models. As a result, nine papers related to design, assessment and validation of maturity models were identified. These nine papers are sorted by ascending year of publication and summarised in Table 2. This shows that previous research assessed BI/BA maturity models in terms of characteristics of different types of maturity models, BI maturity models, BA maturity models, methodological approaches used for design, assessment and validation of maturity models, key results and findings of analysis of BI/BA maturity models.

Author(s) (Year)	Paper Title (abbreviated)*	Maturity Model	Design	Assessment	Validation	Summary
Becker, Knackstedt, and Pöppelbuß (2009)	Developing Maturity Models for IT Management	IT Management	Yes	Yes	Yes	• Documented maturity models to provide a consolidated procedure for theoretical development and evaluation of maturity models.
Lahrmann, Marx, Mettler, Winter, and Wortmann (2011)	Inductive design of MMs: applying the Rasch algorithm	BI	Yes	Yes	No	• Positive impacts on organisational performance could be derived financially and with business functions based on actionable outcomes from BI systems.
Lukman, Hackney, Popovič, Jaklič, and Irani (2011)	BI maturity: transitional context within Slovenia	BI	Yes	Yes	No	• BI maturity considered three segmentations and viewpoints: technological, business and information quality.
Cosic (2020); Cosic et al. (2012)	BA Capability Maturity and Development; BA Capability Maturity Model (BACMM)	BA	Yes	Yes	Yes	• Holistic view of sixteen BA capabilities of organization grouped in four capability areas: governance, culture, technology and people.
Raber, Wortmann, and Winter (2013a, 2013b)	Situational BI Maturity Models: An Exploratory Analysis; Towards The Measurement Of BI Maturity	BI	Yes	Yes	Yes	• Explored influence of contextual factors on evolution of BI maturity. • Assessed BI maturity using Rasch Analysis and then Hierarchical Clustering Analysis to determine difficulty and maturity level of each measurement item and related capability for each respondent on a standardised scale. • Then assigned measurement items into maturity levels.
Halper and Stodder (2014)	TDWI Analytics Maturity Model (AMM) Guide	BA	No	Yes	No	• Five stages: nascent, pre-adoption, early adoption, corporate adoption, and mature/ visionary. • An online assessment measures analytics maturity across five dimensions essential to derive value from analytics.
The Institute for Operations Research and the Management Sciences (2017)	INFORMS Analytics Maturity Model (AMM) User Guide	BA	No	Yes	No	• Online platform for organisation to perform self-assessment that analyses three critical organisational themes. • For each 12 factor questions, it calculates overall score, category and factor scores, determine scores are Beginning, Developing, or Advanced level.
Lasrado, Vatrapu, and Mukkamala (2017)	The influence of different quantitative methods on the design and assessment of maturity models	Social media	Yes	Yes	Yes	• Analysis of data set and maturity scores computed using five quantitative methods (Additive Logic, Variance Techniques, Cluster, Minimum Constraints, and Rasch Analysis), and compared sensitivity of measurement scale and maturity stages. • Relationship between social media maturity and business value were validated using SEM Partial Least Square (PLS) technique.
Ariyarathna and Peter (2019)	BAMMs: systematic review	BI and BA	No	No	No	• A systematic literature review of BAMMs for BI and BA. • No consensus in method of assessing maturity level.
International Institute for Analytics (n.d.)	Analytics Maturity Assessment (AMA)	BA	No	Yes	No	• Software-driven MM based on Five Stages of Analytics Maturity Framework Davenport and Harris (2007). • Also based on DELTA (Data, Enterprise, Leadership, Targets, and Analysts) Model by Davenport, Harris, and Morison (2010).

Table 2: Design, assessment and validation maturity models
(* Full reference details of papers listed accessible in References list)

2.1 Maturity Models

Table 2 above shows that most systematic literature reviews of maturity models give a very general description of the characteristics and classification of maturity models but do not provide technical details on how the methodological approaches used could be applied. The property, characteristics and references of MMs are summarised in Table 3. Wendler (2012) conducted a systematic mapping study which found that most publications deal with the development of maturity models in empirical studies, but there is a lack of theoretical and reflective publications that show how maturity models can be grounded in both theory and practice.

Property	Characteristics	References
Maturity levels	• Archetypal states of maturity of object assessed. • Each level should have set of distinct characteristics that are empirically testable.	Raber et al. (2013a)
Number of stages or levels	3 to 6, depending on model and purpose.	Raber et al. (2013a); Van Steenbergen, Bos, Brinkkemper, Van de Weerd, and Bekkers (2013)
Stage fixed or Continuous	• Continuous models allow scoring of characteristics at different levels. • Staged models require all elements of one distinct level are achieved.	Raber et al. (2013a); Van Steenbergen et al. (2013)
Maturity score	Use of numeric values for benchmarking purposes. Most common way of visualising is Spider cobweb design.	Raber et al. (2013a); Van Steenbergen et al. (2013)
Dimensions	• Also termed Benchmark variables, process areas, capability, and critical success factors. • Each dimension is characterised by measures such as practices, objects or activities at each maturity level.	Lasrado (2018); Menukhin, Mandungu, Shahgholian, and Mehandjiev (2019)
Sub-categories	Second level variables on which key dimensions depend.	Van Steenbergen et al. (2013)
Assessment Approach	• Qualitative assessments use descriptions • Quantitative use numeric measures.	Lasrado (2018); Menukhin et al. (2019)
Assessment method	• Self-assessment via surveys most widely adopted instrument. • Third-party assessment or certifications are other applied techniques assessed by certified experts.	Wendler (2012)

Table 3: Characteristics of Maturity Models (Adapted from Lasrado (2018); Menukhin et al. (2019))

2.2 Business Intelligence (BI) Maturity Models

BI Maturity Models listed in Table 2 are summarised in terms of focus, design, assessment and validation in Table 4.

Maturity Model	Focus	Design	Assessment	Validation	Source
BI	BI dimensions derived from existing literature, Dimensions: Strategy, Organisation/ Process, IT support	Quantitative bottom-up approach (Rasch Algorithm supported by cluster analysis used to derive maturity levels)	Questionnaire results; 51 companies; cross-industry	No information provided.	Lahrmann et al. (2011) [Academia]
BI	BI in Slovenia	Quantitative bottom-up approach (K-Means algorithm)	Questionnaire results; 131 companies; cross-industry	No information provided.	Lukman et al. (2011) [Academia]
BI	Dimensions: Strategy, Social System, Technical System, Quality, Use/Impact	Quantitative bottom-up approach (Rasch Algorithm supported by cluster analysis used to derive maturity levels)	Questionnaire results; 51 companies; cross-industry	Discussion of final model with three industry experts on comprehensiveness, self-assessment, potential BI roadmap	Raber et al. (2013a, 2013b) [Academia]

Table 4: Comparison of BI maturity models

2.3 Business Analytics (BA) Maturity Models

In turn, the BA Maturity Models listed in Table 2 are summarised in terms of focus, design, assessment and validation in Table 5. The majority of BA maturity models were developed by practitioners with no documentation on the foundations of the design of the BA maturity model. The model development process proposed by Cosic et al. (2012) is based on the construction approach by Becker et al. (2009) which shows that BA maturity models can be adapted from maturity models developed for other IT domains such as IT Management.

Maturity Model	Focus	Design	Assessment	Validation	Source
IT Management	Problem definition and comparison of existing maturity models based on transfer of structure or contents to new domains	Determination of development strategy; Iterative maturity model development	Delphi method and creativity techniques	Names a regular validation as necessary without describing the step in detail.	Becker et al. (2009) [Academia]
Business Analytics Capability Maturity Model (BACMM)	Assess BA initiatives within large-scale Australian organisations	The model development process is based on approach of Becker et al. (2009)	16 key capabilities that can be aggregated to provide a measure of maturity for each of the four high-level BA capabilities and finally an aggregated measure for the overall BA capability.	A Delphi study with an expert panel used to validate and refine BA Capability Framework constructs	Cosic (2020); Cosic et al. (2012) [Academia] based on the construction approach by Becker et al. (2009)
TDWI Analytics Maturity Model	Predictive analytics, social media/ text analytics, cloud computing, and big data analytics approaches	No information provided.	Assess enterprises' analytics capabilities	No information provided.	Halper and Stodder (2014) [Practitioner]
INFORMS Analytics Maturity Model	Benchmarking capabilities and identifying actions to improve the analytical maturity	No information provided.	Each dimension has a potential high score of 10 points.	No information provided.	The Institute for Operations Research and the Management Sciences (2017) [Practitioner]
International Institute for Analytics (IIA) Analytics Maturity Model	Optimizing performance by improving analytics capabilities	No information provided.	Analytics Maturity Assessment is evaluated against 33 unique competencies within five DELTA model categories.	No information provided.	International Institute for Analytics (n.d.) [Practitioner]

Table 5: BA maturity models with sources

The four BAMMs in Table 5 are compared in more detail based on purpose, origin, stages/levels, dimensions and assessment in Table 6 below. According to Becker et al. (2009), a maturity model is descriptive in purpose of use if it is applied for as-is assessments when the current capabilities of the organisation under investigation are assessed against given criteria. A maturity model is prescriptive in purpose of use, if it indicates how to identify desirable maturity levels and provides guidelines on improvement measures. Most practitioners' maturity models are prescriptive and use proprietary assessment methods and measurement items.

3. Methodological Approaches used in Design, Assessment and Validation of Maturity Models

Lasrado et al. (2017) explored the influence of different quantitative methods on the design and assessment of maturity models. The quantitative methods used in design, assessment and validation of maturity models are summarised by method, assumption and application in Table 7.

Maturity Model	Business Analytics Capability Maturity Model (BACMM)	TDWI Analytics Maturity Model	INFORMS Analytics Maturity Model	International Institute for Analytics (IIA) Analytics Maturity Model
Purpose	Descriptive	Prescriptive	Prescriptive	Prescriptive
Origin	Cosic (2020); Cosic et al. (2012) [Academia]	Halper and Stodder (2014) [Practitioner]	The Institute for Operations Research and the Management Sciences (2017) [Practitioner]	International Institute for Analytics (n.d.) [Practitioner]
Stages/ Levels	5 levels: Level 0 – Non-existent Level 1 – Initial Level 2 – Intermediate Level 3 – Advanced Level 4 – Optimised	5 stages: Nascent, Pre-adoption, Early Adoption, Corporate Adoption, Mature/ Visionary	3 levels: Beginning, Developing, Advanced	5 stages: Analytically impaired, Localized analytics, Analytical aspirations, Analytical companies, Analytical competitors
Dimensions	4 dimensions: Technology, People, Culture and Governance	5 dimensions: Organisation, Infrastructure, Data Management, Analytics, Governance	3 dimensions: Organisational, Analytics Capability, Data & Infrastructure	5 dimensions: Data, Enterprise, Leadership, Targets, Analysts
Assessment	• BACMM combines framework for BA capabilities with five level maturity scale (Paulk et al., 1993). • Maturity scale is applied to each of the sixteen BA capabilities. • After maturity levels are assigned to each of the sixteen lower-level BA capabilities, they are aggregated to provide a measure of maturity for each of the four high-level BA capabilities and finally an aggregated measure for overall BA capability.	Each dimension potential high score of 20 points. 	Score per Dimension	Stage
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4–7.1	Nascent
7.2–10.1	Pre-Adoption
10.2–13.3	Early Adoption
13.4–16.6	Corporate Adoption
16.7–20	Mature/ Visionary		Each dimension potential high score of 10 points. | Score per Dimension	Stage
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1 – 3	Beginning
4 – 7	Developing
9 – 10	Advanced		• Analytics Maturity Assessment is evaluated against 33 unique competencies within five DELTA model categories. • DELTA scores are calculated on a 1.00-5.99 scale with descriptive stages of maturity assigned to each of five score ranges (1-1.99, 2-2.99, etc.) and aligned with five stages.

Table 6: Comparison of BAMMs: Academia (Descriptive) and Practitioners (Prescriptive)

Phase	Method	Assumption	Application Summary	Source
(1) Design	Rasch Analysis	Organisations with higher maturity have high probability of successfully implementing capabilities.	Rasch analysis combined with cluster analysis first used to empirically describe evolution of software development process in organisation using capability maturity model (CMM) questionnaire.	Dekleva and Drehmer (1997)
			Based on results of application of Rasch analysis and cluster analysis, an initial MM can be derived in design phase.	Berghaus and Back (2016); Lahrmann et al. (2011) Raber et al. (2013b)
	Set Theory: QCA and NCA applied together.	An underlying assumption of equifinality that there exist multiple paths towards maturation.	Qualitative Comparative Analysis (QCA) with Necessary Condition Analysis (NCA) were used to design a social media maturity model using six step procedure.	Lasrado et al. (2017)
(2) Assessment	Cluster: Two Step Clustering, Fuzzy Clustering (FC) or other methods depending on the data.	There are groups of organisations homogenous across particular set of maturity capabilities.	Cluster analysis was used to categorise companies in study on organisational maturity on information system skill needs.	Benbasat, Dexter, and Mantha (1980)
			Clustering was adopted to assess organisations' situational corporate collaboration maturity for handling mixed-scaled data.	Jansz (2016)
	Additive Logic: Summation or average of capabilities with or without weights for capabilities.	There is only one single linear path to higher maturity. The underlying assumption is organisations with higher maturity will have implemented more capabilities.	Summation, simple average, and weighted average wherein the formulation of weights is arbitrary or non-empirical are commonly used for maturity assessments.	Chung, Andreev, Benyoucef, Duane, and O'Reilly (2017); Luftman (2001); Van Steenbergen et al. (2013)
			Empirical calculation of weights using methods such as structural equation modeling (SEM) is rare.	Winkler, Wulf, and Brenner (2015)
	Minimum Constraints: (a) Statistical Squared Distance (SSD)	There is only one single linear path to higher maturity. The underlying principle is based on theory of constraints; the overall maturity is the level of maturity of the lowest capability.	SSD is calculated for each of the maturity levels using characteristic values of 21 items to categorise an organisation based on its respective maturity level at which it shows lowest SSD. SSD is weighted by standard deviation at capability level.	Joachim, Beimborn, and Weitzel (2011)
	(b) Euclidian Distance (EUC)		EUC is computed for specific maturity dimension of organisation between answers given to specific items of dimension (See Section 4 for details)	Raber et al. (2013b)
(3) Validation	Variance Techniques: Regression, correlation coefficients with tests for statistical significance.	Organisations with high maturity will also realise higher business benefits, performance and business value than those at a lower maturity level.	Validating maturity using regression with tests for statistical significance.	L. Chen (2010); Joachim et al. (2011); Sledgianowski, Luftman, and Reilly (2007)
			Validating maturity using correlation coefficients against self-reported maturity, perceived benefits or performance.	Marrone and Kolbe (2011)
			Calculated maturity level can be validated using structural equation models (SEM).	Lasrado et al. (2017); Raber et al. (2013b)

Table 7. Quantitative Methods used in Maturity Models Research (Lasrado et al., 2017)

Figure 2 explains (1) design and development of maturity model survey instrument in Phase A, (2) classification of each organisation into a maturity level in Phase B, and (3) validation of maturity levels in Phase C.

In (1) Design Phase, set theory is used in design of MMs to reduce the number of conditions by dropping or merging conditions (i.e. using AND, OR, any other logical set operations) and arriving at macro conditions, in order to remove measurement items that have no influence on outcomes. Rasch analysis can be used in the design phase to develop the initial maturity model by reducing the number of measurement items, and can also be used in the assessment phase to calculate maturity scores and to classify organisations based on data collected through surveys together with cluster analysis.

In (2) Assessment Phase, cluster, additive logic and minimum constraints using statistical squared distance and Euclidian distance can be used to classify organisations into a maturity level.

In (3) Validation Phase, variance techniques such as regression, correlation coefficients with tests for statistical significance, can be used to determine the extent to which an assigned maturity level an organisation's use of BA contributes to business value.

4. Methodological Approaches used in Design, Assessment and Validation of BI/BA Maturity Models

Figure 2 shows that the main methodological design approaches used in construction of MMs are Rasch analysis and Set theory. However, Rasch analysis has been adopted by most researchers for both the design and assessment phases of BI/BA maturity models. Lahrmann et al. (2011) proposed a rigorous methodological approach for the construction of MMs which applies Rasch analysis and hierarchical cluster analysis to construct MMs. Rasch analysis has been used to measure variables such as abilities, attitudes and personal characteristics for psychological and educational assessments. Rasch analysis allows for inductive allocation of organisational capacities to different maturity levels and thus supports rigorous design and development of Capability Maturity Models (CMM) (Cleven, Winter, Wortmann, & Mettler, 2014). The use of Hierarchical cluster analysis provides a rigorous rather than arbitrary approach to allocating an organisation's capability at different levels of difficulty and maturity in order to overcome subjectivity of defining maturity levels arbitrarily (Lahrmann et al. 2011: 177). Raber et al. (2013b) developed an empirically grounded MM using an approach adapted from Lahrmann et al. (2011). The measurement instrument used by Raber et al. (2013b), assessed BI maturity using Rasch analysis and then used Hierarchical clustering analysis to determine the difficulty and maturity level of each measurement item and related capability for each respondent organisation on one standardised scale and then assigned the measurement items into corresponding maturity levels. The maturity level with the smallest Euclidean distance represents the maturity level of an organisation. An example was provided by Raber et al. (2013b) showing how the measurement instrument could be used for assessing the BI maturity levels in an organisation. The BI maturity instrument developed by Raber et al. (2013b) was used to determine whether BI maturity is linked to business benefits. The assumption is that organisations with high BI maturity are able to generate greater business benefits than organisations with a lower level of BI maturity. The rigorous approach to developing a BIMM adopted by Raber et al. (2013b) is not specific to BI, it can be used for other related domains in order to overcome methodological weaknesses of other BAMMs. This approach is summarised in Figure 3, which explains (1) design and development of a BIMM survey instrument in Phase A, (2) classification of each organisation into a BI maturity level in Phase B, and (3) validation of BI maturity levels in Phase C.
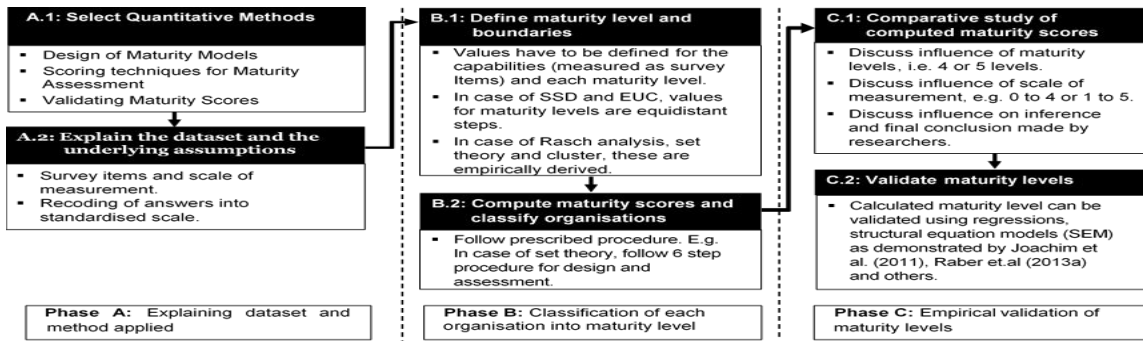
Figure 2: Methodological Framework for the Multi-Method Comparative Study of Maturity Models (Lasrado et al., 2017)
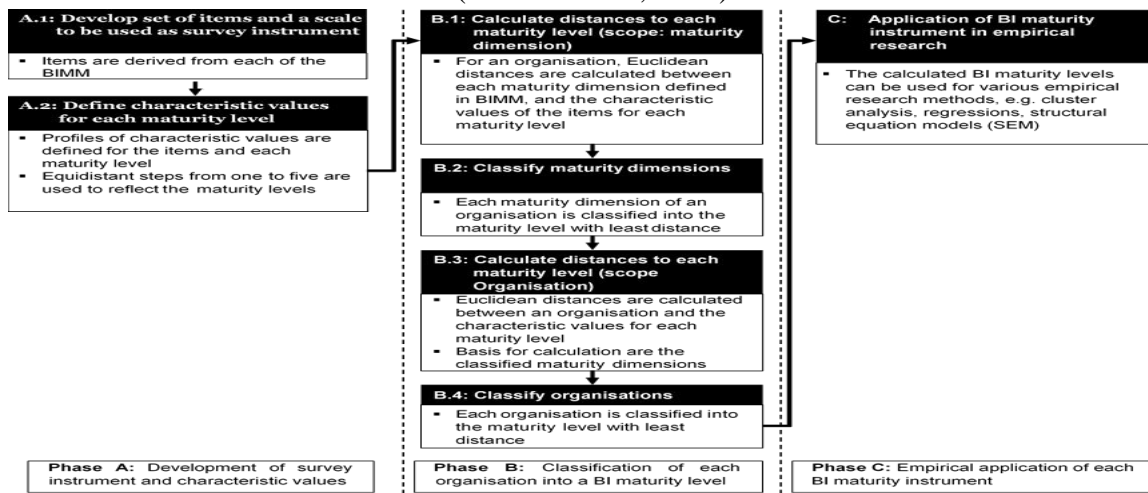

Figure 3: Methodological Approach used in Design, Assessment and Validation of BI/BA Maturity Models (Raber et al., 2013b)

5. Analysis and Results

A systematic review of methodological approaches used in design, assessment and validation of maturity models revealed that (1) main methodological design approaches used for maturity models are Rasch analysis and Set theory; (2) main methodological assessment approaches used for maturity models are Cluster, Additive Logic, Minimum Constraints using Statistical Squared Distance and Euclidian Distance; and (3) main methodological validation approaches of maturity models are variance techniques using regression, correlation coefficients with tests for statistical significance against self-reported maturity, perceived benefits or performance. The rigorous approach to developing a BIMM adopted by Raber et al. (2013b) opens a new application of Rasch analysis and cluster analysis to assess maturity levels that could be applied to construct BAMMs. Most of the BAMMs developed by academia are descriptive. In contrast our research also identified that practitioner developed BAMMs are prescriptive. These two groups have opposing aims with their respective BAMMs. Practitioners as BAMM consultants need to provide organisations with measurable outcomes so that organisations determine their current BA maturity level. Practitioners as consultants are motivated financially. Because they need to protect their intellectual property they do not describe in detail the design principles and assessment approaches used in proprietary BAMMs. Whereas BAMMs of academics are largely descriptive in that the design and assessment approaches of BAMMs are defined but often not empirically validated. Hence academic BAMMs in many instances have not been empirically validated in a real world setting. This is an important finding that emphasizes the disconnect between academic research and practice in the domain of BAMMs. Therefore, we argue that more empirical studies and evidence are also required to not only design and assess but also to empirically validate BAMMs.

6. Conclusion

There is only generic research on the design and assessment of MMs with little specific application to BA validated in real world settings. Many adopted measurement instruments using Rasch analysis were built on the assumption that the maturity increases in equidistant steps and provides a basis for determining the level of maturity in a systematic and rigorous way. Rasch analysis is the most widely used design and assessment method for the construction of MMs. Set theory using QCA and NCA is used by Lasrado et al. (2017) in the design of a maturity model by reducing the number of measurement items. However, the validity and reliability of the measurement instrument needs to be tested and confirmed by larger sample survey data. Future research should be directed towards performing more empirical studies in real world settings to demonstrate the validity and usefulness of BAMMs in contributing to quantifying the business value that can be attributed to the use of BA in organisations.

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23. Temporary Access to Medical Records in Emergency Situations

Zhi Chen
Auckland University of Technology (AUT)
rgk3484@autuni.ac.nz

Samaneh Madanian
Auckland University of Technology (AUT)
Sam.madanian@aut.ac.nz

Farhaan Mirza
Auckland University of Technology (AUT)
Farhaan.mirza@aut.ac.nz

Abstract

Access to patients Electronic Health Records (EHR) is a daily operation in mainstream healthcare. However, having access to EHR in emergencies while is vitally important to save patients' life, it could potentially lead to security breaches and violating patients' privacy. In this regards, getting access to patients' medical records in emergency situations is one of the issues that emergency responder teams are facing. This access can be temporary until patients reach hospitals or healthcare centers. In this paper, we aim to explore different technology-based solutions to give responders temporary access to patients' medical records in emergency situations. The core of this study is patients and responders authentication methods that can save precious emergency time and protect the privacy and confidentiality of patients data to the utmost. We also have explored control access mechanism and security audits to increase the security of the procedure and patient privacy.

Keywords: Emergency, Temporary Access, Authentication, Access Control.

1. Introduction

Electronic health record (EHR) and Electronic medical records (EMR) are important to resource in delivering healthcare. EHR is a digital version of the patient's standard clinical data. EHR is a patient-centric real-time record that allows authorized users to obtain information immediately and safely (Tavares & Oliveira, 2016). On the other hand, EMR constitutes data from electronic medical applications and is the data source of patients' EHR (Enaizan et al., 2020). It consists of the medical and treatment history of a patient for episodic healthcare or clinical events. As these systems contain all longitudinal information of patients' health background and history, they that can be a valuable source of information for clinical decisions and play a vital role in providing effective healthcare, especially in emergency situations.

In emergencies, a responsive emergency system plays a vital role in saving patients' lives in time. For decision support in emergencies, emergency responders and other involved parties should have timely and accurate medical information to provide swift rescue and appropriate medical interventions. At the same time, patients health and medical information should be protected against any potential privacy breaches. Therefore, based on patients' health circumstances and involved medical teams, different role levels authority, system privileges, and data access levels should be defined to provide clear, readable and practical information while protecting patients' privacy.

Although different countries have different legislations to regulate and manage EHR and EMR, there are different arrangements when it comes to emergencies. The main reason is to avoid personal injury or death due to the inability to obtain the patient's medical information in time, an action that violates the normal work process taken (Wickramage, Fidge, Sahama, & Wong, 2017). Similarly, based on the Health Insurance Portability and Accountability Act (HIPAA), in emergency situations, even if there is no

relevant data usage authority, the government has authorized medical workers to decrypt any patient-related data (T. Chen & Zhong, 2012).

In this regard, the concept of *Temporary Access to Medical Record* (TAMR) in emergency situations has emerged. In these situations, data availability is more important than security and confidentiality, and EHRs are also obliged to provide critical data for medical providers involved in emergency care (Wickramage et al., 2017). However, effective authentication methods to quickly obtain relevant patients' information within their respective authorized scope can reduce and even prevent cybersecurity incidents.

The fundamental motivation of this paper is to explore authentication and access control mechanisms available for temporary access to EHR, to conduct this exploratory work we conducted a literature review looking into security in medical information systems, access control, and auditing. On the basis of our literature search we postulate a feasible mechanism to find patient information in emergencies without compromising patients' privacy.

2. Research Background

There is an exponential interest in EHR security and privacy. However, not many research studies have been done on TAMR in emergencies and the security and privacy of patients' medical records. This makes EHR utilization uncertain in emergencies, as it is not clear how emergency responders should get patients' consent and access to medical records.

Therefore, TAMR has attracted research interests, recently. TAMR focuses on three aspects: (i) EHR system with a uniform format, clear structure and standardized definition. (ii) security and confidentiality of patient medical records; (iii) comprehensive, flexible and secure access control system. Our *research problem* deals with having patients' medical background and timely access to the information is vital in emergency situations and help the responders' team to save precious time and get more accurate medical decisions (Ben-Assuli, Sagi, Leshno, Ironi, & Ziv, 2015). Our *research question* therefore is: Can we can propose a solution to deal security and access control in parallel manage patient privacy while accessing their EHR in emergencies. Our research solution (presented in section 3) is a proposed system design catering for three scenarios: conscious patients, unconscious patients, and disaster scene. The implications of security, access, and privacy vary for these three scenarios, therefore an effective solution should manage TAMR accordingly. The following sections introduce some background literature.

2.1 Security in Medical Information Systems

Different security mechanisms have been proposed for EHR systems. To cope with the conflict of requirements for balancing speed and safety in emergency medical situations, separating emergency data from the EHR system is proposed (Darnasser, 2013). This approach could be useful to minimize the amount of leaked data in the event of emergency access violations. Cloud services that provide reliable distributed storage approach can improve the EHR system's security and reduce information exchange time (Alamir, Raman, Alhashimi, Almoaber, & Alremeithi, 2019). However, to enhance security, ubiquitous security access through a palm vein pattern authentication system is suggested (Alamir et al., 2019). In another study, Digital Rights Management (DRM) and digital certificate technologies were proposed for EHR sharing and clinical integration system in the cloud (Y. Y. Chen, Lu, & Jan, 2012). These systems could use non-repudiation digital signatures, to enhance confidentiality and discover problems through audits.

More recently, a biometric-based Blockchain is proposed to improve EHR access while maintaining patient privacy and identity security (Baqari & Barka, 2020). The natural decentralization of the Blockchain and its cryptographic services makes it a potential medium for communication between the cloud EHR systems and users. The patient's identity cannot be traced back to a specific EHR record.

2.2 Access Control in Medical Information System

Privacy is an important challenge in the medical systems and access control can be the main mechanism for protecting patients' privacy (Eikey, Murphy, Reddy, & Xu, 2015). In emergencies, the goal is satisfying the need to maintain the privacy of EHR and the need to access these records (Gardner, Garera, Pagano, Green, & Rubin, 2009). Therefore, an *access control system* would be an effective and realistic approach to protect patient privacy and confidentiality and obtain patient data in an emergency. This access can be controlled in the following three layers:

2.2.1 Identity Authentication

Identity authentication is to confirm medical team identity and patients, and their legitimacy through the identification service. The purpose is to establish an end-to-end secure link between both parties through authentication. In this regard, Khan and Sakamura (2016) proposed eTRON tamper-resistant cards to authenticate users. The system uses public-key encryption technology to achieve identity verification and tamper resistance. The public key certificate is provided by the eTRON certification authority. Compared with smart cards that use a shared key, this system is more secure as the tamper-resistant function can resist physical and man-in-the-middle (MITM) attacks and prevent copying and modification.

A finger-based system to identify patients in emergency situations and obtain EHR access is proposed by Choosang and Vasupongayya (2015). Palmprints is suggested in Karthikeyan and Sukanesh (2012) due to their higher recognition accuracy in comparison with fingerprints and more secure than smart cards. The combination of facial and fingerprint recognition and password for Emergency Medical Technicians (EMT) is proposed in (Gardner et al., 2009) for authorization of EHR access in general and emergencies. In the proposed system, patients' data are securely stored on a smartphone and available for emergency responders even if the patient is unconscious.

Recently, Jayanthy, Anishkka, Deepthi, and Janani (2019) designed a system for facial recognition for confirming patients' identity. This system performs accurate facial recognition and replaces the unified health code with facial recognition technology. In another study, face and eye recognition, QR Code and fingerprint are suggested for user authentication (Sandamal et al., 2019). This comprehensive method is based on biometric access control and could be promising in identifying patients and balancing the system's flexibility and security by restricting the contents of the medical records that can be viewed in an emergency.

Some other technologies are also proposed for authentication purposes. NFC is proposed for identity authentication and EHR storage system access (Sethia, Gupta, Mittal, Arora, & Saran, 2014). An Android application is developed to access NFC tags and to perform close-range data reading and identity authentication. In another study, an augmented card system based on augmented reality technology (RA) is proposed to recognize RA markers and confirm the identity (Ierache et al., 2016).

2.2.2 Access Control Strategies

Access control is used to restrict access capabilities and scope, limit access to key resources and prevent illegal users from intruding, or damage caused by legitimate users' improper operations. This enhances the safety and legal use of medical information. To ensure the medical data access, a red-alert protocol is proposed by (Oliveira, Michalas, Groot, Marquering, & Olabarriaga, 2019). In this approach, medical providers can only visit patients' data within the time required to complete specific procedures related to the patient's condition (e.g., transfer of patients to the hospital). Although this approach provides high security in access data, it has low availability in difficult situations.

Sicuranza and Esposito (2013) summarized access control models based on Mandatory Access Control (MAC), Discretionary Access Control (DAC) and Role-Based Access Control (RBAC). RBAC has

greater flexibility than MAC and easier to handle than DAC. In their research, based on RBAC, a multi-level patient privacy attribute model was designed which is a fine-grained access model in line with the main security requirements of the EHR system. By defining purpose, checklist, time and restriction components the system administrator can dynamically manage document access that puts patients' privacy in the centre.

RBAC was combined with the contextual-attribute-based access control (ABAC) model to design a more flexible and dynamic RBAC model (Khan & Sakamura, 2016). This model also embodies the design ideas of dynamic, temporary and patient privacy and safety in the centre.
However, the best privacy protection strategies in EHRs are segmentation, isolation, separate management, and e-consent, aiming to fine-tune sensitive medical records according to predefined standards (Rothstein, 2012). By improving the RBAC model, the goal of EHRs access control, the balance of security and ease of access, can be achieved.

2.2.3 Security Audit
The widespread application of EHRs has increased the need for a health information log audit mechanism to prevent deliberate or unconscious destruction and abuse of health information (Wickramage et al., 2017). Such audit requirements are more needed in emergency situations. Wickramage et al. (2017) in their research defined log files with additional information and applies them to the audit process to monitor deviations in the expected sequence of events during health care emergencies.

King, Smith, and Williams (2012) proposed a user-based non-repudiation audit mechanism. By studying the impact of 16 types of conventional auditable events on non-repudiation, focusing on the specific auditable events of protected health information, the non-repudiation of audit logs was improved. Khan and Sakamura (2016) believe that because the delegation token contains the subject's eTRON ID in its file access control block, the access control delegation log can be audited so that the system has stronger medical privacy protection.

3. Proposed System Design for Medical Emergency System
Having patients' medical background and timely access to the information is vital in emergency situations and help the responders' team to save precious time and get more accurate medical decisions (Ben-Assuli, Sagi, Leshno, Ironi, & Ziv, 2015). In this regards, a responsive emergency system can play a vital role in saving patients' lives by allowing emergency participants to obtain the patient's medical records in a timely manner. This emergency system grants patients' medical record access to emergency responders. Therefore, it can be assured that medical responders have access to the vital health records in emergencies that save time and support appropriate medical interventions.

On the other hand, the research and realization of the task of temporarily obtaining medical records in emergencies mainly need to focus on three aspects. The first is the participants in the whole process; the second is the definition of the information of medical records in different contexts and how to obtain it; the third is the authority and security of data. Clear definition and thoughtful planning of the above issues are the fundamental way to complete this task effectively. These areas are discussed and covered in this section.

In an emergency, different stakeholders or participants need temporary access to patient medical information in addition to the hospital's emergency system. This includes: (i) Ambulance service; (ii) Rapid Response Team (RRT); (iii) Medical Assistance Team (MAT); and (iv) Trained first aid. In different countries, we may have different involved parties might be different based on the healthcare structure and hierarchies. However, RRT is now a standard configuration in many modern hospitals. RRT in hospital wards is to examine patients with clinical deterioration in emergency situations to reduce morbidity and mortality in the hospital (Orosz et al., 2020). MAT is a disaster medical assistance team

comprises doctors and nurses from different clinical sub-specialities, but mainly from emergency and rural medicine or general departments. Trained first aids are the first-aid measures that bystanders can use, do not need or rarely need medical equipment, and take emergency and critically ill patients.

Based on the introduction to existing EHR systems and emergency requirements, it is clear that the proposed system should be based on the current EHR system to authorize and provide corresponding medical information for different participants by effective verification method. Therefore, the focus of our proposed system is the timely authorization of medical providers for temporary access to medical records in an emergency situation, under the premise of ensuring the safety of patient health information as much as possible.

3.1 Identity authentication
The first step in emergency response and accessing patients medical record would patients identification. In this regard, according to different situations and patients' identity, it is necessary to provide a suitable mechanism and method to identify and authorize different participants and groups involved in emergencies, including patients. In the following sub-sections, an introduction to the procedure and the possible technologies utilization for the authentication system is provided. The overall steps and their sequence of identity authentication are presented in Figure 1.

3.1.1 Conscious Patients
If patients are conscious, they can confirm their identity and authorize emergency responders to have access to their medical records. However, some security mechanisms can be used to provide further privacy protection. For example, to support the authorization process and manage the security and privacy of patients' records, a variety of technologies can be leveraged for EHR access including fingerprint, passwords or faceID. As the system response time is important in emergencies, based on the research results none of these technologies significantly increase the response time of the system (Sun, Zhu, Zhang, & Fang, 2011; Zhang, Zang, & Tian, 2015). Encryption technology can be also useful to prevent any data security hacks and replay attacks.
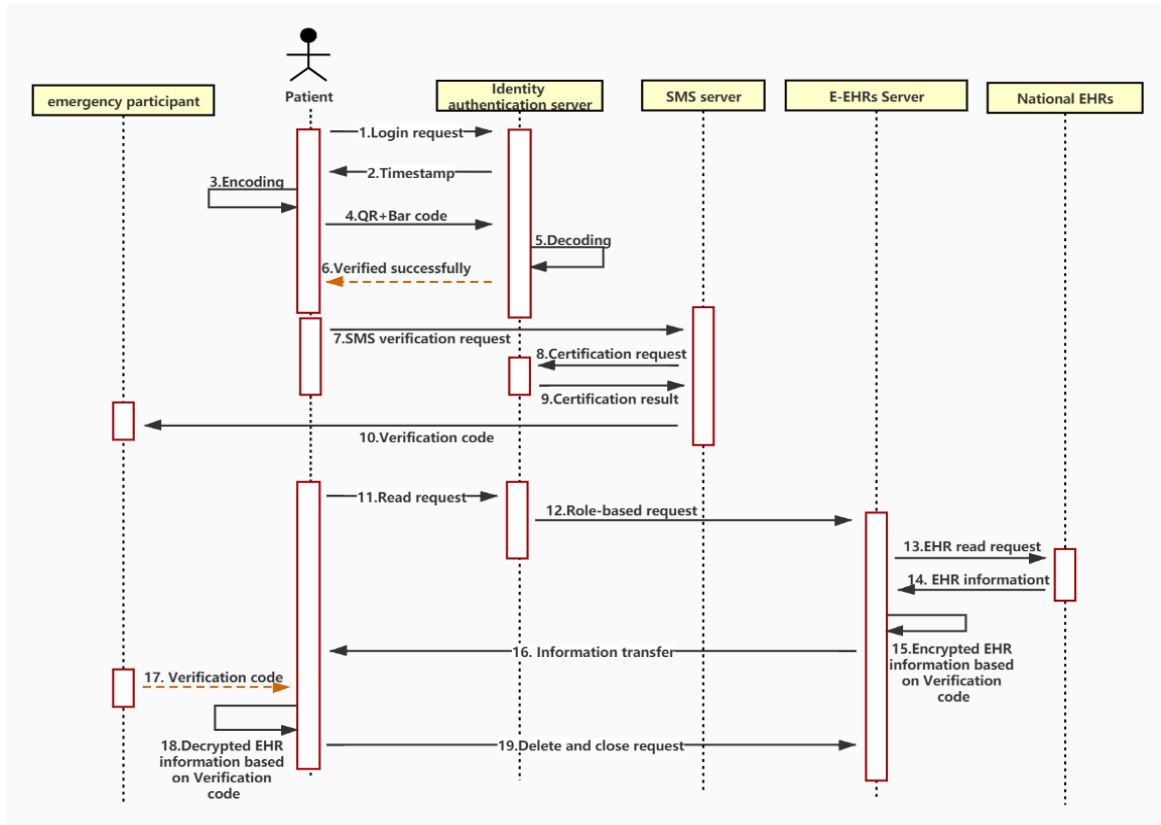
Figure 1: Sequence Diagram of Patient Identity Authentication in Emergencies

3.1.2 Unconscious Patients

The most challenging situation in emergency response is when the responders are dealing with unconscious patients. In these situations, knowing patients' health background and having access to medical records could be a matter of life and death. However, these patients cannot communicate their medical conditions and they are also physically incompetent to retrieve their health records or authorize the emergency responder teams (Sun et al., 2011).

Different approaches have been introduced for these situations such as emergency contact group or trusted users by (T. Chen & Zhong, 2012) and (Thummavet & Vasupongayya, 2013) to authorize emergency responders. However, these approaches take precious time and might be not effective. Therefore, proper technology-based security and privacy mechanisms are required to prevent any misuse of medical data and protect patients' privacy while enabling the responder to have access to patients' medical records.

For this purpose, temporary access to patients' medical background can be provided by using different technologies in parallel with proper patients and response team identity authentication. As patients are unconscious two separate procedures for identity authentication and verification are required, one for the patient and one for the emergency responder. Patient's identity verification in parallel with the responders' identify authentication helps to determine whether the patient's encrypted medical records can be viewed by the responder or not. This double parties identity identification and authentication can prevent any unauthorized access to patients' medical records while supporting emergency responders to have the access to patients' medical history to save a life.

To have such a system in emergencies, EHR systems should capture patients' fingerprints or other biometric identifiers when they set up for a patient. At the same time, there should be a database system for emergency responders with their staff ID, biometric identifiers and mobile phone numbers. These elements can be used in emergencies for patients and responders identity authentication. This set of

mechanisms is believed to improve the access performance of EHR without sacrificing patient privacy and identity security.

Based on these elements we can use either text messaging approach or biometric capturing technologies in emergencies. For example, staff ID and mobile phone number of the responder can be sent to the central server to authenticate the responder and getting a verification code via text messages to grant the temporary access to the patients EHR. This approach maximizes controlling information access in the shortest time while preventing MITM attacks. In more advance systems, biometric (e.g. fingerprint) authentication could be used to authenticate the responders and granting access to patients medical records. As such authentication process includes a timestamp, it can prevent replay attacks and match the patient's identity more accurately. A proposed system workflow is demonstrated in Figure 2.
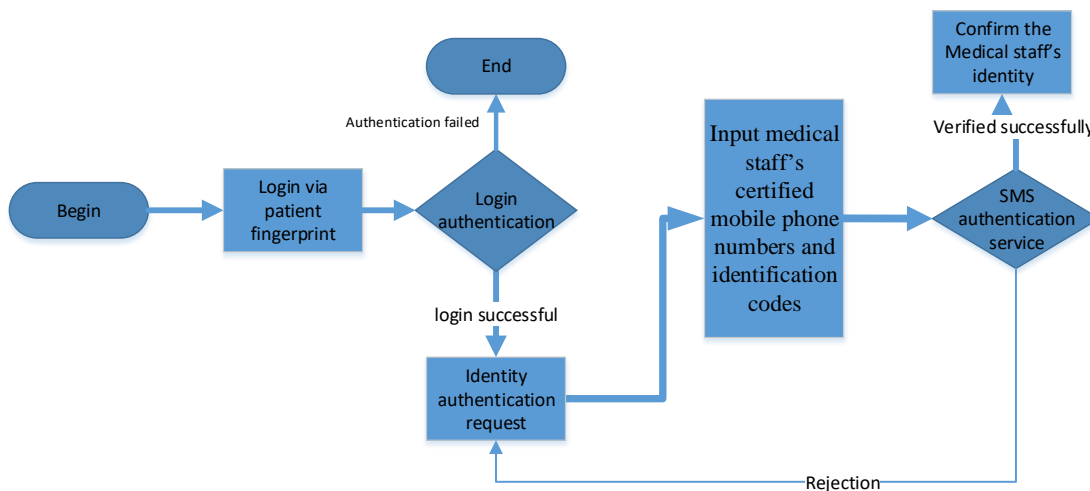

Figure 2: Proposed System Flow for Responders and Patients Authentication

On top of this system, there can be lightweight cryptography models to provide an extra secure system against data breaches.

Other technologies such as physical cards empowered with QR Codes or barcode can be also used in this scenario. Nevertheless, their effectiveness can be less than biometric identification, as they are easy to lose or forget to carry.

3.1.3 Disaster scene

In disaster situations, the number of patients in need of emergency treatment normally surpasses the available disaster responders and other healthcare resources. As saving emergency time and patients' lives should be the most important principles, the system should be designed to accommodate the situation requirements.

In disaster situations, biometric identifications both for disaster casualties and responders is more appropriate due to quick system run up and verification time. The system can be designed with time-limited temporary authorization access.

3.2 Access control

Access control is a necessary and important mechanism to keep patients' health record secure and confidential. At the same time, access control systems must be robust and flexible (Khan & Sakamura, 2016). To protect the privacy and confidentiality of patients, it is necessary to adopt RBAC and DRM-based information encryption technology. Defining the role, time, and corresponding authority of each person who accesses the patient's medical records can prevent patient information from being leaked or abused by authorized personnel. Moreover, in the process of information acquisition, the information

encryption of the patient's medical records based on the license system can prevent information from being stolen or MITM attacks.

As suggested by Darnasser (2013), the idea of separating emergency data from EHR can further improve the privacy of data in this stage. Moreover, restricting the contents of the medical records that can be viewed in an emergency can enhance security (Sandamal et al., 2019).

For effective access control, it is recommended that the EHR system should be based on the HL7 and FHIR information model for the data exchange standard. In the discussed cases, and based on the involved medical teams, the semantic and structural composition of the patient's medical record is expressed in the form of HL7 FHIR standard, and the patient's medical record is called according to the role attributes based on the XML format. Moreover, each request only retrieves medical information related to the role's requirements. The information can be based on default classification or customized by patients.

In the default classification, the calling system classifies EHR information according to categories such as demographics, medical, surgery and lab test backgrounds. The main purpose is to separate the vital information required for rescuers' medical decisions from other information through classification. This information can help rescuers have the most understanding of the patient's situation in the shortest time and take effective rescue measures based on this information.

In contrast, the customized classification by patients is a patient-centred design, as one of the core ideas of today's EHRs. Patients can share the medical information they want to share according to their actual situation and hide some basic information according to their own wishes. For example, patients can choose whether to display the patient's name and address when sharing personal medical information. They can also share their own operation records and X-rays taken due to fractures to emergency personnel through a customized function. It can more effectively help emergency personnel to decide on rescue measures while protecting personal privacy to the greatest extent. To prevent some key emergency information from being hidden due to the limited medical knowledge of the patient, the customized function is only effective for the limited information classification.

3.3 Log Audit and Information Access Sequence

Since in emergencies, time is precious and saving the lives of patients is the first priority, so sometimes it is necessary to compromise between protecting the privacy and saving time. Therefore, the after-the-fact audit system is particularly important in emergency access to the patient's medical record system. A reasonable audit system can effectively prevent the patient's EHR from being misused accidentally or deliberately.

Under normal circumstances, the role of the after-the-fact audit is to find abnormal log records in normal operations and make corresponding identifications or prompts. However, in emergencies, the audit log becomes more complex, and the incompleteness and inconsistency of the log record increase the difficulty of log auditing. Therefore, there is a need to conduct an effective log audit of privacy violations and improve the log recording and presentation mechanism. Need to add information items for the audit log to help improve the audit log and help the system make correct analysis and inference. This also matches the idea of RBAC.

The enhanced audit log mainly needs to answer several questions: who, when, what, and how. Based on these four log entries, privacy violations can be identified and inferred. Besides, the patient can add three emergency contacts in the application as additional monitors for the log information. To save emergency time, it is unwise to add emergency contacts as authorized persons for access control in some studies.

Doing so will invisibly increase the waiting time and waste precious treatment time. But using emergency contacts as log reviewers is a good choice. When the system sends patient medical data to emergency personnel with access rights, it will send the access behaviour to the emergency contact person designated in advance by the patient in the form of a short message, which can help the system better detect unauthorized access to medical records.

4. Discussion and Conclusion

The focus of this paper is how technology can facilitate to authenticate patients identification and emergency responders to grant patient medical information access for emergency purposes. This access is temporary until patients transfer to medical facilities. In this research, besides authentication, we have explored role-based access control and log audits to enhance the security and privacy for patients in providing the emergency responders with medical information for. These tasks are based on the premise that standard medical information can be obtained from EHR systems.

In this article, we have explored some potential technological solution to access patients' data in emergencies in three scenarios: conscious patients, unconscious patients and disaster situation. Among the explored solutions, TAMR based on biometrics identifiers, such as fingerprints, is more promising due to short time for system runup and higher accuracy in identity identifications. However, it is necessary to verify the identity of participants through multiple authentication methods. Therefore, besides biometric identifications for patients, other approaches such as SMS verification was also explored and suggested that can enhance the reliability of identity authentication. The combination of biometric and SMS for patients and responders authentication in an emergency would be an effective, convenient, and easy-to-implement verification method that can enhance system security. This technology integration for verification strengthens the recognition accuracy and security of the system without significantly extending the system login time. Furthermore, SMS verification codes, while enhancing the reliability of identity authentication, try to solve the emergency time as much as possible. To control access to patients' records, RDAC is proposed. Through the RDAC mechanism, different emergency personnel, regardless of their role, will have enough information required emergency diagnostics and treatment. With RDAC the function of patient customized information is increased, which increases the system flexibility. Adding additional information (who, when, what, how) to the audit log logically helps the log audit system determine privacy violations. Add an additional emergency contact system to help the system find abnormal behaviours through emergency contacts set by patients in advance.

Based on the identity verification method and role-based EHR information acquisition method mentioned above, the identity authentication of emergency participants can be strengthened through the SMS verification system and fingerprint verification system; the security protection during the information transmission process can be strengthened through the fingerprint and different encryption techniques. In this case, the patient's privacy is protected to the utmost extent through role-based access control. By adding emergency contacts and standardizing audit logs, the audit mechanism is improved, and measures to protect patients' EHR are strengthened. The future development direction of this field should focus on establishing a unified nationwide EHR access system in emergency situations.

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24. The rise of social applications and sustainable development: The Ribon Case

Helena Brito de Freitas
Universidade Federal de São Paulo
helena.b.de.freitas@gmail.com

Luis Hernan Contreras Pinochet
Universidade Federal de São Paulo
luis.hernan@unifesp.br

Vanessa Itacaramby Pardim
Universidade Nove de Julho
itacaramby@uni9.pro.br

Marcia Carvalho de Azevedo
Universidade Federal de São Paulo
marcia.azevedo@unifesp.br

Abstract

This article aimed to identify, from the user and the company's point of view, what leads to engagement with social applications that contribute to sustainable development. In the research design, a qualitative, exploratory approach was used, based on the inductive nature of obtaining data through a case study. Multiple sources of evidence were used, which allowed data triangulation. After data collection, the content analysis technique was used using the CAQDAS/Iramuteq software. The results indicated that the subcategory "Impact of effective altruism" was the one that had the most significant presence of textual body among the comments of users since effective altruism is configured as a fundamental element, in which the motivation to volunteer is a donation. In users' comments, the sensation of "warm glow" was observed, a model in which the agent gains utility in the act of donating. The "Motivating about volunteering" class, on the other hand, had the smallest textual body due to users having difficulty perceiving the app as a means for the practice of volunteering. Thus, the application modifies the flow considered traditional fundraising for social causes and innovates by offering a more straightforward and more casual way of carrying out voluntary work.

Keywords: Social Application, Social Technology, Gamification, Altruism, Volunteering, Credibility.

1. Introduction

In the digital age, Information and Communication Technology (ICT) are no longer a luxury for the few and become, among others, an essential resource for political engagement and social participation (Boulianne, 2015). In this context, one of the technological revolution tools is smartphones, whose number of users has been growing at an accelerated rate due to their advanced computing capacity and data connectivity through wireless, 4G, and Wi-Fi services (Roy, 2017). Added to this is the wave of mobile apps (apps), configured as one of the fastest-growing sectors in the downloadable software market (Lee & Raghu, 2014; Roy, 2017). The rise in the use of apps can be felt as they are being used for numerous functionalities, starting with educational use, going through health care, e-commerce, transportation, among other aspects (Liu, Au & Choi, 2014).

In this scenario, the concept of social technology (TS) emerges, which, for Gartner (2021), is "… any technology that facilitates social interactions and is enabled by a communications capability, such as the Internet or a mobile device". Bruggencate, Luijkx and Sturm (2018) corroborate by stating that STs facilitate interaction between individuals and influence social processes, connecting people to other people, the community, and society. Therefore, they can also facilitate communication between organizations and people who carry out or who wish to carry out voluntary work. That is, they help to solve problems that conventional business models cannot solve.

Thus, social applications arise, which should not be confused with social relationship applications such as Instagram or Facebook. The social apps we refer to are considered social technology tools and appear

with a greater purpose than consumption, entertainment, and management, focusing on socio-economic sustainability (Moresi et al., 2017). In this context, several startups are born - a new business in which entrepreneurs combine ideas and resources to create products or services in a scenario of extreme uncertainty and can also be defined as a temporary organization while seeking a repeatable and scalable model (Kim, Kim & Jeon 2018). It is based on a social business model that seeks the financial objective and the social objective.

Depending on the context presented, this article aims to identify, from the user and the company's point of view, which leads to engagement with social applications that contribute to sustainable development. The Ribon application's choice was due to its importance for a better understanding of the phenomenon in the Brazilian context. This work is justified since there is a continuous expansion of the use of technology in the world population's daily life (a factor often interpreted as a revolution with a pejorative connotation), requiring studies that investigate how technologies can be used to benefit society.

2. Methodological Procedures

2.1 Research design

The present study was carried out using a qualitative approach. As for the objectives, exploratory research was adopted, based on the inductive character in obtaining the data (Jebb, Parrigon & Woo, 2017), and developed through a case study in a Brazilian social application company (Yin, 2017). In data collection, multiple sources of evidence were used - comments from Ribon application users, semi-structured interviews with employees and founders of the startup, as well as documents provided by the company, as can be seen in Figure 1 -, allowing thus the data triangulation.
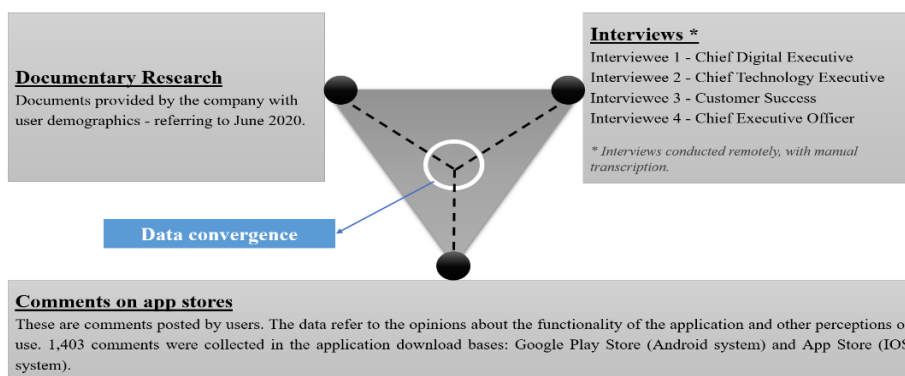

Figure 1: Research evidence sources
(Source: own elaboration)

2.2.Procedures for data analysis

In the analysis of the collected data, the content analysis technique was used. For this purpose, computer-aided data analysis software (CAQDAS) was used to help in the coding and categorization of a large amount of data. In the case of this study, the software used was the Iramuteq. The software in question uses the method of descending hierarchical classification (CHD), so it performs the material's lexical analysis. It splits the text into hierarchical classes (clusters) identified from segments that share the same vocabulary, using the Content Analysis technique (Miles, Huberman & Saldaña, 2013).

3. Results and Discussions

3.1. The Ribon case

Created in 2016 in Brasília, the startup contemplates a social innovation model that seeks to positively impact the altruistic cause, configuring itself as a social business in which the user can exercise digital volunteering. In the startup case, digital volunteers receive "ribbons" (the virtual currency of the

application) in exchange for their time. The acquisition of the currency is possible by reading news sponsored by companies or philanthropists and displayed on the main page. The stories published in the app have social relevance content, such as sustainability, diversity, and innovations carried out worldwide, relating, in general, to social and environmental development. For each "good news", the volunteer collects 100 ribons.

The number of ribons collected by the digital volunteer can be sent to the institution chosen by him, considering that, among others, each destination has a different value for donating. This type of business model has a strong appeal among younger users, encouraging them to enter the universe of volunteering simply and practically (Ebrashi, 2013). In the words of its founder,

> "[...] we think that giving and helping others is good, but lately, **because of the process, the experience is bad.** You are on Paulista Avenue, and you have to avoid people and feel bad about it or receive a ticket at home and **be compelled to donate** [...]" (Interviewee 4, 2020, emphasis added).

Thus, the application modifies the flow considered traditional fundraising for social causes and innovates by offering its users a more straightforward and more casual way of carrying out voluntary work. Thus, through the application, the participant does not necessarily need to use their own money to help humanitarian causes but only volunteer (remotely and digitally) to help those in need. Also, the accumulation of coins becomes something fun and challenging, while it has different levels for donating.

The app started with four basic destination options for donations: Medicines (Schistosomiasis Control Initiative); Drinking water: (Evidence Action); Food fortification (Project Healthy Children); e Essential health (Living Goods). In 2020, with the Covid-19 pandemic situation, three more causes were added, totaling seven possible causes for donation. The cause focused on helping Covid-19, which promotes the donation of tests for the disease to communities in Rio de Janeiro (Favela without Corona). Causes were added that promote food delivery to public school students (WFP - World Food Program) and another that helps in the early diagnosis of breast cancer (Américas Amigas).

What is clear is that the company is willing to embrace new donation options with national and international coverage and intends to expand the number of institutions available for donation. The criterion used to select NGO options is to occupy the right positions in platform rankings that evaluate impact institutions worldwide to prove their efficiency, such as Give Well and The Life You Can Save. As a form of transparency for the user, the application publishes monthly proof of donations in the "Community" section, which can be consulted, such as information on the number of drugs donated, water, and other initiatives. Also, in the user's profile, it is possible to view the exact amount of ribons donated for each selected cause and the impact of the guaranteed days of assistance.

Altogether, more than 500 thousand donations have been made, which exceeds 1.2 billion ribons that have been converted into cash, with about 40.3K of users of the application today. This audience is mostly female (69.8%) and young, aged 18-24 years, and lives mostly in São Paulo, followed by Brasília, the organization's place of origin (Ribon, 2021). In this way, Ribon believes that reaching generations Y and Z is a focal point for its development and the organization's success.

> "**We believe that millennials and generation z are much more digital, as they are practically digital natives, and the way of donating is still very adapted for previous generations.** [...] in the research that we were seeing, generation Z is the most altruistic generation" (Interviewee 2, 2020, emphasis added)

It should be noted that unlike what occurs with older generations - before the 1980s - who have more difficulty with technologies because they are not part of their daily lives, the younger Y and Z generations have intense integration with digital (Bruggencate, Luijkx & Sturm, 2018). Thus, the ease of using social apps to generate a positive impact with their actions becomes an attractive factor and makes this segment of the population more likely to engage in voluntary actions but in digital format.

3.2. Conducting Iramuteq procedures

The Correspondence Factor Analysis (CFA) is a graphical representation of the data that helps visualize the proximity between classes or words by calculating the frequencies and the chi-square correlation values ($\chi2$) of each word in the textual body. The pre-defined frequency and the execution of the CFA in a contingency table cross the active forms and the variables. The CFA results were represented and analyzed by different groupings of words or subjects that make up DHC's classes, divided into similar colors. It is also possible to know each word's expressiveness in the set of classes due to the size in which it appears in the graph, that is, words that most appeared in the textual sets (Ratinaud & Marchand, 2012).

Descending Hierarchical Classification (DHC) is a method that classifies textual segments according to their respective vocabularies, in which the set is divided based on the frequency of stemmed words (reduced forms), resulting in classes that present vocabulary similar to each other. Moreover, simultaneously, different from other classes, the text segments are correlated to form a hierarchical scheme of classes (Ratinaud & Marchand, 2012). This procedure resulted in a textual corpus consisting of 1,401 texts and 1,434 text segments, with 1,279 text segments - corresponding to 89.19%. 21,256 occurrences of words, forms, or words emerged, 1,499 active forms configured as the main words found in the corpus. The analysis and categorization of the textual body resulted in 4 clusters or classes, with the following text segment composition: Class 1 (41.83%, n=535), Class 2 (27.76%, n=355), Class 3 (13.37%, n=171) and Class 4 (17.04%, n=218).

3.3. Analysis of Categories and Subcategories

The distribution of comments by the class according to its $\chi2$, indicates that the most representative comments in the contribution of its classes were: *u_368 (class 3, $\chi2$=12.98); *u_2, *u_60, *u_26, *u_224, *u_147, *u_34, *u_32, *u_181, *u_183, *u_216, *u_316 and *u_222 (all belonging to class 4 and with $\chi2$=9.75). The results graphically indicate each comment's position on the Cartesian plane in relation to the others, according to the form frequencies. From the comments' similarities, it was possible to obtain four classes, represented in the dendrogram (Figure 2).
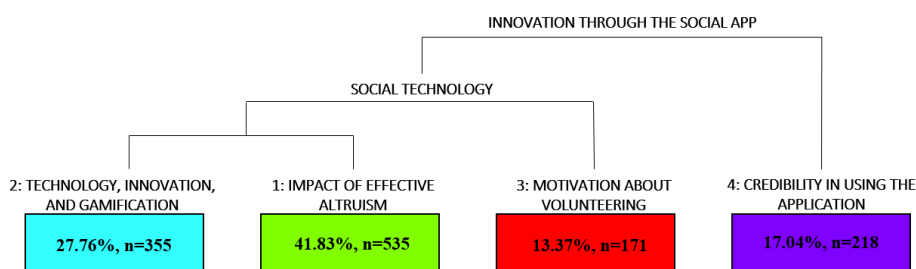

Figure 2: dendrogram of the formed classes
(Source: output from the Iramuteq software)

3.4. Dimension: INNOVATION THROUGH THE SOCIAL APPLICATION
3.4.1. Category - Class - SOCIAL TECHNOLOGY

After the classes' formation, it is noted that there is a connection between subcategories 1, 2, and 3, which constitutes a class, which was called "Social Technology". Social technology presupposes the use of technologies to solve social problems. That is, it implies a "[...] set of techniques, transformative methodologies, developed and/or in the interaction with the population and appropriated by it, which represent solutions for social inclusion and improvement of living conditions" (ITS Brasil, 2007, p. 29). Concomitantly, as a connector and largest driver of data, there is the dendrogram's total dimension, "Innovation through the Social Application". Thus, with the support of Iramuteq, the four subcategories that will be presented next emerged.

Subcategory Class 1 - Impact of effective altruism

The differentiation between the donation of money and donation of time generates a discussion to know which one would be the best factor to achieve effective altruism. The feeling of "warm glow" - model in which the agent gains utility in the act of donating. It is significant when the individual donates his time, constituting a potential motivating factor for volunteering, together with prestige, reciprocity, justice, social pressure, and impact philanthropy (Brown, Meer & Williams, 2018). In the words of its user:

> "We need to help social causes, and this app is one of the ways that we can do that. Moreover, detail, without you spending your own money. It is an application made by someone with a good heart for people of goodwill. It is wonderful to see that someone developed this application and that it is reaching out to people. **My heart is even warm**" (*u_312, emphasis added)

In this context, altruism - helping other people with no apparent personal reward - is a fundamental element in which the motivation to volunteer would be the donation (Veludo-de-Oliveira, Pallister & Foxall, 2015). This level of altruistic voluntary work is related to the desire to promote well-being through political or religious conviction, a personal donation to the practice, and the socialization of initiatives that attest to superior human qualities (Kee, Wang & Kailani, 2017). Also, it is characterized as a philosophical and social movement. Effective altruism aims to revolutionize how philanthropy is carried out, seeking to encourage individuals to do the greatest good that can be done for organizations that perform and develop better (Gabriel, 2017). In other words, it applies the concepts of "evidence and reason" in search of finding the most effective ways to develop positive changes in the world through the choice of causes that will have a tangible impact (Eikenberry & Mirabella, 2017), as can be observed in the following excerpt:

> "[...] we had only four NGOs within the app, four projects, which are international, operate mainly in Africa and Southeast Asia and are **ranked both in The Life You Can Save and in the Giving Well as the largest most efficient NGOs in the world, in order to follow effective altruism**, which is a movement that preaches precisely that the impact be measured and that it reaches the largest number of people for the longest amount of time [...]"(Interviewee 2, 2020, emphasis added)

It is evident in the speech of Interviewee 2 a concern with "doing well by doing good", the slogan of effective altruists (Eikenberry & Mirabella, 2017). After all, often only a small percentage of the donated money finds its way to the individuals who most need these donations due to reasons that hinder the effectiveness of donating, such as low quality of information, carelessness, and parochialism (Gabriel, 2017). With regard specifically to the profile of the volunteer, it is possible to identify three aspects: "Patchwork Volunteers" - they participate in different NGOs, in different stages of life; "Engagement Hoppers" - are active in some seasons, depending on demand and your availability; and "Crowd Volunteers" - perform small tasks virtually (Kapsammer et al., 2017). It is possible to fit users of the Ribon app to the latter category, while these individuals perform the act of donating their time when reading the news and collecting the virtual currency offered so that they can donate effectively:

> "[…] **Every day he shows good news. When reading it, the user receives credits** (sponsored by large companies), which he can use to make donations of drinking water or medicines to those in need through serious organizations. **It costs nothing and is worth a lot. I recommend**." (*u_175, emphasis added)

Regarding user 175, it is possible to consider him as active. However, there is the phenomenon of evasion among this audience, the product of using the application for a certain period and, subsequently, this frequency starts to decrease until they stop using it. Sometimes this evasion can occur after the first access because of existing apps' plurality with the same purpose (Lee & Raghu, 2014).

> "[...] you use it, then you donate, then you forget about it for a while [...] like we are trying **to increase our retention.**" (Interviewee 1, 2020, emphasis added)

To reverse this situation, Ribon uses the strategy of collecting a higher number of ribons in a single day, different from the amount they would typically receive. This condition concerns the company, as it does not guarantee that the user will become regular in using the app.

Subcategory Class 2 - Technology, innovation, and gamification
The so-called social businesses, a hybrid model that combines characteristics of the private sector with third sector skills, seek to solve social issues by innovating and using market mechanisms to solve social problems (Ebrashi, 2013). In other words, it focuses more on causes than on profit, but it works to cover its operating costs, and its managers are entitled to recover their investment.

Along these lines, the social innovation that Ribon brings pleases users, as it is a business model that brings a different and unexpected way of practicing volunteering and making donations, incurring positive consequences for users, the company, and the supported cause. From the feeling they experience; users feel the need to share this initiative and express gratitude for the opportunity provided by Ribon.

> "I was invited to meet Ribon. When I read the purpose of the application, I was immediately interested because that **is exactly what humanity is very much in need of**, to know that there are, yes, good things happening and that we can always do something for the other. **I sent it to several of my WhatsApp contacts. I hope that this initiative will spread across our planet. […]**" (*u_333, emphasis added).

Another point that draws the users' attention is that it is aesthetically pleasing and light, factors that also contribute to generating interest in downloading.

> "[...] it's **adorable**, Congratulations to the creators, the app is amazing [...] **the app is cool (and light).** Get down." (*u_331, emphasis added)

In this sense, a device that has been used in applications proposal of gamification elements inherent to its operation. This concept has its origins in games, that is, in activities that provide entertainment and the desire to overcome challenges. In this way, gamification can be defined as the use of facets of game design in scenarios not characteristic of games themselves, such as goods and services, increasing the value perceived by the consumer and encouraging consumption, loyalty, engagement, and, even, product advertising (Hofacker et al., 2016). That is, gamification creates a layer on top of the real world, enabling engagement and retention in apps (Pechenkina et al., 2017). Thus, this resource is considered a powerful engagement tool and used in several sectors.

About social applications, using gamification is a necessary means of stimulating individuals' contribution to collective initiatives of common interest. That is why Ribon's choice for a gamified strategy to increase his target audience's engagement is justified because it involves emotional experiences that hold the user's attention. Thus, to collect virtual coins, "ribonites" need to spend time and dedication, which contributes to generating attendance on the user's part when using the app. According to the Ribon executive, the gamification part developed in the app is essential to guarantee the experience and permanence of its users:

> "[...] I **think we still have a lot to do in terms of gamification** because there is a lack of urgency and the APP has a greater engagement [...]" (Interviewee 3, 2020, emphasis added)

25. In this way, the social innovation provided by the Ribon application brings, as a fundamental characteristic, the possibility of providing greater visibility and differentiation through the use of gamified elements in the user experience, which are viewed positively and promote engagement by the users.

Subcategory Class 3 - Motivation about volunteering
Motivation is a complex psychological process that results from the interaction between the individual and the environment surrounding him, generating a set of forces that induce the individual to initiate a

specific behavior. It can also be defined as a desire or need for something, an internal feeling, an impulse to do something, or also as a set of biological and psychological mechanisms. That enables the triggering of action, guidance (towards a goal or, on the contrary, to get away from it), and, finally, intensity and persistence (Hao, Farroq & Zhang, 2018).

Concerning voluntary work, individuals' motivation arises, even if they perform actions that will not provide financial rewards, acting in an altruistic way (Kee, Wang & Kailani, 2017). For Interviewee 3, one of the prominent factors that motivate users, and the altruistic purpose is the ease of use of the application.

> "I think first, from the users' **perspective, really the ease**. Every time we ask, they talk about practicality so, like, it costs nothing is the least I can do and such [...] being easy from the point of view of users so **I can do a good thing very easily** [...]" (Interviewee 3, 2020, emphasis added)

Regarding the choice of Ribon, many of the users had never volunteered before using the application. According to a survey conducted by the own company.

> "[...] in this research that we do, we asked users if they had ever donated or done voluntary work. **60% users had never done it, doing it for the first time at Ribon** [...]." (Interviewee 1, 2020, emphasis added)

Another factor that induces people to volunteer and make donations is faith. After all, philanthropic behavior, though, for example, volunteering, is encouraged in different religious institutions (Yeung, 2017). Furthermore, the cultural context factor is considered since the local culture influences an individual's emotions, cognition, and behavior, making the propensity to donate different depending on the observed culture (Mateiu-Vescan, Ionescu & Opre, 2020).

> "It is so good to see initiatives like this. I am amazed. We often think about how we can help, here comes a fantastic App like this. Congratulations to those who invented it. Brands that sponsor, people who donate for the initiative. This is a wonderful world in just one click. God bless you richly. It is exciting. **Thank you, God, for giving us such spectacular people** [...]" (*u_368, emphasis added)

In a broad sense, there is a feeling of collectivism, that is, an awareness of the application users who are engaged in favor of the common good, with a feeling of satisfaction and gratitude for the effect that the application has and with its creators. In this way, the Ribon app works to connect individuals who have the motivation and interest to volunteer and contribute to social causes but do not find in the traditional forms of volunteering the means to do so. They often do not have the resources needed to make donations. As can be seen in the comment below:

> "It is incredible. **There are many good-hearted people who, unfortunately, are unable to help others. However, with this App, there are no more barriers**. [...] in so many apps designed solely for its users, one aimed at real empathy. Thanks." (*u_242, emphasis added)

Thus, through Ribon, the user can complete this selfless desire for free, which brings enormous satisfaction to those who use it, generating a feeling of "warm glow" (Brown, Meer & Williams, 2018), internal and externally.

Subcategory - Class 4 - Credibility in using the application

When it comes to applications, factors such as usability and credibility are vital parts to attract attention and motivate the download of the app and be crucial as regards the intention to continue the use, encouraging the user's permanence and loyalty (Wu et al., 2020).

The need for trust when the user is in an online environment and, especially when using applications, is shown to be necessary since it can convey an image of vulnerability and risk regarding the transactions carried out. In this way, trust can be understood as the willingness of one party to be vulnerable to the

actions of the other party, based on certain expectations of how this second part, to which trust will be directed, will act in each situation (Mayer, Davis & Schoorman, 1995). That is, trust exists when a person believes in the integrity of the agent involved in an exchange.

In the case of Ribon, there is confidence on the part of the user that the digital coins that are collected and donated in the application are reaching the final recipient, helping the institutions involved. It should be noted that this new way of volunteering and donating digitally, at first, tends to cause strangeness due to the lack of familiarity with this model. It can discourage the use of the app, showing how much trust in transactions carried out internally. Also, its external effects are determinant for the motivation of individuals concerning its use. The trust factor on the user's part about the data involved in the application is shown as an essential point to be observed by the company.

In addition to placing trust in the application's operation, the volunteer also expects that his donation to registered organizations is being used and generating favorable results. It would generate a process of trust with the NGOs assisted by Ribon, which are chosen according to the startup's effectiveness criteria. It has the challenge of passing on this aspect of credibility to its users.

> "It does not accept registration with a Google account, only Facebook **(data sales)**. **The app also seems a little out of the Brazilian reality** since there is no need to go far (Africa) to find major social problems. It does not seem very palpable. **Anyway, if the app does what it promises, I hope it gets better over time.**" (*u_222, emphasis added)

Because of the growing offer of applications on the market, there is an increase in competitiveness in this niche, thus increasing the importance of maintaining high levels of visibility of the application, through the position occupied by the app in the ranking of virtual stores, which are made from user reviews. In the case of Ribon, a differential of its application compared to the others is based on the possibility of being classified in the emerging category freemium (combination "free" and "premium"). A model that is attractive due to the possibility of downloading for free from the app. However, some users are expected to choose to upgrade to the paid version, which usually has more features available, no ads, additional services, among others (Liu, Au & Choi, 2015). To boost the number of donated ribons, the user can choose to pay R $ 4.90 per month (or 0.90 USD), which guarantees the monthly entry of a specific amount of the virtual currency, increasing donations be accomplished by him.

> "[...] **we want to increase the recurring paying user base.** We want to triple this base in a short time, the percentage of active users versus paying users [...]" (Interviewee 4, 2020, emphasis added)

In this context, comments left in app stores are a primary source of information that helps potential users reduce uncertainty (Liu, Au & Choi, 2014). This factor can be applied when purchasing and using an app. Another critical factor is the design issue that attracts users due to its ease of use and aesthetic elements. However, in the case of the Ribon app, some factors need attention and correction to improve the user experience and, thus, give an image of credibility regarding its use. For example: "excess of bugs" (*u_316) and "remember the login" (*u_147). Quality updates can increase the survival rate of an application by up to 3 times (Lee & Raghu, 2014), which only highlights the importance of the startup investing in actions of this nature.

4. CONCLUSION

This study brought a better understanding when identifying, from the user and the company's point of view, which leads to engagement with social applications that contribute to sustainable development. The analyzes, from an exploratory and inductive study, resulted in the emergence of the dimension "Innovation through the social app" and in the following classes: "Impact of effective altruism"; "Technology, innovation, and gamification"; "Motivation about volunteering" and "Credibility in using the application".

The subcategory "Impact of effective altruism" was the one with the largest textual body among users' comments (41.83%, n=535) by the DHC method, as it relates to the altruistic motivation of the volunteers. As can be seen, effective altruism is a fundamental element in which volunteers' motivation is a donation. One of its most important aspects is the long-lasting and organized activity for the other's benefit, thus being an essential characteristic about volunteering (being supportive and helping). Together with these feelings, the feeling of "warm glow" can be noticed by the users' comments, which is configured as a model in which the agent gains utility in the act of donating (Brown, Meer & Williams, 2018). It can be translated as the positive feeling that the user feels when making donations, which also happens through the application's digital donation. Effective altruism seeks to find the most effective ways to develop positive changes in the world (Eikenberry & Mirabella, 2017). What can be observed at Ribon, when choosing what causes to incorporate in its application. The possibility of measuring the impact made by these NGOs is a determining factor for the startup and users of the app.

In the "Technology, innovation and gamification" class, the findings support social innovation and social application, and gamification concepts. They are considering the emergency scenario of startups together with a social technology bias. In this context, points like the app's design and how it works resulted in a positive opinion on the part of users. Although the question of the gamification process involved in the app is so intrinsically connected to the development and flow of processes, consequently, users do not feel that they are participating in a game or do not have the need to comment, negatively or positively, on this process. Therefore, the app fulfills its role by bringing game characteristics to the user's reality, introducing elements in harmony with the real world experienced by the individual, an essential characteristic of gamification (Pechenkina et al., 2017).

The "Motivating about volunteering" class had the lowest textual body among users' comments (13.37%, n=171) using the DHC method. It is because users have had difficulty perceiving the app as a means for the practice of volunteering - placing greater emphasis on the issue of donation based on an altruistic feeling. In this way, social motivation is interlinked with the impact of altruism carried out effectively. Thus, it is understood that the volunteer chooses to act when he recognizes a need, based on social responsibility principles, and without worrying about monetary rewards arising from this activity (Mateiu-Vescan, Ionescu & Opre, 2020). In this context, Ribon helps its users become involved with volunteering by providing the necessary conditions for this to happen virtually.

Finally, the class "Credibility in using the application" addresses the app's aesthetic and content issues that stand out as something that users have noticed. For example, "good news" provokes beneficial feelings among users. However, the app presents the need for adjustments to promote the necessary improvements in its performance, mainly taking into account the issues raised by its users that, if not corrected, can lead to evasion, even if they recognize the importance of the proposal.

In this way, the startup differentiates itself from the competition. The Interviewees presents a value proposition based on new volunteers' entry (donors), while most companies in this scenario act as donation managers (crowdfunding). The company also benefits from financial factors and the social impact part, reaching revenues of R$400 thousand (73,126.60 USD) in 2019.

According to the CEO, the guiding reason for creating the application was the desire to help create a donation habit in people, but in a simple way and with the help of a smartphone, which would inevitably attract a younger audience, considering the profile of generations Y and Z regarding the use of technologies. In surveys conducted by the startup, it was possible to observe the reach of the generations mentioned. At this point, Ribon covers the gap in practical experiences related to volunteering and also stands out about the possibility of making donations at no cost. The experience provided by the app also makes it possible to increase donations through subscriptions (freemium model).

Besides, the startup and developing volunteering users also acquire information and develop knowledge through the educational initiative that the company proposes to do, providing relevant news and facts as a bargaining chip for the donation. When reading the news, the user collects ribons that will be sent to an institution of their choice.

Regarding future strategies, the respondents signaled that the focus is on understanding users' behavior patterns and, consequently, increasing the paying base. Invest in gamification strategies, creating a culture of giving in a format that young people will engage and want to participate. Internationalization of the user base to open to foreign NGOs and philanthropists. In addition to the possible implementation of a blockchain system to keep the record of all donations unchanged.

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25.Transformação Digital para Além da Tecnologia
Uma Análise sobre as Pessoas e os Processos Relacionados com o Uso das Mídias Sociais na Prefeitura de Salvador-Bahia

Emanuelle Daltro
Prefeitura Municipal de Salvador
emmanuelle.fonseca@salvador.ba.gov.br

Marques dos Santos
Universidade Federal da Bahia
emarques@ufba.br

Mira da Silva
Universidade de Lisboa
mms@tecnico.ulisboa.pt

Resumo

As mídias sociais alteraram os modos de relacionamento entre os indivíduos e as organizações e podem ser compreendidas como um dos elementos catalisadores da transformação digital no setor público. Este trabalho tem o objetivo de analisar as pessoas e os processos relacionados ao uso de mídias sociais na prefeitura de Salvador, Bahia, Brasil, como elementos de transformação digital. Para atingir o objetivo proposto, foi realizado um estudo qualitativo que utilizou análise documental, observação direta de sites e entrevistas como técnicas de coleta de dados. Os dados foram categorizados e analisados em triangulação. Os resultados evidenciaram os atores e os processos envolvidos com uso das mídias sociais, sendo o mais influente deles o chefe do poder executivo, reafirmando o disposto na literatura de que a transformação digital pressupõe uma liderança forte e envolvida ativamente com a implantação e implementação das tecnologias, tendo, portanto, um viés top down.

Palavras-chave: Mídias Sociais, Transformação Digital, Setor Público.

1. Introdução

As mídias sociais, a exemplo do Facebook, Instagram, YouTube, Twitter e blogs em geral, tem alterado profundamente os modos de relacionamento entre os cidadãos e a administração pública (Aurylaitė, 2017; Daltro, Barbosa, Machado, Santos & Barrios, 2017; Mergel, 2010, 2012, 2013a, 2013b), constituindo-se da quinta onda de inovação no governo (Zhan & Xiao, 2017). Tais tecnologias são compreendidas como sites na internet que permitem a criação colaborativa de conteúdo, interação social e compartilhamento de informações em diversos formatos, tais como textos, imagens, áudios e vídeos (Arnaut *et al*., 2011; Evans, 2010; Malini, 2008; Telles, 2010), se conformando como "oportunidades mediadas para aproximar pessoas, incentivando redes sociais e comunicação dialógica" (Sweetser & Lariscy, 2008, p. 180). As mídias sociais são tecnologias digitais com potencial para transformar processos e modelos de negócios - incluindo a concepção de negócio enquanto serviços prestados pelo poder público, e podem ser entendidas como um dos elementos que contribuem para a transformação digital neste setor.

Por lidarem diretamente com a prestação de serviços e atendimento de demandas imediatas em seus municípios, as prefeituras brasileiras têm encontrado nas mídias sociais a rapidez e a versatilidade necessárias para se comunicar com seus cidadãos, com um custo baixo o suficiente para não comprometer seus orçamentos (Silva, Daltro, dos Santos & Oliveira, 2015). De acordo com os dados apresentados pela TIC Governo Eletrônico 2017, 82% dos governos municipais brasileiros utilizam as mídias sociais, em especial o Facebook (Barbosa, 2018).

Nesse contexto, considerando que a utilização de mídias sociais pelo setor público encontra-se no plano das experimentações (Bonsón, Royo & Ratkai, 2017; Rothberg & da Silva Valença, 2014), nota-se que

há lacunas no conhecimento específico sobre o uso de tais tecnologias neste setor. Deste modo, estudos que contribuam para o aperfeiçoamento da utilização e da gestão das mídias sociais pelas prefeituras, empresas de tecnologia e gestores municipais são justificáveis, uma vez que seus processos diferem da dinâmica da comunicação pública tradicional.

Diante deste cenário, o objetivo geral deste trabalho é analisar as pessoas e os processos relacionados ao uso de mídias sociais na Prefeitura de Salvador, como elemento de transformação digital, buscando verificar se, no cenário do estudo, tal transformação se aproxima ou se distancia do viés *top down* proposto na literatura.

Além desta introdução, este artigo está organizado em mais quatro partes. A primeira delas apresenta uma visão geral sobre transformação digital e mídias sociais e governos. A seguir, são descritos os procedimentos metodológicos, evidenciando o campo empírico, a coleta e a análise de dados. Na terceira parte são discutidos os resultados da pesquisa e, por fim, é apresentada a conclusão do estudo, ressaltando os principais achados, as limitações e as indicações de estudos futuros.

2. Visão Geral sobre Transformação Digital e Uso de Mídias Sociais pelos Governos

O surgimento de novas tecnologias é o principal direcionador da transformação digital. Contudo, diversos autores afirmam que a chave para tal transformação vai além da tecnologia per se, sendo imperativo superar a visão de que apenas ela - a tecnologia - é a responsável pelo processo de transformação digital (Berger, 2014; Keane, 2000; Stief, Eidhoff & Voeth, 2016; Westerman, Tannou, Bonnet, Ferraris & McAfee, 2012).

Para Haffke, Kalgovas e Benlian (2017), a transformação digital desafia as expectativas tradicionais da função de Tecnologia de Informação (TI), uma vez que as organizações exigem usos inovativos em um contexto de negócios digitais. A transformação digital é vista, portanto, como uma oportunidade para a revisão de processos e possibilita a construção de uma nova estrutura, visando à eficiência operacional resultante da utilização de Tecnologias de Informação e Comunicação (TIC).

Para Ross *et al.* (como citado em Sebastian, Ross, Beath, Mocker, Moloney & Fonstad, 2017), uma transformação digital bem sucedida contempla a definição de uma estratégia digital que defina uma proposição de valor baseada no uso de tecnologias digitais; de um conjunto de processos, tecnologias e sistemas que facilite a excelência operacional e da adoção de uma plataforma de serviços digitais que permita rapidez de inovação e responsividade às novas oportunidades de mercado.

Para que a transformação digital ocorra, duas dimensões devem estar presentes e fortalecidas nas organizações. A primeira delas é a própria competência digital, que se traduz não apenas pela presença de tecnologias digitais, mas, principalmente, pela forma como as novas tecnologias são vistas por estas organizações, e, em seguida, as competências de liderança que são identificadas nas pessoas envolvidas com o processo de transformação digital (Berger, 2014; Keane, 2000; Westerman *et al.*, 2012).

Para Mergel, Edelmann e Haug, (2019), as abordagens de transformação digital fora do setor público estão alterando as expectativas dos cidadãos em relação aos governos e suas capacidades de fornecer serviços digitais de alto valor em tempo real. Em resposta a tais expectativas, os governos estão mudando seu modo de operação para melhorar a prestação de serviços públicos e serem mais eficientes e eficazes em seus projetos, alcançando seus objetivos como maior transparência, interoperabilidade ou satisfação do cidadão (Mergel *et al.*, 2019).

A transformação digital é um cenário ao qual o setor público está exposto e para o qual é demandado um esforço de reflexão e planejamento, uma vez que há pouca visão sistemática sobre a forma como os gestores públicos lidam com o fenômeno em suas próprias práticas do dia-a-dia (Mergel *et al.*, 2019).

Para Roncaratti, Hartz, Vellozo Júnior e Judice (2019), o setor público, em geral, não vem conseguindo absorver a transformação digital na mesma velocidade em que a sociedade vem incorporando as novas tecnologias, o que prejudica, ainda mais, os níveis de confiança do cidadão em relação ao Estado.

O advento da internet ocasionou mudanças nas formas de comunicação no setor público, possibilitando a construção de pontes estratégicas para aproximação dos governos com os cidadãos, sendo a adoção das mídias sociais um dos exemplos desse fenômeno (da Rosa & de Almeida, 2018). Neste sentido, Cunha, Przeybilovicz, Macaya e Santos, (2016) afirmam que o monitoramento das mídias sociais auxilia as autoridades locais a empreenderem uma melhor gestão urbana.

Nesse contexto, os órgãos de administração pública, em suas diversas esferas, têm utilizado as mídias sociais como meios de informar e prestar contas à sociedade. Conforme Lucena e Chaves (2019), a tecnologia das mídias sociais, elaborada com fins de interação social, foi amplamente adotada por organizações empresariais de todo o mundo, aproximando clientes e empresas, sendo perceptível sua adoção, também, nas interações entre cidadãos e organizações públicas.

No que se refere à participação cidadã, o estudo de Joia e Soares (2018), reconhece que as mídias sociais dão poder e conscientização às pessoas. Contudo, os autores destacam que o processo de construção de demandas por mudanças sociais e políticas depende de motivações e cadeias de influência que transcendem as capacidades técnicas das mídias sociais (Joia & Soares, 2018).

Deste modo, mesmo reconhecendo os usos inadequados das mídias sociais, sobretudo no que tange à disseminação de informações falsas, as chamadas *fake news*, e à manipulação de algoritmos, por razões alheias ao interesse público (Amaral & Sofia,2019), a utilização das mídias sociais pode ser considerada uma inovação na entrega do serviço governamentais, uma vez que se constitui como um novo e potente canal de comunicação.

3. Aspectos Metodológicos

Este trabalho trata de um estudo qualitativo que tem como objetivo analisar as pessoas e os processos relacionados ao uso de mídias sociais na prefeitura de uma capital brasileira, destacando as características inerentes à transformação digital.

Como campo da pesquisa empírica foi selecionada a Prefeitura Municipal de Salvador (PMS), capital do Estado da Bahia, Brasil. Com 2.886.698 habitantes, Salvador é o município mais populoso do Nordeste e quarto do Brasil, segundo estimativas do Instituto Brasileiro de Geografia e Estatística [IBGE] (2020). A opção por analisar uma prefeitura deu-se em função de ser o nível de governo mais próximo da população (*local government*) (Bonsón, Torres, Royo & Flores, 2012). Os critérios de seleção da PMS incluíram o uso intensivo de mídias sociais, de forma oficial, pelos órgãos, departamentos e agentes políticos municipais e o fato de Salvador possuir diversas iniciativas voltadas para o incremento tecnológico e ocupar a 146ª posição no ranking das principais Smart Cities do mundo, divulgado pelo IESE Business School, em 2019, sendo a única cidade do Nordeste do Brasil entre as que aparecem no ranking.

Já a escolha dos órgãos da PMS para aplicação do estudo empírico deu-se em função do trabalho de Cunha *et al.* (2016) que identifica os setores responsáveis pela saúde, educação, economia, gestão, segurança, meio ambiente e mobilidade como prioritários quando se trata de incremento tecnológico. Deste modo, foram selecionados para estudo a Secretaria Municipal de Ordem Pública (SEMOP) e a Defesa Civil de Salvador (CODESAL), representando o setor de segurança e meio ambiente, e a Superintendência de Trânsito de Salvador (Transalvador), representando o setor de mobilidade.

As técnicas de coleta de dados utilizadas neste estudo foram o estudo documental, a observação direta de sites e entrevistas semiestruturadas. Quanto ao estudo documental, foram recuperados leis, decretos e portarias que tratam do uso de mídias sociais no âmbito governamental da PMS, por meio de pesquisa das palavras-chave "redes sociais", "rede social", "mídias sociais", "mídia social" e "sites de relacionamento" no site de Leis Municipais (https://leismunicipais.com.br), resultando em 22 documentos par análise. No que diz respeito à observação direta de sites, além do site oficial da PMS, foram observados os sites de redes sociais oficiais da SEMOP, CODESAL e da TRANSALVADOR, nas mídias sociais Facebook e Instagram. Tais mídias sociais foram escolhida por serem as primeiras no ranking de utilização pelos cidadãos brasileiros.

As entrevistas, por sua vez, foram realizadas em fevereiro e março de 2020, face a face, no setor de trabalho de cada participante. Dente os quatro sujeitos entrevistados, um é diretor e três são gestores de mídias sociais dos órgãos estudados, com idades entre 29 e 63 anos. A seleção dos entrevistados deu-se pelo critério de acessibilidade dentre os agentes públicos que atuavam com a gestão ou operacionalização de mídias sociais nos setores selecionados. Com duração média de 20min 46s, variando entre 11min57s e 32min43s, as entrevistas foram gravadas em mídia eletrônica, após a leitura e assinatura do termo de consentimento livre pelo entrevistado.

Para a análise dos dados, as entrevistas foram transcritas, revisadas e codificadas com vista a garantir o sigilo e o anonimato dos entrevistados e, juntamente com as informações obtidas nos documentos e nos sites, foram categorizadas e analisadas em triangulação.

4. Resultados e Discussão

Esta seção identifica atores e processos envolvidos com o uso das mídias sociais, bem como a interação gerada entre eles, evidenciando os fatores individuais e os fatores organizacionais, poderes e conflitos relevantes para a transformação digital.

Além do corpo diretivo responsável pela gestão central das tecnologias e das mídias sociais da PMS, esta pesquisa identificou que, nos órgãos estudados, existem estruturas que respondem setorialmente pela gestão de mídias sociais. Apesar de serem estruturas enxutas, gerenciadas e operacionalizadas pelos assessores de comunicação com apoio de pessoal técnico bastante restrito, observa-se uma condução eficiente dos processos relacionados ao uso das mídias sociais.

Já fora argumentado neste trabalho que a transformação digital deriva da interação entre a tecnologia e as pessoas, sendo imprescindível o deslocamento da visão tecnocêntrica para uma visão que priorize a interação social, na qual a tecnologia deixe de ser um mito e passe a ser parte de uma estrutura que se adapte às demandas organizacionais e que gere o máximo de eficiência para a organização.

Coadunando com o exposto, observa-se que, no nível setorial, a figura do Assessor de Comunicação representa a operacionalização do uso das mídias sociais no setor público e, deste modo, uma das primeiras análises apresentadas é quanto às características destes atores, resultando no perfil que se segue.

A existência tanto de nativos quanto de imigrantes digitais (Prensky, 2001), dentre os assessores de comunicação, poderia ser um gerador de conflitos no uso das mídias sociais. No entanto, todos os entrevistados demonstraram ser favoráveis ao uso de mídias sociais na administração pública e, embora com diferentes preferências quanto às plataformas utilizadas, todos relataram ter habilidade no uso, como exemplificado a seguir.

> [...] gosto muito do Facebook porque permite, digamos, textos mais... bem mais conteúdo. O Instagram é mais ligeiro, vamos dizer assim, aí eu gosto mais do Facebook. (Entrevistado 3)

A formação profissional dos assessores entrevistados é bastante robusta, sendo todos jornalistas com pós-graduações na área, que variam de especialização a doutorado em curso. No que se refere à capacitação para o uso de mídias sociais, há repetidas referências ao aprendizado no fazer cotidiano, que se iniciou no âmbito pessoal e, ocasionalmente, foi aperfeiçoado em empregos anteriores ou em cursos oferecidos pela municipalidade.

> [...] não tomei curso não. Olha, teve um curso que eu participei que foi até promovido pela prefeitura, pelos assessores aqui da prefeitura, e eu também fiz a pós-graduação em comunicação estratégica, o que me deu uma visão bem bacana dessa questão de comunicação estratégica e de como posicionar sua marca, de como conversar com seus stakeholders, que a gente chama público-alvo. (Entrevistado 4)

> [...] primeiro eu era jornalista num jornal grande aqui de Salvador e houve um curso de treinamento, porque eles tinham interesse em dar visibilidade a canais específicos. No caso eu gostava tanto que eu fiz jornalismo científico, o meu canal era divulgação de ciência, então eu fiz um treino que elas ensinaram, nesse tempo o Instagram era engatinho, o Facebook que era grande novidade. O Orkut? Usei, não conte para ninguém, mas não era tão velho assim não, é década de 2000, né (Risos). (Entrevistado 3)

> [...] quando eu me formei nem se falava na faculdade e rede social. O que a gente falava muito era internet e em site, a gente não pensava em aplicativo, em rede social, que os professores batiam muito que é o que está acontecendo hoje, que impresso ia perder, que a revista ia perder, que a gente ia virar revista eletrônica, enfim, então foi uma coisa que foi acontecendo, foi acontecendo... quando eu me vi no Facebook, e comecei a ver que os políticos estavam começando a realizar política através de Facebook, eu fui começando a procurar cursos. Na realidade, não foi um interesse meu, foi um interesse profissional que me fez ir atrás de cursos de rede social para eu ter conteúdo suficiente para vender a minha assessoria. (Entrevistado 1)

Em relação ao vínculo trabalhista dos assessores de comunicação que lidam com as mídias sociais, registre-se que todos são terceirizados, ou seja, possuem contratos de trabalho com prazo determinado. Tal situação pode fragilizar a institucionalização das novas estruturas formadas no processo de transformação digital gerado pelo uso de mídias sociais, isto porque estes atores são centrais para a ocorrência do fenômeno em tela e a falta de estabilidade no cargo ocupado é uma desvantagem estratégica para a consolidação do trabalho já iniciado. Nesse contexto, a descontinuidade do uso das mídias sociais, em decorrência de substituição de profissional, por exemplo, fora relatada por um dos entrevistados.

> [...] por mudança de profissional local houve uma perda de senha [de acesso a mídia social], mas depois a gente conseguiu recuperar, um técnico novo conseguiu fazer isso. (Entrevistado 3)

Para além dos assessores de comunicação, os dirigentes dos órgãos, também, são responsáveis pelas mídias sociais, pois mesmo não operacionalizando tais tecnologias, eles são os provedores dos recursos necessários para tal. Dessa forma, entende-se que o apoio do líder, seja ele secretário, diretor ou superintendente, é decisivo no processo de transformação digital.

Com nível superior completo, especialista em direito público municipal e com formação na área de comunicação, dentre outras qualificações acadêmicas, o dirigente entrevistado neste trabalho utiliza redes sociais tanto de forma particular quanto institucional e é entusiasta da utilização destas tecnologias na gestão pública. Tendo atuado anteriormente em outros cargos e funções na PMS, o Entrevistado 2 relata a importância do uso de mídias sociais no serviço público, como transcrito a seguir.

> Eu uso mídia social desde que foram abertas, [...] eu observei o alcance e a facilidade em comunicar melhor com as pessoas, sobretudo aquelas as quais eu tinha relação por conta da minha função [...], quando eu virei subprefeito do subúrbio ferroviário. O subúrbio ferroviário é uma região muito distante, até outro dia era muito distante, inclusive, da vida social da cidade, e aí eu comecei a me questionar, [...], como eu faço para que as pessoas saibam o que nós estamos produzindo aqui? Somando a isso outras questões, como mostrar o lado bom daquela região, a gente sempre escutava nos programas televisivos e tudo o mais essa necessidade de falar que era morte, que tinha problema, que tinha coisas ruins... e eu enxergava outras coisas quando trabalhava naquela localidade. Eu comecei a fazer esse tipo de divulgação dos restaurantes, das belas praias, mostrar que tinha outro lado, das pessoas bacanas da localidade. Quando apareceu

o Instagram que, embora tivesse há mais tempo, eu percebia que tinha, na região na qual eu atuava, uma penetração, uma presença maior de usuários do Facebook. De um tempo para cá eu comecei a fazer casado, então toda publicação que eu coloco no Instagram automaticamente eu replico para o Facebook, exceto aquelas que são limitadas, que são as de links, [...] Instagram tem esse problema, ele fica estático, ele não tem a capacidade de clicar num link e direcionar para a matéria em si. É uma pena! É uma perda que tem hoje nessa plataforma, mas de uma forma ou de outra você termina indicando e apontando caminhos, então essa é minha jornada com essas plataformas"

Aspectos organizacionais também acrescentam relevância ao uso de mídias sociais na administração pública da capital baiana. Em se tratando de setores imprescindíveis para administração pública de uma metrópole, a SEMOP, a CODESAL e a TRANSALVADOR carregam consigo enormes responsabilidades e demandas. A fala de um dos assessores de comunicação entrevistados revela a magnitude do trabalho desenvolvido, como transcrito a seguir:

Meu secretario [...] fala que ele foi escolhido para ser síndico da cidade, não secretário. Nós temos a ordem pública que vai de ambulante, vias públicas, nós temos iluminação, nós temos Salvamar... aí, dentro de ambulantes, tem baianas de acarajé, temos guarda municipal, Codecon, poluição sonora, e cada uma com suas especificidades e dificuldades, bem variado. Acredito que seja para quem está na parte administrativa muito tensa, e para a gente da imprensa, na assessoria de comunicação, também é muito tensa, as pessoas não têm noção o quanto, porque uma faiscazinha a imprensa transforma em um incêndio, em qualquer coisa, em qualquer situação, em qualquer setor. (Entrevistado 1)

Com o dever de estarem sempre atentos e proativos, os órgãos que atuam com prevenção e segurança se beneficiam das redes sociais como um observatório complementar às outras tecnologias digitais. A capilaridade das mídias sociais colabora para fazer chegar alertas em tempo oportuno, bem como para acompanhar situações de risco postadas e compartilhadas pelos cidadãos, contribuindo para que a resposta aos riscos seja dada com a celeridade necessária.

Defesa civil de Salvador, historicamente, ela atuou na perspectiva da resposta, contingência... tinha problemas na cidade e aí as equipes iam a campo realizar vistorias, afastar o risco, enfim, dar resposta, sobretudo, ao problema já ocorrido. Em dois mil e dezesseis o prefeito [...] fez toda uma restruturação do nosso órgão, de tal modo que se viu lançando nova defesa civil de outro órgão, de uma série de profissionais qualificados, engenheiros civis, engenheiros ambientais, engenheiros agrônomos, arquitetos, técnicos, as mais diversas linhas de atuação, meteorologistas... para que todos pudessem conceber e praticar as ações desse novo momento do órgão, fora isso um órgão com a tecnologia extremamente avançada [...]. (Entrevistado 2).

4.1 Liderança Forte: Transformação Digital *Top Down*

O espírito das mídias sociais, bem como o contexto fluido no qual elas foram inseridas na administração pública, concorreram para a elaboração do pressuposto de que o uso de mídias sociais pela prefeitura ocorre de forma emergente e não deliberada, em confronto com a literatura especializada, a qual afirma que a transformação digital é sempre *top down*.

Nesse sentido, em que pese a ausência de memória fidedigna sobre a identidade das pessoas que criaram as páginas dos órgãos supracitados, bem como do cargo ou função que ocupavam à época, há evidências de que tal ação não fora disparada por meio de uma demanda oficial única e estruturada, pois, nos relatos dos entrevistados, houve citações a diversos atores marginais que, possivelmente, estiveram envolvidos na decisão de criar as páginas nas redes sociais. Este achado de pesquisa levou, inicialmente, à reflexão de que o uso das mídias sociais partiu de setores e atores posicionados em baixa hierarquia e, portanto, que a transformação digital catalisada pelo uso de mídias sociais é do tipo emergente (*buttom up*), ou seja, não deliberada.

Contudo, um olhar mais aprofundado sobre os dados, atrelado à literatura sobre transformação digital, permitiu uma nova reflexão acerca do achado acima descrito. Considerando que a transformação digital bem-sucedida depende de um conjunto de processos, tecnologias e sistemas que facilitem a excelência operacional (Sebastian *et al.,* 2017), apenas a criação de páginas nas redes sociais não representaria, em tese, um elemento de transformação digital, caso não fosse acompanhada de regras, processos e uma série de fatores individuais e organizacionais para que novas estruturas surjam e sejam institucionalizadas.

Coadunando com o acima exposto, identificou-se, por meio da análise das entrevistas, que há um direcionamento assertivo para o alcance da eficiência na utilização das mídias sociais na PMS, reforçando que há uma estratégia deliberada para o uso de mídias sociais nesta capital, evidenciado, inclusive, nos documentos de planejamento estratégico local. Tal direcionamento é capitaneado, de forma inequívoca, pelo atual chefe do poder executivo, conforme identificado nos trechos transcritos a seguir, nos quais os entrevistados falam sobre o tema.

> [...] poucos gestores dão tanta importância a comunicação, a não ser quando existe uma crise [...] assim, a gente tem a sorte que o prefeito é uma pessoa midiática, é um gestor midiático...ele acredita na comunicação, tanto que o sucesso dele é muito devido a isso, ele sabe se comunicar. Então, por isso que a gente tem essa facilidade de as secretarias terem uma equipe de comunicação, de ter uma diretora de rede social, mas eu não sei se acontecer de mudar uma gestão, se isso vai ter esse mesmo olhar. (Entrevistado 1)

> O prefeito [...] é um craque nisso! Então é uma figura que atua muito bem, milita muito bem nessa coisa da rede social. Ele faz uso da rede social. Ele tem um Staff que trata disso, uma vez ou outra ele mesmo que entra, futuca, olha e responde. (Entrevistado 2)

> Na atual administração, talvez até pela faixa etária do prefeito e do grupo que acompanha e dá o apoio a ele, há muito interesse em redes sociais, vamos dizer assim [...] nesse sentido há um estímulo de que se use muito redes sociais. (Entrevistado 3)

Diante do exposto, tem-se o uso de mídias sociais pela prefeitura estudada, no contexto da transformação digital, sofre efeitos de uma liderança forte e entusiasta, no caso o chefe do poder executivo local, que contribui para a institucionalização e utilização eficiente desta tecnologia.

4.2 Uma Transformação Digital com Poucos Conflitos

Fazendo um arrazoado sobre os processos que concorrem para a transformação digital, tem-se que o ponto de maior potência é, justamente, a interação social, na qual se espera a ocorrência de conflitos de diversas naturezas, dentre eles os conflitos geracionais, culturais, de assimetria de informação e de aprendizado.

De forma adicional, em se tratando da administração pública, que possui na sua estrutura órgãos com finalidades e competências que se interseccionam, o conflito pode se instalar em função das demandas que, mesmo sendo geradas por um setor específico, acabam por impactar em outros setores como, por exemplo, problemas com a falha no recolhimento do lixo, atribuição da SEMOP, pode impactar no entupimento de bueiros e no deslizamento de encostas, gerando demandas que estão sob responsabilidade da CODESAL.

Como ilustrado no trecho a seguir, observa-se a evidência de um potencial conflito de natureza semelhante ao exemplo hipotético citado acima, que reverbera nas redes sociais oficiais.

> [...] a gente tem uma pessoa que mesmo toda a postagem que a gente fala, ele fala dos bueiros na via. Todas as postagens! Todas não, noventa por cento... a gente já chegou para ele: 'olha, bueiro não é a gente, eu já liguei para o assessor do outro órgão para falar com ele. 'Não, tudo bem, posta outra coisa que não tem nada a ver com bueiro ele: 'e os bueiros? Cadê a Transalvador que não fiscaliza nada? 'Não é a gente que faz essa questão dos bueiros, e ficam cobrando a gente. E a gente tem essa preocupação... a gente, por ser um órgão público, tem que dar sempre satisfação, porque é nossa obrigação mesmo, dar satisfação ao público que é o cidadão, o nosso público é o cidadão, então a gente sempre tem essa preocupação de dar essa satisfação ao cidadão. (Entrevistado 4)

Contudo, muito embora a existência de conflitos não tenha se demonstrado uma característica forte no uso de mídias sociais na PMS, observou-se, nas entrevistas, uma tensão entre os assessores de comunicação que as operacionalizam, não sendo, necessariamente, entre os que foram entrevistados. Um

exemplo de tensão, ainda que latente, é a diferença significativa na geração de conteúdo, observada entre as páginas das secretarias que compõem a estrutura municipal.

> [...] aqui que a gente tem muito assunto, muita forma de postar. Por exemplo, eu tenho outros colegas, de outras assessorias, que não tem o que postar, até pelo próprio negócio. Por exemplo, eu vou citar aqui a questão da SEMGE, as pautas da Transalvador, se comparadas com as da SEMGE, rendem mais rede social do que a SEMGE, então a gente tem esse conflito, se é bom usar, se não é bom usar, e o que a gente vai postar [...]. (Entrevistado 4)

Em que pese à tensão acima relatada, o relacionamento entre os profissionais que operacionalizam as mídias sociais na PMS parece ser harmônico. Contudo, é perceptível a crítica do uso de mídias sociais pela administração pública de modo geral, na qual há referências à falta de capacitação dos profissionais de comunicação, ao uso indiscriminado de plataformas, à dificuldade na relação com outros profissionais que trabalham com mídias sociais [externos à prefeitura], além do restrito investimento na gestão de mídias sociais setoriais. Tais questões são sumarizadas pelo Entrevistado 1, conforme trechos transcritos a seguir.

> [...]as pessoas ainda não têm esclarecimento suficiente para usar a rede social, é uma ferramenta perigosa para quem não sabe usar. Mas, hoje o caminho está sendo totalmente esse e cada vez mais as pessoas estão buscando, mais e mais, aparecer... dez mil tipos de Instagram, eu acredito que será usado dez mil tipos de Instagram[...].
> A relação com outros profissionais que trabalham com mídias sociais [externos à prefeitura] é muito difícil. Assim [...] eu não me vejo muito encantado por esse mundo, porque [...] eu acho um mundo fútil, mentiroso, [...] então eu foco mais no meu estudo acadêmico. Então, eu procuro mais saber de português, de comunicação, de vender, de como fazer com que o meu cliente se torne atrativo para aquele profissional que realmente entende de rede social.

> [...]Na percepção geral, eu dou nota mil às redes sociais da prefeitura, do prefeito e da prefeitura de Salvador, mas zero para qualquer uma, inclusive a minha. De secretarias, zero não sabem usar. Não sei se por ser serviço público, as pessoas não se engajam muito, não se interessam muito, ou se é culpa dos gestores, porque, realmente, para você ter uma equipe boa de rede social tem que ter um custo. Hoje eu acredito que o profissional de rede social é um dos custos mais caros, porque são pessoas que não entendem só de rede social, eles entendem de internet, buscam, pesquisam a hashtag correta... quando sai um serviço feito novo eles já sabem antes do que todo mundo. Então, assim, são profissionais que se dedicam àquilo... os gestores não entendem isso. O prefeito entende, tanto é que a [...] é uma das melhores profissionais que eu já conheci em rede social, aqui da Bahia.

Em síntese, resta demonstrado que o uso de mídias sociais nos orgãos da prefeitura de Salvador estudados se dá de forma deliberada, capitaneada por uma liderança que, juntamente com outras pessoas, está orientada para a transformação digital na administração pública.

5. Conclusão
Esta trabalho analisou as pessoas e os processos relacionados ao uso de mídias sociais na prefeitura de Salvador, destacando as características inerentes à transformação digital.

Os principais resultados evidenciaram a presença de pessoas capacitadas frente à operacionalização e à gestão das mídias sociais nos setores estudados, além de uma visão consolidada sobre os objetivos e os valores subjacentes ao uso das mídias sociais. Evidenciaram, também, que há um risco de ruptura do processo de consolidação do uso das mídias sociais no setor público em função da fraglidade dos vínculos trabalhistas dos responsaveis pela operacionalização de tais tecnologias. Adicionalmente, foi identificado que o uso de mídias sociais na prefeitura de Salvador ocorre em meio a conflitos, com a ressalva de que estes são ínfimos diante do que se esperava frente ao uso de uma tecnologia avançada, que demanda interação entre diversos atores. Tais resultados podem ser utilizados para o aprimoramento gerencial do uso das mídias sociais, tanto no contexto local quanto em contextos semelhantes.

Os dados e análises demonstraram, ainda, que, coadunando com a literatura especializada, a implementação das mídias sociais na prefeitura de Salvador tem um viés *top down*, sendo capitaneada pelo chefe do poder executivo local, que se constitui, neste cenário, numa liderança de alta hierarquia,

cujo apoio promove o processo de transformação digital. Tal achado é uma contribuição para a solidificação da base teórica sobre transformação digital no setor público, no que se refere a sua direcionalidade *top down.*

Como limitação deste trabalho tem-se o número reduzido de entrevistas, em razão da conjuntura estabelecida pelo novo coronavírus. A situação pandêmica da covid-19 gerou sobrecarga de trabalho para os sujeitos de pesquisa, inviabilizando a disponibilização de tempo para participação de entrevistas, mesmo de forma remota. Deste modo, ainda que seja possível uma extrapolação teórica dos resultados deste trabalho, ele não deve ser generalizado em razão das limitações metodológicas e operacionais.

Por fim, indica-se a realização de estudos futuros, ampliando o número de entrevistados, abrangendo os setores de saúde, educação, economia e gestão municipal, para que alcance maior robustez no entendimento sobre o uso de mídias sociais na PMS, bem como sobre as mudanças de paradigma para a gestão pública advindas deste uso.

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26.   Understanding the use of digital payments in Brazil: An analysis from the perspective of digital divide measures

Marcelo Henrique de Araujo
EAESP - FGV
marcelo.haraujo@gmail.com

Eduardo H. Diniz
EAESP-FGV
eduardo.diniz@fgv.br

Abstract

This paper analyzes the factors that influence the use of digital payments in Brazil from the perspective of digital divide studies. For this purpose, the research uses the microdata of the 2019 edition of a Brazilian nationwide survey named ICT Households Survey. The main findings demonstrate that women, as well as users of low-income social class, were less likely to use digital payments. The results also indicate that although different studies highlight the relevance of mobile phones as a means to promote digital financial inclusion to low-income groups, this paper's findings show that the exclusive use of mobile phones to access the Internet had a negative impact on the use of digital payments. These results demonstrate the need to better understand the implications of the exclusive use of this type of device in harnessing digital financial services in the context of developing countries of the global South.

Keywords: Digital Payment Adoption, Financial Inclusion, Digital Divide, Mobile devices, Digital Skills.

1. Introduction

Access to financial services plays a vital role in tackling social inequalities by fostering countries' poverty reduction and economic growth (Pazarbasioglu et al., 2020; Kim et al., 2018). Although the relationship abovementioned is recognized in the literature, the gap in access to financial services persists, and more than 30% of the world's population remains financially under-served with little access to some of the basic formal financial services, such as credit, payments, savings, and insurance (Demirguc-Kunt et al., 2018).

In this scenario, Information and Communication Technologies (ICT) plays a central role in promoting financial inclusion as digital financial services can expand the delivery of basic financial services, mainly to the low-income population, through innovative solutions using mobile devices, digital payment platforms, and mobile money solutions (Rana et al., 2018; De Albuquerque et al., 2014). Digital financial platforms allow providing financial services more accessible, safe, and convenient to users since mobile phones are more pervasive in the population, even among the poorest.

Although mobile devices' beneficial potential for digital financial inclusion is undeniable, many studies emphasize material access to that devices, denoting that it would be sufficient for the individual to use financial services and achieve the expected benefits (De Albuquerque et al., 2014; Ligon et al., 2019; Patil et al., 2018). In contradiction to this understanding, data from the ICT Household Survey in Brazil show that among the total Internet users (74% of the population), 99% connect to the Internet via mobile devices. It is noteworthy that even among users with less economic power, the use of mobile phones is higher than 90%, thus evidencing universal access to the Internet via mobile devices. At the same time, digital payments – the most basic of the financial services – reach only 9% among users of less economic power and 31% of the middle class (CGI, 2020).

The literature in this field indicates a wide variety of determinants for the use of digital financial services, drivers' factors - such as utility, perceived expectancy, perceived ease of use, perceived usefulness (e.g. Kim et al., 2018; Al-Okaily et al., 2020; Sivathanu, 2019; Alkhowaiter, 2020) - or inhibitors ones, for example, perceived security and privacy, trust and risks (Patil et al., 2017, 2018). This paper contributes

to the literature on digital financial inclusion by analyzing the factors that influence the use of digital financial services from the perspective of digital divide studies.

Although the first studies on digital divide focused only on the dimension of material access to the technological artifact (first-order digital divide), the progression of research in this field allowed to broaden the understanding of this phenomenon, highlighting the multiple dimensions of digital divide or digital inequalities (Van Deursen & Van Dijk, 2019; Scheerder et al., 2017). We believe that, just as happens with the digital divide phenomenon, digital financial inclusion is not limited to material access to technological artifacts but also expands to include attitudinal, behavioral, motivational, cognitive aspects (skills), and the use of the technological artifact (second-order digital divide) (Van Dijk & Van Deursen, 2014). Besides, second-order digital divide studies show that Internet use is unevenly distributed based on gender, education, age, geographic area, and social class, factors defined as digital divide determinants (Litt, 2013).

In this paper, we use the microdata of the 2019 edition from the ICT Households Survey in Brazil (CGI, 2020) to investigate digital payment services penetration, an important first point of entry into the formal financial system (Demirguc-Kunt et al., 2018). This investigation proposes the following research question: *How is the use of digital payments influenced by sociodemographic factors, conditions of Internet access, and digital skills of Brazilian Internet users?*

2. Theoretical background

In this paper, we will consider two aspects related to the digital divide that can influence digital payment adoption by the low-income population: material access to the Internet and digital skills.

2.1 Redefining the understanding of material access to the Internet

One of the main pillars of digital divide studies is the dimension of material access to technological artifacts (Van Dijk & Van Deursen, 2014). Although this dimension is closely related to digital inequalities, understanding material access has undergone significant changes over time. After all, this concept of access was initially restricted to the possession of the technological artifact, an essential element in the propagated dichotomy among users with or without access (Dimaggio et al., 2004).

From the expansion of Internet access, the understanding of the digital divide phenomenon demonstrated the existence of digital inequalities related to attitudinal, cognitive, and Internet use aspects, although the dimension of material access is still relevant to qualify the conditions of this access in terms of quality, ubiquity, and mobility (Van Deursen & Van Dijk, 2019).

Since Internet access is no longer restricted to computers, the potential of leapfrogging this access through mobile devices has become a matter of interest to both academia and policymakers. This issue has been the subject of intense debate since some have perceived this leapfrogging effect as beneficial, allowing to quickly and cheaply reduce gaps in Internet access without the need for public policy interventions to deal with the persistent first-order digital divide (Napoli & Obar, 2014). In contrast, others present a critical view of this understanding, arguing that access via mobile devices offers an inferior experience compared to accessing the web via computers (Marler, 2018; Mascheroni & Ólafsson, 2016).

In this debate on access devices, some studies have focused on the clash between mobile and computer devices (Van Deursen & Van Dijk, 2019). Compared to computers, mobile phones offer advantages related to convenience, affordable prices, mobility, continuous use (ubiquity), location-based applications, as well as ease of use for gaming and video streaming (Mossberger et al., 2012). However, such devices have a series of technical limitations, such as memory, processing speed, screen size, limited typing features, characteristics that require additional significant cognitive load by the user (Marler, 2018; Napoli & Obar, 2014).

These limitations in mobile devices' affordances can also entail a reduced level of user engagement, especially in activities that require more immersive use, such as content creation and information search (Napoli & Obar, 2014). In summary, while computational platforms favor the performance of greater capital-enhancing activities, mobile devices are associated with leisure, entertainment, and personal security activities (Marler, 2018; Pearce & Rice, 2013).

Internet access also depends on the types of devices used for the development of digital skills. Some studies show evidence that access to the Internet exclusively via mobile devices can negatively impact the level of digital skills (Napoli & Obar, 2014; De Araujo & Reinhard, 2019). In contrast, users who connect via mobile devices and via computers tend to expand their digital skills array (Napoli & Obar, 2014). This scenario suggests that the exclusive use of mobile devices for Internet access can restrain the level of digital skills, suggesting the existence of a new type of exclusion or a device divide (Pearce & Rice, 2013).

For this paper, this device dimension for Internet access will be operationalized by segmenting users who use the Internet only via mobile devices (cellphones and smartphones), those who connect only via computers (desktop, laptop, and tablet), as well as multiplatform users who connect using both computers and mobile devices (Pearce & Rice, 2013).

2.2 Digital Skills

Although there are different definitions for digital skills, in this paper, we consider it as "the ability to respond pragmatically and intuitively to challenges and opportunities in exploiting the Internet potential and avoiding frustrations in its use" (Dimaggio et al., 2004, p. 378). This definition focuses on the necessary skills to use the Internet regardless of the technological device used. This concept conceives digital skills considering both technical skills and those related to information search, communication, and online content production (Litt, 2013; Helsper & Eynon, 2013; Ferrari, 2012).

Although the literature presents many proposals to conceptualize digital skills from multiple dimensions (Ferrari, 2012; Helsper & Eynon, 2013), all of them assume the premise of contemplating two groups: technical and content-related skills. Van Dijk and Van Deursen (2014), for example, conceptualized a digital skills framework based on six distinct domains. In the technical skills group, they consider (i) operational and (ii) formal skills; the content-related skills concerns to (iii) informational skills, (iv) communication, (v) content creation, and (vi) strategic are highlighted.

Due to the nature of the indicators of the ICT Households survey, digital skills were measured based on the set of activities performed by the online user. Therefore, it is assumed that online activities' performance implies that the user possesses this specific skill (Helsper & Van Deursen, 2017). Thus, in the context of this paper, digital skills were conceptualized in four distinct domains taken from the initial definition of Van Dijk and Van Deursen (2014):

(i) *Operational* – set of technical and basic skills to operate the Internet regardless of the type of device used for access; (ii) *Informational* – measures the Internet user's ability to carry out the entire process of searching, selecting, and evaluating the identified information; *(iii) Communication* – captures the Internet user's competence to encode and decode messages and, consequently, build, understand, and exchange meanings through Internet applications; (iv) *Content creation*– consist of creative ability, that is, measuring the user's ability to create online content with acceptable levels of quality and publish it properly on the Internet.

2.3 Digital Payment Adoption

Digital payments refer to transactions for payments of goods and services made through technological innovations, such as mobile-phone-enabled solutions, electronic money, and digital payment platforms (Rana et al., 2018; Patil et al., 2018). The growth in the use of mobile devices globally has also contributed to the increase in digital payments provision for the most impoverished population, positively impacting financial inclusion and transforming the way people manage and carry out cash transactions (Patil et al., 2017, 2018; Alkhowaiter, 2020).

Digital payments offer several benefits, such as reducing frictions of cash transactions, increasing transactions' efficiency, increasing money circulation speed, and reducing transaction costs (paying and collecting) (Ligon et al., 2019). In addition to increasing transactions' security and transparency, such services can provide an important first point of entry into the formal financial system; the switch to digital payments can lead to substantial increases in savings, as well as the substitution of informal for formal savings (Ligon et al., 2019; Demirguc-Kunt et al., 2018). Several developing countries have been using digital payment platforms with success, such as M-PESA in Kenya, Wizzit in South Africa, GCash, and Smart Money in the Philippines. However, even with the mentioned benefits, digital payments' adoption is uneven, and adoption rates are low in some countries (Ligon et al., 2019). For example, in Brazil, less than 1/3 of Internet users use digital payments (CGI, 2020).

Several authors have carried out literature review studies to systematize the main factors that influence the adoption of digital payments by individuals (Alkhowaiter, 2020; Patil et al., 2018, 2017; Kim et al., 2018). According to these papers, there is a predominance of investigations that are based on the main technology acceptance models used in the field of Information Systems (IS), such as TAM (Technology Acceptance Model) and UTAUT (Unified Theory of Acceptance and Use of Technology). Based on these theoretical lenses, empirical studies conducted in different countries point out a series of facilitating factors (drivers), stimulating the adoption of digital payments, and factors that act as inhibitors to such adoption. Regarding drivers, we highlight: Performance Expectancy (Al-Okaily et al., 2020; Sivathanu, 2019; Patil et al., 2017); Effort Expectancy and Perceived ease of use (Sivathanu, 2019; Patil et al., 2017); Social Influence (Al-Okaily et al., 2020; Sivathanu, 2019); Perceived usefulness (Patil et al., 2017; Kim et al., 2018); Awareness (Kim et al., 2018); and other factors such as price value, facilitating conditional, hedonic motivation and habit. Regarding inhibitors, the following stand out: perceived security and privacy, trust, and risks (Al-Okaily et al., 2020; Alkhowaiter, 2020; Patil et al., 2017, 2018).

This predominance of analyses using technological acceptance models highlights the concentration on adoption factors based on psychological aspects, such as the user's perception, beliefs, and attitudes towards technology, disregarding other factors related to availability and readiness in the use of digital payments. Conversely, another strand of a few studies has sought to explore other factors related to sociodemographic characteristics (Kim et al., 2018), universal access to the Internet, and digital skills (digital literacy) as antecedents to the use of digital payments (Rana et al., 2018).

In addition, the literature portrays a variety of digital payments' adoption cases in different developing countries of the global South, such as Kenya, the Philippines, South Africa, and India, concentrating in countries in Africa and Asia (Kim et al., 2018; De Albuquerque et al., 2014). This paper explores the adoption of digital payments based on the reality of a Latin American country, specifically Brazil. This country has a higher percentage of internet users in comparison to other developing countries (more than 90% of individuals access the Internet via mobile), but at the same time, it is characterized by a low adoption rate in the use of this type of financial service (CGI, 2020). Besides, there is growing pressure for the use of digital payments services in this country, in a scenario in which the government is offering social benefits to mitigate the negative economic effects of Covid-19 pandemics through digital platforms (Gonzalez et al., 2020). Therefore, in this context it is crucial to understand the factors that affect the use of digital payments in Brazil.

3. Methodological Design

In order to explore the effect of digital inequality measures related to Internet access conditions, digital skills, and sociodemographic inequality on the use of financial services for digital payments among Internet users in Brazil, this investigation used the microdata from the ICT Households survey coordinated by the Regional Center for Studies for the Development of the Information Society (Cetic.br). The microdata of the 2019 edition of the ICT Households survey, published in 2020, was used since they were the most recent data available at the time of this study.

The ICT Households survey is a nationwide survey carried out since 2005 whose objective is to measure the availability, possession, and use of ICT by the Brazilian population aged 10 years and older. This survey's data collection occurs through structured questionnaires, composed of closed questions with defined answers, and applied in face-to-face interviews with the respondents. The ICT Households survey adopts a rigorous sampling design using the stratified multi-stage cluster sampling procedure selected probabilistically to the size population (CGI, 2020). The decision to use the microdata from the ICT Households survey was based on the wide variety of items that measure conditions of access, skills, and uses of the Internet in Brazil, as well as the representativeness of the sample in relation to the national reality.

As this is a large-scale survey, data includes two units of analysis (households and individuals), as well as several thematic blocks (e.g., computer use, Internet use, electronic commerce, e-government) and sociodemographic characteristics. Tables 1 and 2 summarize the variables used in this paper.

To perform data analysis, the binary logistic regression technique was used (Hair et al., 2009) to capture the Internet access conditions (related to devices used to access the Internet), digital skills, and sociodemographic factors (age, geographic area, social class, and gender) on the use of digital payments.

The first set of variables shown in Table 1 are the sociodemographic factors, that is, the digital exclusion determinants related to personal and positional characteristics. Those variables represent the most commonly cited inequalities in the literature (Scheerder et al., 2017): geographic area, age, socioeconomic status, and gender.

The geographic area (home location) is classified as urban or rural, based on the legislation in force at the time of the Demographic Census. The Cetic.br survey defines cities (municipal headquarters), towns (district headquarters), or even isolated urban areas as urban areas, and other locations that exceed this limit are classified as rural areas. The respondents' age represents only users aged 16 and over due to the focus on financial services. Following respondents' gender, the social class represents the respondents' socioeconomic class concept based on three social classes: AB (higher), C (middle), and DE (lower). Besides the variables considering the device used to access the Internet, the binary dependent variable indicates whether the user has made digital payments in the last three months.

	Variables	Items/Scale
Demographic Factors (determinants of digital divide)	Geographic Area	0 = Rural 1 = Urban.
	Age groups	1 = 16 to 24 years old. 2 = 25 to 34 years old. 3 = 35 to 44 years old. 4 = 45 to 59 years old. 5 = 60 years or older.
	Gender	0 = Female. 1 = Male.
	Social Class (*Socioeconomic Status*)	1 = Class AB (higher class) 2 = Class C. (middle class) 3 = Class DE (low-income class).
Device used to access Internet	Desktop	1 = Yes; 0 = No.
	Laptop	1 = Yes; 0 = No.
	Tablet	1 = Yes; 0 = No.
	Mobile phone	1 = Yes; 0 = No.
	Game Console	1 = Yes; 0 = No.
	TV Set	1 = Yes; 0 = No.
Digital Payment	Financial Information, making payments and other financial transactions	1 = Yes; 0 = No.

Source: (CGI, 2020)

Table 1: Variables

Table 2 presents indicators used to operationalize the four digital skills domains (operational, informational, communication, and content creation) used in this investigation. Given that this paper's interest falls on the skill levels in each of these four dimensions, these measures were operationalized through an indicator representing the sum of the items in each dimension.

Digital Skills Domain	Dichotomous Items
Operational	Downloading films Downloading songs Downloading games Downloading computer software, programs or applications
Informational	Looking up information on products and services Looking up information on health or healthcare services Looking up information on travel and accommodations Job searches or Sending resumes Looking up information in virtual encyclopedia websites such as Wikipedia Looking up information available in government agencies websites
Communication	Sending and receiving e-mails Sending instant messages, such as chatting via Facebook, Skype or Whatsapp Talking to people using programs such as Skype Taking part in social networks sites, such as Facebook, Orkut or Google+ Participating in discussion lists or forums Using microblogs, such as Twitter
Content-Creation	Sharing content on the Internet, such as texts, images or videos Creating or updating blogs, Internet pages or websites Posting personally created texts, images or videos on the Internet

Source: (CGI, 2020)

Table 2: Items used to measure each one of the dimensions of digital skills

4. Presentation and Discussion of Results

In the 2019 edition of the ICT Households survey, 20,536 face-to-face interviews were conducted with individuals from all Brazil regions to obtain a representative sample. Due to the scope of this investigation, selected data met the following criteria: (i) individuals classified as Internet users (13,332 respondents) – i.e., users who reported having used the Internet at least once in the last three months before the interview – and (ii) aged 16 and over. Based on these criteria, the sample adopted is composed of 12,214. To operationalize the statistical techniques, the weighting (sample weight) defined by Cetic.br was used, thereby reducing the sample's inaccuracies and biases.

4.1 Characterization of Brazilian Internet users

The results in Table 3 show a predominance of Internet users from urban areas of the country (>90%). This digital inequality related to the geographic position is highlighted in the literature and results from limitations in the technological infrastructure of rural areas (Scheerder et al., 2017). Results also reinforce age inequality, with a very sharp drop of internet users over the age of 60. Results also show a higher proportion in this sample of Internet users in class C (~ 50%), followed by class AB (~ 27%) and class DE (~24%). Finally, there is a certain balance for the distribution of Internet users by gender, with a slightly higher proportion for women.

Regarding the devices used for Internet access, results show the mobile phone's importance as the main device for accessing the web since this device is used by 99% of Internet users. It should be noted that even segmenting this indicator by the user's social class, mobile phones' use is above 98% even among individuals of the low-income class (class DE), showing a universality in the use of mobile by Brazilian Internet users.

To operationalize Internet access conditions, the combination of devices used for such connection was used, segmenting users among those who connect only via mobile phone; those that connect only via computational devices (desktop, laptop, and tablet); and multiplatform users - who connect both via mobile and computational devices. Figure 1 illustrates the percentage of users in each of these groups. The aggregate data (total) show that more than half of the individuals use the web combining mobile and computational equipment (multiplatform). However, when segmented by economic class, the dynamics

of device use is different among socioeconomic strata. In class AB, multiplatform users are predominant (74.4%), while among class DE, the majority of users access exclusively via mobile phone (86.3%). Although mobile phones are the primary device for connecting to the Internet among Brazilian internet users (99%), their role differs among socioeconomic strata. Among members of the class AB, the mobile phone acts as a *complementary access device* to other equipment (desktops, laptops, tablets), while in the class DE, the mobile phone acts as a *substitute device* for those who do not have the economic conditions to acquire computer equipment (Van Deursen & Van Dijk, 2019). This finding suggests the mobile leapfrogging effect (Mascheroni & Ólafsson, 2016; Napoli & Obar, 2014) in class DE, with the mobile phone acting as the primary way to access the Internet.

Table 4 illustrates the level of digital skills of Brazilian Internet users. The results show a lower level of competence in the domains of operational and informational skills and a higher level of communication skills, suggesting an internet use pattern more related to online social interaction activities. Analyzing the specific items that measure these communication skills, the most frequently used activities involve sending instant messages (such as WhatsApp) (94%) and using social networks (78%). It is worth mentioning that the activities mentioned are the most frequently used in all social classes analyzed.

	2019 (%)
Geographic Area	
Urban	90.6
Rural	9.4
Age Groups	
16 to 24 years old.	22.8
25 to 34 years old.	23.7
35 to 44 years old.	22.4
45 to 59 years old.	22.0
60 years or older.	9.0
Gender	
Male	47.6
Female	52.4
Social Class	
Class AB	26.7
Class C	49.2
Class DE	24.1
Device Used to access Internet	
Desktop	23.5
Laptop	29.6
Tablet	10.5
Mobile phone	99.1
Game Console	8.4
TV Set	35.9

Table 3: Demographic profile of the sample of Brazilian Internet users
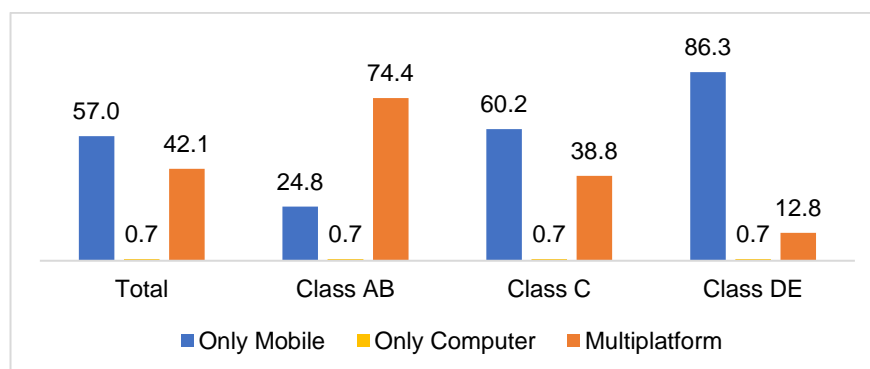
Figure 1: Combination of Internet access devices (%)

Digital Skills Domains	2019				
	Items	$\bar{X}$	Md	SD	α
Operational [0-4]	4	1.1	1.0	1.2	0.7
Informational [0-6]	6	2.3	2.0	1.8	0.7
Communication [0-6]	6	3.3	3.0	1.3	0.6
Content-Creation [0-3]	3	1.3	1.0	1.0	0.6

$\bar{X}$= Mean; Md = Median; SD = Standard Deviation; α = Cronbach alfa.

Table 4*: Digital Skills Level of Brazilian Internet Users (2019)*

Figure 2 illustrates the proportion of financial services' use related to digital payment, considering that this financial service is still restricted to about 1/3 of internet users. When segmented by sociodemographic factors, this rate of use is higher among urban users, in the age group from 25 to 44 years old, among men, and in the higher social class. The results also demonstrate that the use of digital payments has a proportion of 65% in class AB; however, this percentage is approximately 11% in the class DE, showing the relevance of socioeconomic inequalities in the use of digital payment services.
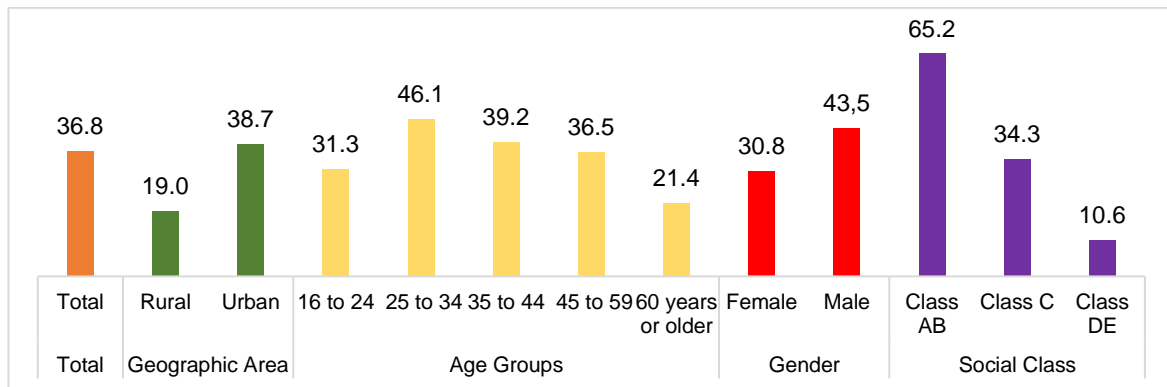
Figure 2: Use of digital payments (percentage)

4.2 Effect of access conditions, skills, and sociodemographic factors on digital payments

To test the relationship between Internet access conditions, digital skills, and sociodemographic factors on digital payments' use, we applied the binary logistic regression using digital payment use as a dependent variable and the other variables as independent (Table 5).

Four models were estimated to assess: (1) isolated effect of sociodemographic factors on the use of digital payments; (2) isolated effect of internet access conditions on the use of digital payments; (3) isolated effect of digital skills on the use of digital payment and the (4) combined effect of the three dimensions on digital payments. Table 5 summarizes these results, presenting the odds ratio measures for each attribute by measuring how much each independent variable influences the likelihood of digital payment use (Hair et al., 2009). Before applying the technique, data were inspected, verifying the lack of multicollinearity problems that would violate the technique's assumptions (VIF<5). Nagelkerke's Pseudo R2 was used to measure of adjustment of the estimated models.

Analyzing the isolated effects of sociodemographic factors on digital payments' use, it is possible to observe that the lower the socioeconomic strata, the lower the chance of using digital payments. Individuals from classes C and DE presented a reduction of 72.7% and 93.8%, respectively, in relation to members of the higher class. Regarding gender, the results also show that the use of digital payments is more associated with men, as this group has a 53.7% increase in the odds to use these services compared to women. These findings are in line with Pazarbasioglu et al. (2020) and Kim et al. (2018), which point out that access to financial services – in this case, digital payments – is lower among the poorest and women.

Analyzing the conditions of Internet access, the results demonstrate that users who connect combining mobile devices' convenience and mobility with the more immersive use provided by computational

devices (multiplatform users) are more likely (Odds = 6.445) to use digital payments. Although there is an understanding of the role of mobile devices in providing access to financial services for the most vulnerable groups (Demirguc-Kunt et al., 2018; Rana et al., 2018), in this study, the propensity to use digital payments was not superior among those who access the Internet exclusively via mobile phone. This suggests that, based on the Brazilian context, the availability of Internet access only through mobile devices has not proved to be sufficient to boost the use of this type of digital financial service. On the other hand, these findings are supported by the digital divide literature, which points out that exclusive access via mobile is negatively related to capital enhancing activities – such as the use of digital financial services – due to the technical limitations of the device, making the user experience more complex and demanding more significant cognitive load from the user (Marler, 2018). These results demonstrate the need to understand better the implications of the exclusive use of this type of device in harnessing digital financial services.

	Model 1	Model 2	Model 3	Model 4
	Odds Ratio	Odds Ratio	Odds Ratio	Odds Ratio
Age	0.983***			1.010***
Gender (ref. Female**)**				
Male	1.537***			1.591***
Geographic Area (ref. Rural)				
Urban	1.335			0.987
Social Class (ref. Class AB)				
Class C (middle class)	0.273***			0.526***
Class DE	0.062***			0.196***
Device to access Internet (ref. Only mobile)				
Only Computer		0.537		0.757
Multiplatform (both computer and mobile)		6.445***		1.903***
Digital Skills				
Operational			1.125**	1.141**
Informational			1.608***	1.423***
Communication			1.603***	1.484***
Content-Creation			1.119**	1.209***
Nagelkerke Pseudo R2	**0.244**	**0.230**	**0.374**	**0.459**

Note: *** p< 1%; ** p<5%

Table 5: Effect of sociodemographic factors, conditions of access, and digital skills in the use of digital payments (odds ratio)

Findings in Table 5 demonstrate the positive effect of digital skills on the use of digital payments. Therefore, the higher the digital skills level, the greater the likelihood to use digital payments. Among the categories of digital skills, the role of information and communication skills has increased by 60% (Odds >1.6) the likelihood to use digital payments, which is the conditioning factor with the most significant effect to explain the use of digital payments, according to Nagelkerke's R2 analysis. This positive relationship between digital skills and digital payments' use is aligned with the digital divide literature, which points out the contribution of skills in the use of online activities that promote beneficial economic, social, personal, and cultural results (Helsper & Van Deursen, 2017).

Additionally, these findings suggest the existence of a knowledge barrier for digital payments use, suggesting that the greater the mastery of digital skills, the greater the likelihood to use this type of financial service. These findings are aligned with Rana et al. (2018), indicating the positive effect of digital literacy in the use of digital financial services. At the same time, it is understood that the highest level of digital competence can contribute to an experience without significant difficulties in the use of digital payment applications and can positively impact the perception of ease of use and expectation of effort, factors widely cited as drivers in the adoption of digital payments (Sivathanu, 2019; Patil et al., 2017).

These results suggest the importance of the material access dimension to digital payment adoption. On the one hand, if mobile phones contributed to the increase in the number of Internet users in Brazil, reducing the first-order digital divide, on the other hand, the exclusive use of this device negatively affects the adoption of digital payment. Therefore, evidencing the existence of a digital inequality specifically related to the type of device used for Internet access or device divide (De Araujo & Reinhard, 2019). In conclusion, this study contradicts the more optimistic view of the role of mobile in digital financial inclusion, demonstrating that this relationship goes beyond the mere availability of technological resources (mobile phones) but involves other dimensions – such as sociodemographic factors and digital skills – that need to be better considered to understand the factors that influence the use of digital payments.

5. Final Remarks

In terms of theoretical contribution, the findings of this investigation show the relevance of digital divide studies to understand the phenomenon of adopting digital payments, elucidating aspects related to the qualification of material access to the Internet, as well as digital skills, dimensions that are scarcely explored in studies that analyze the adoption and use of digital financial services. In terms of contribution to practice, the findings of this investigation explain the growing relevance of the mobile phone as an Internet access device, but also the challenges that financial institutions (banking or non-banking) have in offering digital financial services. Given the large proportion of users who connect exclusively via mobile, especially between low-income individuals, the findings suggest that financial services should be made available in more friendly and intuitive interfaces, aligned with the specificities of mobile devices, requiring less cognitive load and previous digital skills for the use of such services. One of the main limitations of this study is the analysis in a single cross-section of the data, potentially reducing the understanding of the studied phenomenon's evolution. In this sense, it is recommended that future studies replicate the analysis carried out in this study in a historical series and also considering the effect of data before and after the Covid-19 pandemic.

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27. Usage Patterns of an ePortfolio-Platform - On the Potential Conflict between Short- and Long-term Usage Scenarios of ePortfolios

Martin Dobiasch
Department for Continuing Education Research and
Educational Technologies
Danube University Krems
martin.dobiasch@donau-uni.ac.at

Stefan Oppl
Department for Continuing Education Research and
Educational Technologies
Danube University Krems
stefan.oppl@donau-uni.ac.at

Abstract

ePortfolio-platforms are popular tools to facilitate and promote lifelong learning. One of their major usage scenarios is enabling users to document their learning outcomes in an institution-independent way beyond formal learning settings. Aside this, ePorfolios are also promoted as a way to facilitate qualitative assessment in courses. The latter scenario introduces a short-term usage perspective that can be counterproductive for establishing sustainable long-term usage practices. In this paper, we analyse the usage data of the ePortfolio-platform mahara.at with respect to the prevalent usage patterns. This instance was active from 2007 until 2019 and featured more than 22.000 users from nearly 200 different institutions. As part of the analysis, we reviewed the activity on the platform on the basis of users' login behaviour and content creation activities. Activity data shows that ~ 50% of the users used the platform for only half a year and sustainable usage practices over longer durations of time can hardly be observed. Both logins and content creations show cyclic patterns which correspond to the academic year. Based on these indications we conclude that users used the instance mainly for course-based scenarios rather than as a lifelong-learning portfolio.

Keywords: ePortfolio, usage patterns, Mahara, lifelong-learning.

1. Introduction & Related Work

ePortfolio-platforms are popular tools to facilitate and promote lifelong learning by documenting and disseminating individual learning achievements (Fisher et al., 2014). Around 2010, research about and the implementation of ePortfolios in learning have begun to flourish (Bryant & Chittum, 2013). A central promise of ePortfolios is to support learners in their journey from formal learning in schools, universities, and continuing education to non-formal learning (Balaban et al., 2011; Thibodeaux et al., 2017). It was claimed that ePortfolios will engage students to continue learning and work on their portfolios after leaving their respective educational institutions, thus enhancing LLL from a technology perspective (Balaban et al. 2011). Therefore, the hope is that this tool also enhances personal skills such as self-regulation and cognitive monitoring (Scully et al., 2018).

As a central concept of ePortfolios, learners create digital artefacts representing their learning efforts using a (usually) web-based platform, which provide a way for teachers to qualitatively assess learners's achievements. Conceptually, there are only a few restrictions on the type and shape an artefact can take (e.g., (hyper-)text, picture or an arbitrary binary file). In addition to studying and teaching purposes, artefacts can represent employment history (Scully et al., 2018) and serve as institution-independent documentations of past learning achievements (ibid.). Consequently, an ePortfolio can also serve as a CV (Balaban et al., 2011). Furthermore, some ePortfolio platforms allow students to create goals, which can be used for tracking learning effort (Buyarski et al., 2015).

This broad field of targets pursued by ePortfolios are potentially problematic in shaping users' expectations and intentions of use, in particular when contrasting short-term usage scenarios such as assessment for a single course (Hallam & Creagh, 2010) with longer-term scenarios such as creating a

structured portfolio of learning outcomes (Prastiwi et al., 2020). The activities required to meet the assessment criteria in a single course likely do not lead to the development of sustainable and consistent usage practices, which would be beneficial for longer-term usage (Hsieh et al., 2015).

Recent studies by Bollinger and Sheperd (2010), Prastiwi et al. (2020) and Douglas et al. (2019) all report positive attitudes and responses of students towards electronic portfolio creation and usage of portfolios for assessment. They also indicate willingness for longer-term use, but do not investigate whether persons are following their proclaimed intentions. Mobarhan & Rahman (2014, 2015) investigated the continuance intention of users using a theoretical literature derived model based, among others, on the self-determination theory (Ryan & Deci, 2020) highlighting satisfaction as the most influential factor. Yan et al. (2012) stress the importance of habitual use for continuance intention. Chen et al. (2012) link user motivation for continued use of ePortfolios to perceived usefulness, in particular for learning and career development. However, none of the existing studies has explicitly investigated whether continuance intention actually leads to continued use, i.e. overcomes the intention-behaviour gap (Bahattacherjee & Sanford, 2009; Yan et al., 2021).

In our current project, we aim to contribute to closing this research gap by providing evidence on usage patterns from an institution-independent ePortfolio platform. We hypothesize that didactical scenarios for ePortfolio use in formal educational settings (Hallam & Creagh, 2010), which is often related to qualitative forms of assessment (ibid.), might lead to usage behaviour that, despite all good intentions, lead to unsustainable long-term usage scenarios.

Consequently, in this paper we aim to answer the question: Which usage patterns do users of an ePortfolio platform exhibit and are they in line with the hypothesis of an intention-behaviour gap? We set out to explore the usage patterns of ePortfolios in a structured way by examining data collected during the operation of mahara.at. Mahara[2] is one example for an ePortfolio software. Its development started in 2006 and the software is still maintained and developed as of 2020. In an attempt to facilitate institution-independent usage of ePortfolio software and promote long-term development of individual portfolios, the Mahara-instance mahara.at was established in 2007 as an openly available platform. It was promoted in Austrian educational institutions on all levels to allow for wide dissemination and gained nearly 22,000 users over its 10 years of active operation (registration was ceased in 2017, and the platform was replaced with a new version of Mahara in 2020).

The remainder of this paper is structured as follows: In the next section, we describe the metrics in platform usage patterns that can be used to distinguish short- from long-term usage scenarios based on the data captured by the Mahara platform. In sections 3 and 4, we present evidence on these metrics derived from the usage data of mahara.at from 2007 to 2019, covering the activities of about 22,000 users from nearly 200 different institutions. In the final section, we discuss the results in the light of our working hypothesis and outline paths forward for developing strategies for sustainable ePortfolio use based on the found evidence.

2. Methodology

In our attempt to examine usage scenarios that were implemented using the ePortfolio-platform mahara.at, we have analysed the data Mahara keeps in its database by default about user activity and content creation. The database of the examined instance holds data from mid 2007, when the platform was made publicly available, to mid 2019, when it was replaced by a new instance and shut down. The data was preprocessed by the technical administrator of the platform before handing it over to the researchers for analysis, removing all personal data that would allow identifying individuals. Data was pseudonymized to allow for tracking of user activity over time. Furthermore, all content created by users

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2   https://mahara.org

was removed for analysis, only metadata (e.g., creation dates, ownership, etc.) was kept for analysis. Consequently, our analysis of usage patterns is based on two sources: statistics about users and their login behaviour and statistics about artefact creations of users. As the data is pseudonymised, no data privacy issues arise. Data was processed using R 4.0.5.

At the time of shutting down the examined Mahara-instance on mahara.at in 2019, a total of 21.929 users were registered on the platform. Most of these users were assigned to one of the 197 institutions that were registered on the Mahara instance – open registration for users outside educational institutions was available, but hardly used. However, accounts were not suspended after users left their original institution (i.e., were removed from their respective groups by institution admins), but remained active, providing them with the opportunity to use their portfolio beyond the original context of introduction. The institutions were different forms of K12 or K13 schools, technical schools and universities, and stemmed from five different countries (Austria, Bulgaria, Czech Republic, Germany and Turkey), with a focus on Austrian institutions.

User login behaviour is used as a metric to determine usage patterns, as, in order to perform any activity on Mahara, users are required to log in to the website. Mahara provides aggregated statistics of this behaviour for every day. Based on these statistics, the level of engagement and in particular when it was happening with which magnitudes can be estimated and serve as a foundation for interpretation. Data on user logins is only available from late 2010 after an update to the platform software included logging of this information.

To examine the usage patterns more in-depth than is possible based on aggregated login data, the engagement of users with the platform in terms of *content creation* was examined on two levels. First, we analysed content creation patterns over time from a platform perspective, i.e., not examining individual user behaviour. This allows to determine the *overall magnitude of and changes in content creation*, which can be put in relation with users' login behaviours, providing a basis for examining whether active content production or passive consumption is the prevailing user behaviour.

Furthermore, since the activity period of users differs and also the number of users on the platform differs over time, we also investigated *individualised content creation patterns*. For this purpose, we defined the life cycle of a user to be the period between the first and last activity (e.g., user profile creation, creation of an artefact) on the instance and computed the amount of content created with the discretised continuum of this life cycle. This analysis has the potential to highlight differences in behaviour changes over time.

3. User Structure

3.1 Users on the platform & development over time

Mahara provides aggregated login statistics for every day, i.e., stores the number of unique logins per day as a single number (note that this data is only available from 2010 after a platform update enabling logging here). As can be seen in Fig. 1, the number of logins per day followed a cyclic pattern repeating in 12-month-cycles with low points mid-year and peaking activity around February/March each year. Login patterns remained largely stable between 2012 and 2014 (the single peak in 2014 is of unclear origin). Logins start to decline from 2015 on, but exhibit a similar pattern as in the initial years of operation. The cessation of user activity in 2018 can be explained by the transition to a new Mahara instance and the continuous migration of users to it, which was finished by 2019.

Furthermore, we investigated how user activity developed per weekday over the cycle of a week (cf. Fig. 2). Users were active during the whole week with no drastic differences between the weekdays, except a drop of user activity on weekends, in particular on Saturdays. This drop is statistically significant

(double-sided t-test, p<0.001) showing that users logged in less often on Saturday and Sunday and, moreover, on Friday, users logged in less frequently than on Monday and Tuesday (cf. Fig. 3).
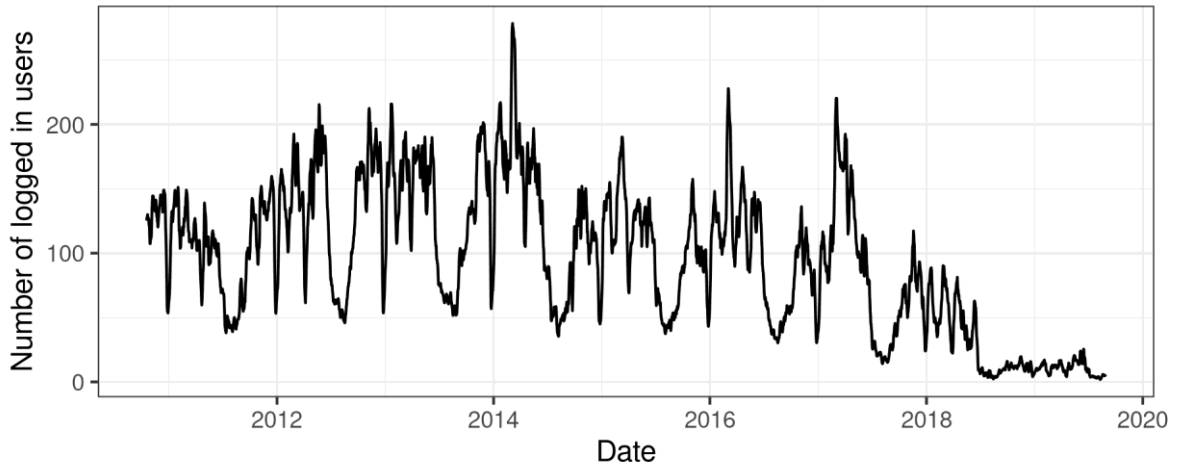

Figure 1: Development of daily logged-in Users. Y-axis displays a seven-day rolling mean.
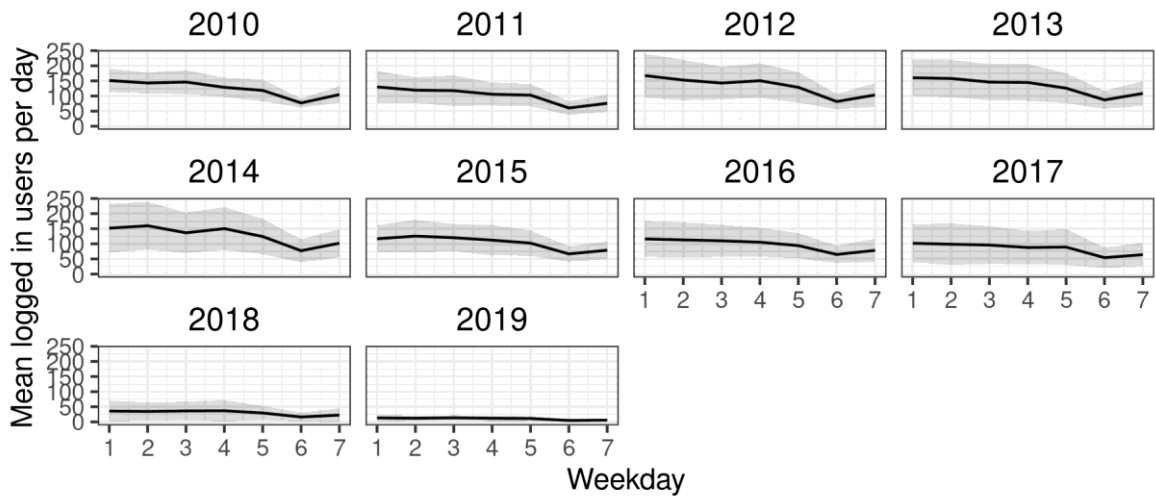

Figure 2: Average logged-in users per Weekday (1 = Monday, 7 = Sunday). Line shows the average value for the respective day, shaded area represents the standard deviation.
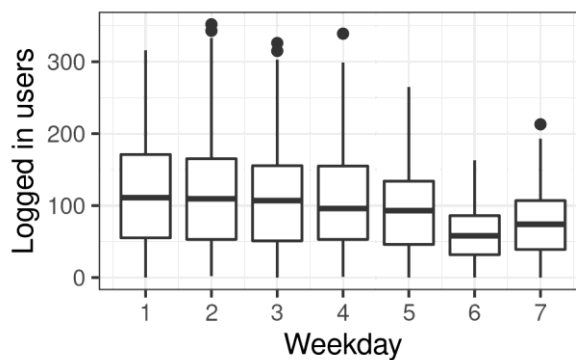
Figure 3: Mean logged-in users per weekday (1 = Monday, 7 = Sunday).
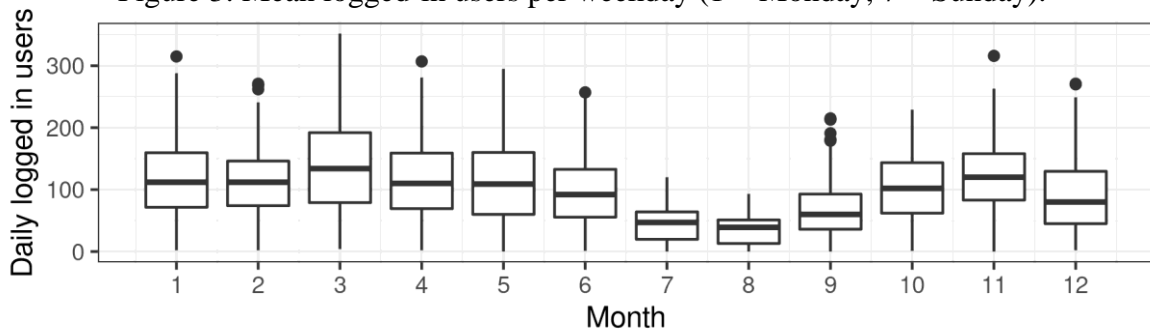
Figure 4: Mean daily logged-in users per month.

We furthermore analysed differences in login behaviour between calendar months to further explore the 12-month-patterns, that are visible in the overall login graph in Figure 1. Several significant differences between the amount of daily logged-in users per month have been identified (cf. Fig. 4). University- and school-years in Austria, were most users stem from, are usually organised in two terms: a fall term starting in September for schools, October for universities and a summer term starting mid-February for schools and March for universities. A peak in logins is visible in March, largely corresponding to the start of the summer term. The drop of logins in July and August corresponds to the summer break of educational institutions. Logins rise again in the months corresponding to winter term, with a peak occurring in November.

3.2 Activity Duration

As described above, ePortfolios can be used for heterogenous scenarios which differ in the duration the portfolio is maintained by users. mahara.at is offered as an institution-independent ePortfolio-platform with the intention to facilitate long-term use, but still was largely introduced as a platform to users in educational institutions. We thus examined whether these introductions led to sustainable use of the platform for prolonged periods of time, which would indicate the willingness of users identified in related studies of Prastiwi et al. (2020) and Douglas et al., (2019) to use an ePortfolio as a life-long learning instrument. Therefore, we analysed the period for how long users have been active on the platform. For this analysis we computed the time span between the first recorded activity on the platform and the last login or activity. More than half of the users in the database (n = 12.472, ~ 57%) used Mahara for less than half a year. As can be seen in Figure 5, the number of users for a given activity duration decreased exponentially (the y-axis of this figure is log-scaled in order to better highlight exponential decline).
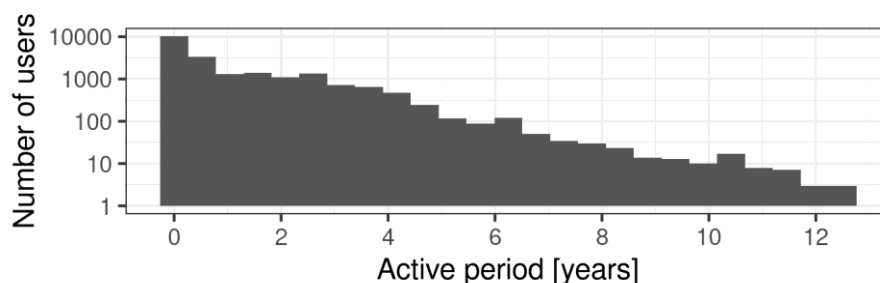

Figure 5: Histogram of the active period of users. Y-axis is log scaled.
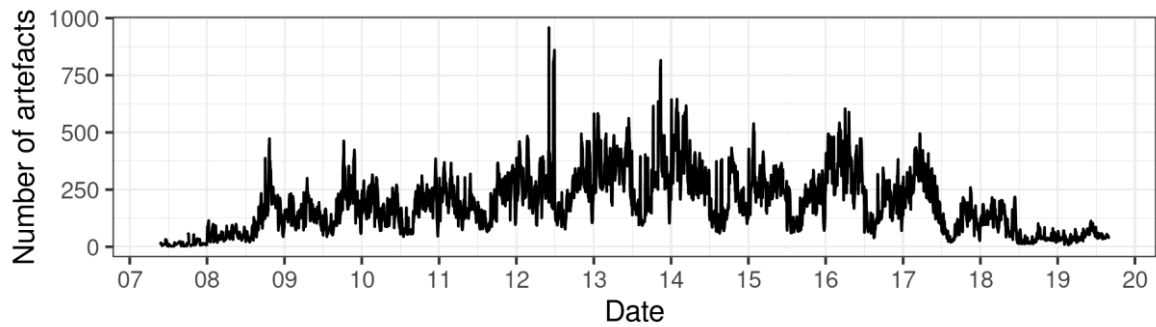Data is binned into half-year steps.

Figure 6: Development of artefacts created per day (7 day rolling mean).
X-axis denotes years 2007 until 2019.

3.3 Interpretation

Summarising the findings from login and activity data, we found evidence that the use of mahara.at was largely shaped by deployment in formal (i.e., institutional) educational settings. The fact that users have been significantly less active on the weekend than during the week and activity has varied along the progression of school/university terms, gives rise to the hypothesis that the Mahara instance was largely used in the school/university context for short-term usage scenarios, such as qualitative assessment. Furthermore, the fact that more than 50% of users have been active on the platform only for a short period of time (less than half a year) also provides evidence for the prevalence of short time usage scenarios, which did not lead to sustainable use of the platform after they have completed the assignments which has brought them there.

4. Content Creation on the Platform

Mahara allows users to create different forms of content: As its central content category, Mahara allows creating and storing arbitrary data as so-called artefacts using a plug-in system. Examples for these artefacts include blogs and blog-posts or files uploaded to the platform. These files can then be used not only in blog-posts but also in other content forms, for example sites representing a description of a task, which are usually stored in HTML format. Furthermore, users can create forums and posts in them in order to facilitate exchange among users.

4.1 Artefacts

In analogy to the analysis of user logins described in section 3.2, the development of artefact creation over time was analysed. As can be observed in Figure 6 also this aspect followed a cyclic pattern. The login activity and artefact creation declined in similar patterns, indicating that users' logins largely were linked with content creating activities.

The mean artefact creation per month also follows a pattern similar to the pattern of user logins described above: Users are less active during "vacation months" than during the rest of the year (cf. Fig. 7). During July, August and September fewer artefacts than during the rest of the year were created. Moreover, artefact creation was lower in December.

Artefact creation per weekday (cf. Fig. 8) again follows a pattern similar to user logins: activity seems to be higher during the week and dropping over the weekend. On weekend days and Friday, significantly fewer artefacts were created than during the week.

4.2 Forums

Posts in forums followed a pattern similar to user logins and artefacts, but on much lower quantitative level: yearly cycles repeated with (cf. Fig. 9). Several peaks indicate days on which posting activity was

unusually high. Still, the number of artefacts created per time unit approximately is at least one order of magnitude higher than the number of forum posts, indicating that the platform was largely used for content production purposes rather than reflection and exchange on already available content (for which usually forums would be used in Mahara).
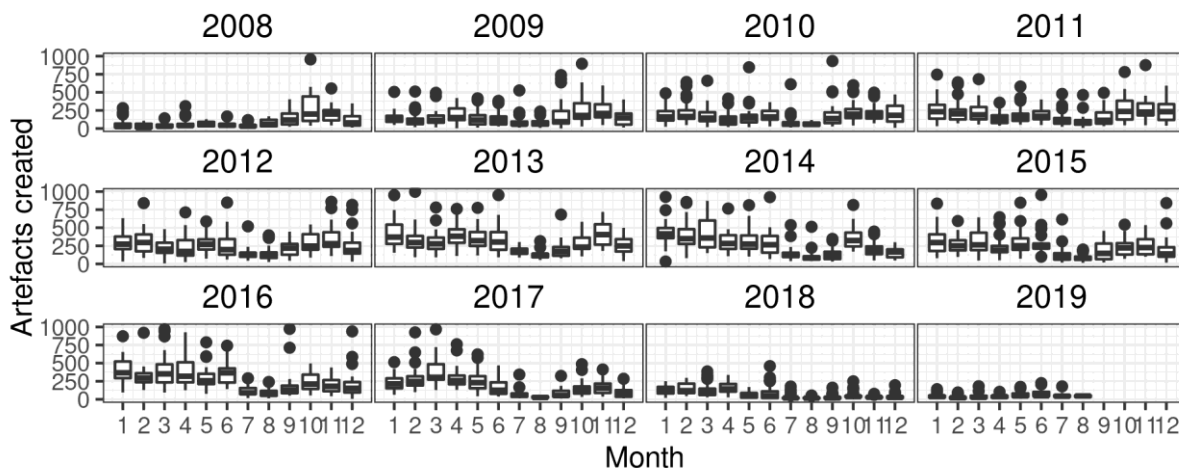

Figure 7: Artefacts created per month.
Note that 10 outliers were removed from the plot for clarity of presentation.
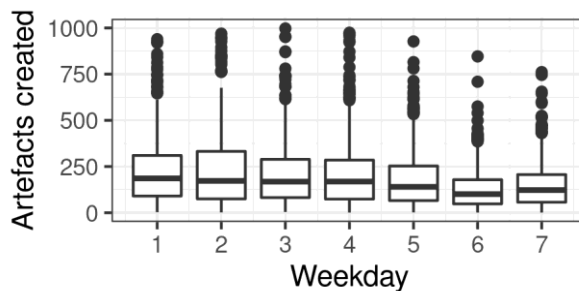

Figure 8: Artefacts created per weekday.
Note that 10 outliers were removed from the plot for clarity of presentation.
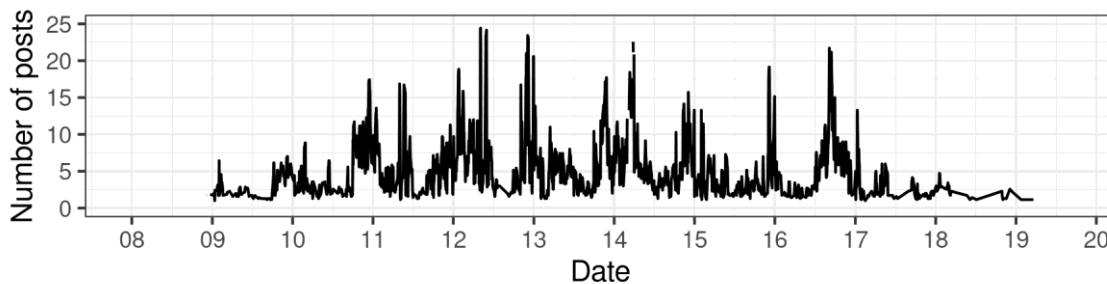

Figure 9: Posts created per day (7 day rolling mean).
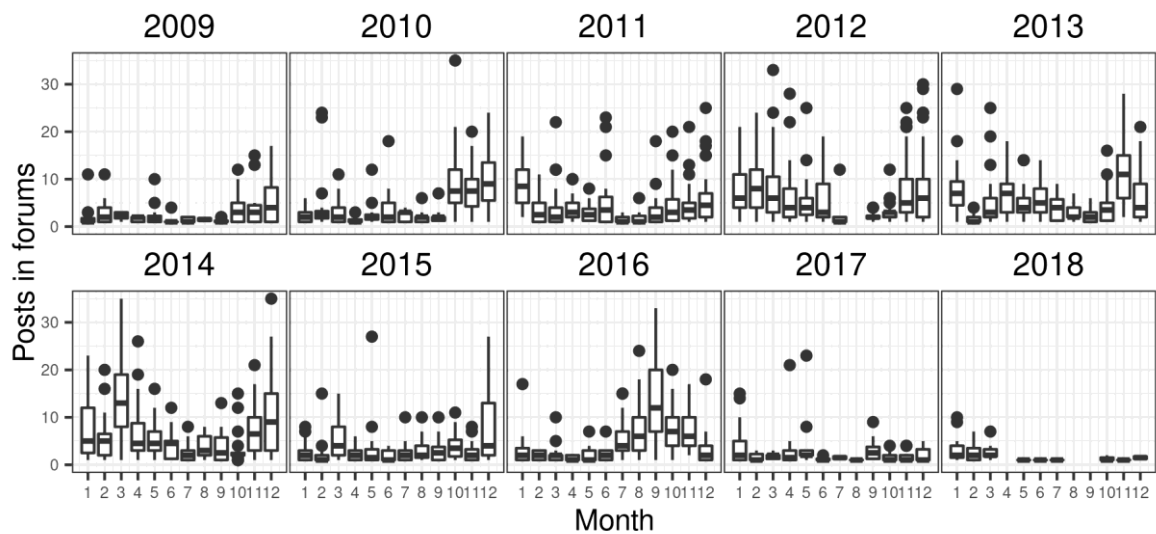Note that outliers were cropped from the path for clarity of presentation.

Figure 10: Mean number of posts created in a month.
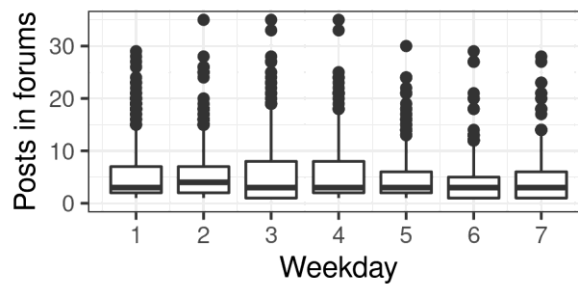Note that some outliers were removed for clarity of presentation.

Figure 11: Number of posts created per week day.
Note that seven outliers were removed from the plot for clarity of presentation.

In contrast to the patterns of user logins, only a few differences in numbers of created posts between months were found (cf. Fig. 10). For example, posts in February (4.54 ± 5.09) differed from those in March (8.07 ± 15.0) and December (7.75 ± 8.27). Furthermore, posts in March were different to all other months except January (5.70 ± 5.73), November (7.26 ± 7.42) and December. Posts during the vacation season in July (3.15 ± 2.84) and August (3.91 ± 3.74) were different to posts in November and December.

Moreover, during a week an increased number of posts compared to weekends were found: Wednesdays (7.09 ± 11.2) differed from Fridays (4.90 ± 6.65), Saturdays (4.08 ± 4.43) and Sundays (4.5 ± 4.76); and furthermore, Thursdays (6.13 ± 7.19) differed from Saturdays (cf. Fig. 11).

4.3 Content Creation in the Activity-Duration of a User

In order to examine the development of content creation, we defined the activity-duration of a user to be the period between the first and last activity (e.g., user profile creation, creation of an artefact) on the instance. These durations then were normalized to an interval [0..1], where 0 indicates the start of the activity period and 1 indicates the end of the activity period. The number of activities were summed up in increments of 5% (0.05) of the respective activity duration and also represented as a fraction of the overall amount of created content in the respective categories. We then segmented the user population in

two parts: those who were active for half a year or more (n = 9.457) and those you were active less than half a year (n = 12.472) to identify potential differences in usage behaviour.
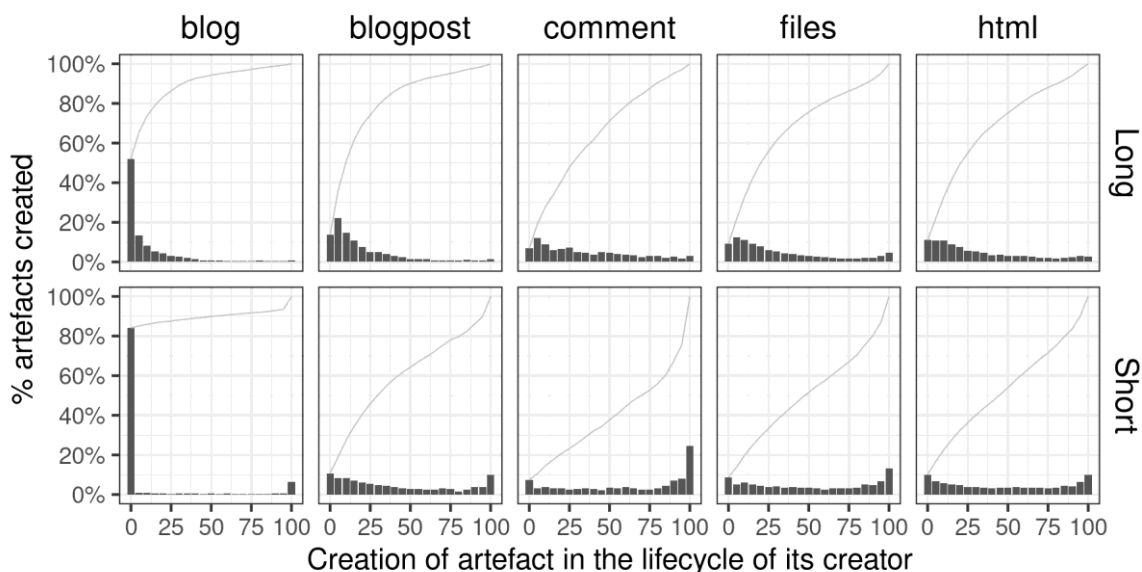

Figure 12: Artefact creations of users active on Mahara. Upper part shows users active for half a year or more, lower part shows users active for less than half.

As can be observed in Figures 12, short-term and long-term users differ with regard to their usage of Mahara. As is observable in the lower part of the figure, persons who use Mahara only for a short period of time showed peaks for creation of artefacts during the last five percent of their active period. This means that immediately before they stop using the platform, they create a majority of their comments and create a large proportion of their files and content. Long-term users lack that final peak, but create most of their content over an extended duration of time usually with an emphasis in the first third of their activity period.

4.4 Interpretation
The findings with respect to content creation also found evidence that mahara.at was used in large parts in an institutional learning setting rather than as a personal tool for life-long-learning. This is based on the fact that, similar to login behaviour, the amount of creation activity largely follows the patterns of school or university years and furthermore, that users have created less content on weekends. The observation that short-term users show content creation spikes in their final days of activity (the final 5%-bin equals about 1 one week for people having been active for about half a year) can be interpreted as activity that is necessary to meet course requirements for assessment. For longer-term users, such activity spikes cannot be observed – they rather show declining usage activity, indicating that users active more than half a year usually do not develop sustainable content creation activities and eventually cease to actively use the platform as a way to document their learning experiences.

5. Discussion & Conclusion
Data from our study suggest that a majority of learners stopped using Mahara as a platform for their ePortfolio immediately after the course / study program in they have been introduced to it. This is in contrast to findings a study by Balaban et al. (2011), in which continued usage ePortfolios platforms was reported and from which the authors derive the hope that ePortfolios could be used as sustainable tools for learning documentation.

In their study Bollinger and Sheperd (2010) reported that students had the intentions to continue using the ePortfolio platform after their respective course. Although, intentions are not covered as part of our study the results give no evidence for a broad realisation of such intentions, pointing at a potential intention-behaviour gap (Bhattacherjee & Sanford, 2009).

Based on the findings of this study it can be concluded that the usage patterns of the analysed Mahara instance were not reflecting expectations for a sustainable long-term use as an ePortfolio platform, but rather as a platform for short-term usage scenarios such as assessment purposes or – in some cases - as an in-class communication platform. The findings of our study, however, suggests that even for such scenarios, content creation and communication is not driven by users' needs, but rather by external pressure such as submission deadline. This is based on the observation that short-term users seem to create a large proportion of their comments and content just before their departure from the platform.

We hypothesize that the didactical approaches behind these usage patterns prevent users from developing an understanding of the potential added-value ePortfolios could provide to their professional and personal development and thus lack a sense of relevancy and importance for integrating the use of ePortfolios in their learning activities, and thus form unsustainable usage habits (Chen et al., 2012; Yan et al., 2021). Such a sense of relevancy and importance, however, is the prerequisite to develop self-determined usage patterns (Ryan & Deci, 2020) that survive the removal of external demands and lead to sustainable usage (Mobarhan & Rahman, 2015). As a consequence, we question whether the "dual-use"-approach (implementing short-term-scenarios while providing users with the opportunity for long-term-use) when introducing ePortfolios in institutional learning settings is an appropriate way for users to develop sustainable usage practices.

The study presented here has examined the usage of ePortfolios from a bird-eyes-view using data from an over 10-years-deployment of Mahara in the institution-independent instance mahara.at. The study is limited by the fact that only meta-data on platform usage was analysed, which leads to certain constraints in its interpretation. The actual content created on the platform could not be examined in detail, neither could potential different roles of users (e.g., students, teachers). Furthermore, the underlying reasons for the behaviour could not be studied due to the design of the investigation (data-based). The overall patterns still provide clear indications that mahara.at was mainly used for course-based scenarios despite its aspiration to provide a platform for long-term development of one's own lifelong learning portfolio.

Our future research will examine these usage patterns in more detail to develop a better understanding of how it was used by individual users, providing the foundation to identify usage patterns that are linked with sustainable content creation. This will provide the foundation to eventually derive suggestions on how ePortfolios can be introduced to inspire long-term usage practices.

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28. Uso da *Design Science Research* para proposição de um modelo de Governança de TI para Instituições de Ensino

Aline Rossales Sengik
Universidade Federal do Rio Grande - FURG
asengik@gmail.com

Guilherme Lerch Lunardi
Universidade Federal do Rio Grande - FURG
gllunardi@furg.br

Isaías Scalabrin Bianchi
Universidade Federal de Santa Catarina - UFSC
isaias.bianchi@gmail.com

Guilherme Costa Wiedenhöft
Universidade Federal do Rio Grande - FURG
wiedenhoft@furg.br

Resumo

O uso da Tecnologia da Informação (TI) nas instituições de ensino tornou-se essencial para sustentar as diversas atividades operacionais necessárias para o bom funcionamento do ensino, pesquisa e gestão dessas instituições, especialmente pela sua estrutura organizacional predominantemente multicampi. Isso resultou em uma maior dependência da área tecnológica, exigindo maior foco dos gestores na efetividade da Governança de TI (GTI), o que se mostra um problema para boa parte dessas organizações. Assim, propõe-se nesta pesquisa o desenvolvimento de um modelo de GTI específico para as instituições de ensino, seguindo os princípios metodológicos da abordagem Design Science Research. O modelo foi desenvolvido a partir de uma base teórica robusta, que levou em consideração diferentes abordagens fundamentadas no alinhamento das boas práticas e nas áreas-foco da GTI, além de observar a conformidade com a legislação e a atual situação dessas instituições no Brasil. O modelo consiste na integração de quatro principais componentes: a estrutura organizacional da GTI, as áreas-foco da GTI, os mecanismos estruturais, processuais e relacionais, e os indicadores de desempenho. A avaliação do modelo foi realizada através da sua demonstração a membros do Comitê de TI de uma instituição federal de ensino, que confirmaram a usabilidade e eficácia do modelo proposto.

Palavras-chave: Governança de TI, Instituições de Ensino, Modelo, *Design Science Research*, *IT Governance Canvas*.

1. Introdução

As instituições de ensino são organizações complexas que, nos últimos anos, têm passado por uma série de transformações no Brasil. A exemplo, a interiorização dos campi de várias universidades e institutos tecnológicos, que reforçou o fenômeno organizacional multicampi nessas instituições. Essa mudança resultou na transformação da estrutura organizacional de muitas delas, bem como na forma de gerenciamento de suas unidades, exigindo uma governança focada nos objetivos da organização como um todo, e não apenas nos objetivos de um ou outro campus específico (Andrade & Pimenta, 2020). Esse contexto tem impacto, também, na área tecnológica dessas instituições. Devido à necessidade de administrar diversos campi, muitos deles distantes geograficamente da Administração central, fica ainda mais evidente a sua dependência tecnológica, tendo em vista que a informatização de diversas atividades operacionais se tornou essencial para o funcionamento das atividades de ensino, pesquisa e gestão, exigindo, dessa forma, sistemas e estruturas de TI adequados para atender as demandas e objetivos institucionais (Andrade & Pimenta, 2020; Bianchi, 2018; Bianchi et al., 2020; Oñate-Andino et al., 2018).

Entretanto, Oñate-Andino et al. (2018) apontam para a utilização de forma indiscriminada e desvalorizada das tecnologias de informação no ambiente acadêmico, identificando ainda a falta de envolvimento da Alta Administração nos processos decisórios envolvendo a área de TI. Nesse cenário, evidencia-se a necessidade de um modelo de Governança de TI (GTI) que possibilite a essas instituições

controlar e direcionar estrategicamente os seus recursos e, consequentemente, o uso da tecnologia em seus diferentes espaços, gerando, assim, valor à instituição (Cordero-Guzmán & Bribiesca-Correa, 2018; Lunardi et al., 2017; Oñate-Andino et al., 2018). Nesse sentido, Wiedenhöft, Luciano e Magnagnagno (2017) apontam que não basta apenas implantar *frameworks* contendo as melhores práticas do mercado ou adotar um modelo praticado por outras organizações, pois a estrutura de GTI de uma organização deve estar adaptada às especificidades do ambiente em que esta está inserida, de modo a proporcionar melhores resultados para a organização. Em observância a este contexto, Oñate-Andino et al. (2018) constataram que apenas 3% das pesquisas realizadas sobre modelos de GTI consideraram as instituições de ensino. Observaram, ainda, que as especificidades identificadas nessas instituições motivam o desenvolvimento de artefatos na forma de modelos de referência para atender a realidade específica dessas organizações que operam em ambientes multicampi – caso de várias instituições de ensino brasileiras, públicas e privadas.

Portanto, propõe-se nesta pesquisa o desenvolvimento de um modelo de GTI específico para instituições de ensino, seguindo os princípios metodológicos da abordagem *Design Science Research* (DSR). Embora a DSR seja uma metodologia de pesquisa relativamente nova, segundo De Maere e De Haes (2017), ela tem recebido grande atenção por parte dos pesquisadores na última década, especialmente porque uma parte significativa das pesquisas conduzidas na Academia não é utilizada pelos gestores em suas organizações por não oferecerem de forma satisfatória orientações para resolver problemas do dia-a-dia. Assim, o artefato aqui proposto foi desenvolvido a partir de uma base teórica robusta, que levou em consideração diferentes abordagens fundamentadas no alinhamento das boas práticas e nas áreas-foco da GTI, além de observar a conformidade com a legislação vigente e a atual situação das instituições de ensino no Brasil. O artigo está estruturado da seguinte forma: na seção 2, apresenta-se uma breve revisão da literatura, enfatizando diferentes modelos de GTI. Na seção 3, descreve-se o método utilizado, enquanto na seção 4 apresenta-se o desenvolvimento e a aplicabilidade do modelo proposto. Na seção 5, destaca-se a avaliação do modelo e, por fim, na seção 6, são apresentadas as considerações finais do estudo, limitações e sugestões para pesquisas futuras.

2. Modelos de Governança de Tecnologia da Informação

Os modelos de Governança de TI têm por finalidade auxiliar as organizações no processo de implementação de uma estrutura de governança que possibilite uma melhor maneira de governar e disponibilizar a tecnologia. Em outras palavras, permitir que as decisões sobre estratégias e investimentos relacionados à TI sejam mais transparentes e consistentes com os objetivos da organização, tendo por propósito no contexto da Administração Pública aumentar o valor público para a sociedade (Lunardi et al., 2017; Wiedenhöft, Luciano, & Magnagnagno, 2017).

A implementação de modelos de GTI ocorre, geralmente, por meio do desenvolvimento de modelos próprios ou pela adoção de *frameworks* comerciais ou guias de referência (Juiz, Guerrero, & Lera, 2014; Lunardi, 2008). Nesse sentido, Almeida (2019) destaca que existem aproximadamente 315 modelos de referência de boas práticas de GTI globalmente reconhecidos (e consolidados no mercado), tais como: COBIT, ITIL, CMMI, PMI/PMBOK, ISO 38500, dentre outros, que poderiam ser utilizados por qualquer organização. Apesar de muitas organizações terem conhecimento sobre a existência de boa parte desses modelos, além de reconhecerem a sua importância, muitas optam por não adotá-los devido às dificuldades encontradas durante o processo de implementação. Mais especificamente com relação às instituições de ensino, alguns pesquisadores apontam que a maioria dessas estruturas foi desenvolvida para apoiar organizações com fins lucrativos (Almeida, 2019; Cordero-Guzmán & Bribiesca-Correa, 2018), o que acaba conflitando com as atividades-fim dessas instituições.

Nesse sentido, um modelo próprio de GTI desenvolvido para essas organizações poderia ser considerado mais preciso e efetivo, devido ao fato de incluir certas particularidades do ambiente organizacional, como as suas atividades desempenhadas, o seu tamanho, os aspectos políticos e culturais. Dessa forma, ao se

propor o desenvolvimento de tal modelo, é necessário reconhecer que ele será influenciado por vários fatores, internos e externos à organização. Além disso, há a necessidade de uma ampla discussão sobre alguns pontos importantes sobre como o modelo será adotado e operacionalizado. Nessa linha, diversos autores sugerem que a construção de uma estrutura de GTI efetiva envolva a definição e a implementação de um conjunto de práticas/mecanismos associados a processos, estruturas e relacionamento que tenham como objetivo o alinhamento entre as estratégias e objetivos da instituição com a área de TI e, consequentemente, na criação de valor para a organização (De Haes & Van Grembergen, 2015; Luciano & Macadar, 2016; Wiedenhöft et al., 2017).

Na literatura internacional, foram identificados alguns estudos envolvendo universidades que implementaram modelos próprios de GTI (Cordero-Guzmán & Bribiesca-Correa, 2018). Ajayi e Hussin (2016) propuseram um modelo de Efetividade de GTI para universidades na Malásia, baseado no relacionamento entre as capacidades de estruturas, processos e relações entre TI e negócios, com a finalidade de se obter um comportamento desejado da TI e de melhorar o desempenho organizacional. Já Olesen, Narayan e Ramachandra (2013) desenvolveram um modelo de GTI para universidades na Austrália, orientado ao processo que fornece orientações úteis para auxiliar as universidades no desenvolvimento de suas estruturas de governança responsiva e responsável. Enquanto no Brasil, Bianchi et al. (2020) propuseram uma estrutura para o desenvolvimento de um modelo próprio de GTI, levando em consideração fatores específicos do ambiente organizacional.

A literatura, também, apresenta uma variedade de modelos para ajudar as organizações na implementação da Governança de TI. Dentre os principais, destacam-se os trabalhos de Weill e Ross (2006) que propuseram um framework baseado na tomada de decisão e nas responsabilidades de TI, cujo objetivo é associar a estratégia da organização às estratégias de tecnologia e incentivar comportamentos desejáveis da organização; De Haes e Van Grembergen (2015) sugeriram que para desenvolver um modelo de GTI é necessário considerar uma combinação de estruturas, processos de negócios e mecanismos relacionais de uma organização, em que esse modelo seja considerado uma solução sustentável para a organização gerir melhor a sua tecnologia. Já o ITGI (2003) destacou a importância de uma estrutura de Governança de TI abranger cinco domínios ou áreas-foco, com o propósito de direcionar os esforços da área de tecnologia para atender aos objetivos dessas grandes áreas e, consequentemente, garantir o melhor desempenho da TI para a organização. Por fim, a ABNT (2018) forneceu um modelo de Governança de TI baseado em três principais funcionalidades da GTI: Avaliar, Dirigir e Monitorar, com a finalidade de auxiliar a Alta administração das organizações a compreenderem e cumprirem suas obrigações legais, regulamentares e éticas em relação ao uso eficaz da TI – esse modelo foi consolidado na norma NBR ISO/IEC 38500.

Esta seção apresentou por meio de uma breve revisão da literatura os principais modelos desenvolvidos, sob a forma de artefato, para solucionar os diferentes desafios levantados neste estudo. No entanto, a pesquisa realizada identificou poucos esforços voltados ao desenvolvimento de modelos de GTI específicos para instituições de ensino que atuem em ambientes organizacionais multicampi, oportunizando o desenvolvimento desta pesquisa. Os procedimentos metodológicos utilizados na pesquisa estão detalhados na seção seguinte.

3. Método

Este estudo foi conduzido seguindo as diretrizes da metodologia *Design Science Research* (DSR), cujo objetivo foi desenvolver um artefato, ao qual referimos como modelo de Governança de TI (MGTI). Esse modelo se trata de uma abordagem para estruturar a GTI nas instituições de ensino, com o objetivo de orientar a melhoria dos processos organizacionais relacionados à TI e ao desempenho da organização. A abordagem DSR adotada nesse estudo seguiu as orientações de Hevner (2007), que identifica esse princípio metodológico como a personificação de três ciclos de atividades intimamente relacionadas, os quais denomina de *ciclo relevância*, *ciclo rigor* e *ciclo design*. É interessante ressaltar que ao se conduzir

a DSR na realização de uma pesquisa em que seja levada em consideração a sua relação com os fatores relevância e rigor, permite-se a profissionais e gestores fazerem uso dos resultados obtidos para solucionar problemas presentes no ambiente em que estão inseridos. A Figura 1 ilustra o escopo da pesquisa e a sua associação com os principais componentes-chave do estudo, baseado nos ciclos da *Design Science Research*, proposto por Hevner (2007).

Em síntese, o *ciclo relevância* "faz a ponte entre o ambiente contextual do projeto de pesquisa e as atividades do *Design Science*" (Hevner, 2007, p. 2). Ao fazer essa conexão, o ciclo permite que sejam identificados requisitos como o problema a ser tratado e a inserção do artefato desenvolvido e avaliado no ambiente, com o propósito de resolver os desafios de pesquisa identificados. Nessa pesquisa, tratou-se dos aspectos relacionados à Governança de TI nas instituições federais de ensino brasileiras e da necessidade de uma estrutura de GTI efetiva nessas instituições, sendo esse o desafio abordado no estudo.

O *ciclo rigor* "conecta as atividades do *Design Science* com a base de conhecimento de fundamentos científicos, experiência e conhecimento que informam o projeto de pesquisa" (Hevner, 2007, p. 2). Em outras palavras, esse ciclo possibilita a seleção e aplicação de teorias e métodos presentes na base de conhecimento, como forma de apoiar nos processos de desenvolvimento e de avaliação do artefato desenvolvido na DSR. Nessa pesquisa, foram identificadas diferentes fontes para fundamentar o desenvolvimento do artefato proposto, como alguns aspectos legais (Portarias, Norma ISO/IEC 38500, Notas técnicas) e, também, aspectos do ponto de vista mais científico, como a análise dos principais assuntos referente ao tema Governança de TI – mecanismos, áreas-foco e modelos. Além disso, buscou-se a aplicação de alguns métodos e técnicas, tais como a Revisão Sistemática da Literatura, a Pesquisa *Survey* e a aplicação de Entrevistas para auxiliar na coleta dessas informações
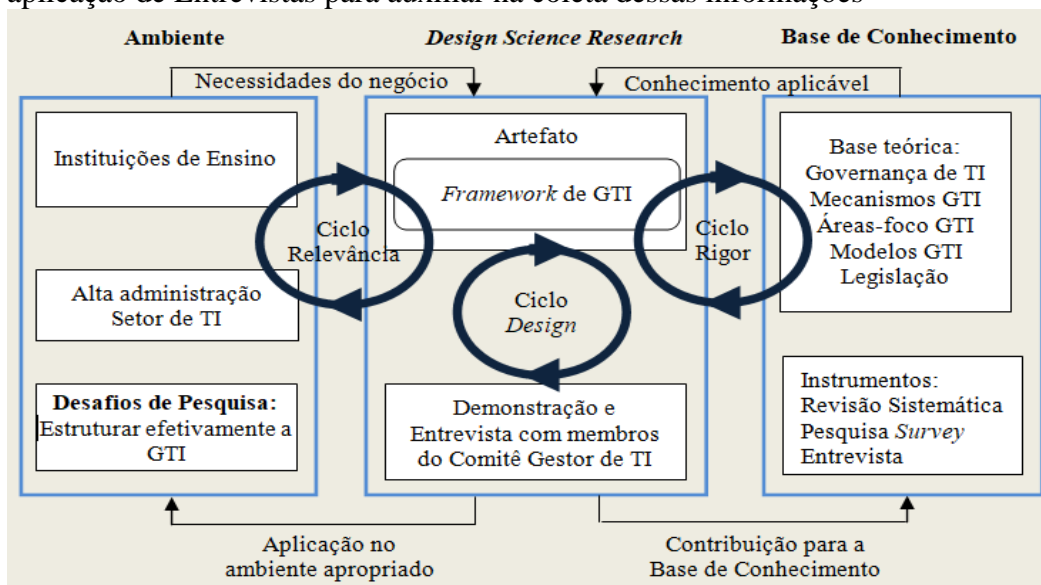

Figura 1: Associação entre os principais componentes do estudo com base nos ciclos da *DSR*
(Fonte: Adaptação de Hevner, 2007)

. Já o *ciclo design* "integra as atividades principais de construção e avaliação dos artefatos e processos de *design* da pesquisa" (Hevner, 2007, p. 2). Esse é o ciclo mais importante em qualquer projeto DSR, pois as atividades desenvolvidas para a construção do artefato devem estar de acordo com as informações obtidas nos ciclos *relevância* e *rigor* da DSR. Nessa pesquisa, propôs-se o desenvolvimento de um artefato, na forma de modelo, para solucionar os diferentes desafios apresentados na seção introdutória desse artigo, cujo objetivo foi contribuir com a implementação de uma estrutura de GTI efetiva em ambientes organizacionais multicampi. Acrescenta-se, ainda, que para avaliar o artefato desenvolvido foi realizada a demonstração do modelo, seguida de entrevistas semiestruturadas.

Dessa forma, para o desenvolvimento do modelo proposto nesse estudo foram seguidas as etapas da DSR, descritas na Figura 2. A Etapa 1 consistiu (i) na identificação do problema, (ii) na exploração da literatura sobre o tema Governança de TI no setor público (a qual auxiliou na definição do modelo de GTI) e (iii) na realização de uma pesquisa *survey* com 291 servidores lotados na área de TI de 245 campi das Instituições Federais de Ensino, localizados em todos os estados da federação, em que se buscou analisar a atual situação da GTI nessas instituições. Essa pesquisa contribuiu com dados relevantes para a proposição do modelo de GTI específico para as IFEs, permitindo realizar um diagnóstico em relação aos

mecanismos e áreas-foco da GTI nessas instituições, cujos resultados foram utilizados na etapa de avaliação, durante a demonstração do modelo. A Etapa 2 consistiu na definição do modelo desenvolvido e na descrição da sua aplicabilidade, enquanto a etapa 3 referiu-se ao processo de avaliação do artefato, em que o modelo proposto foi validado no ambiente para o qual foi desenvolvido. Essa última etapa consistiu (i) na demonstração do modelo de GTI para os membros do Comitê Gestor de TI de uma IFE e (ii) na sua validação, a partir de entrevistas semiestruturadas junto a esses participantes, em que foram realizados questionamentos acerca da aplicabilidade do modelo de GTI na sua instituição.

Figura 2. Etapas DSR percorridas para o desenvolvimento do modelo
(Fonte: elaboração própria)

4. Desenvolvimento do modelo de Governança de TI de acordo com a *DSR*

Conforme sugerido no ciclo rigor da *DSR*, buscou-se através da realização de uma Revisão Sistemática da Literatura, documentos, teorias e modelos pertencentes à base de conhecimento sobre Governança de TI para auxiliar na estruturação do modelo proposto. Essa revisão permitiu identificar diversos aspectos que poderiam ser utilizados para melhorar, ainda mais, a estrutura de GTI presente na organização, tais como: práticas recomendadas, indicadores, modelos existentes, entre outros. A Figura 3 ilustra os principais componentes selecionados na literatura para compor o modelo de GTI desenvolvido nesse estudo, cujo objetivo foi estruturar uma Governança de TI efetiva voltada às organizações de ensino.

Figura 3:
Principais componentes para composição do modelo de GTI proposto
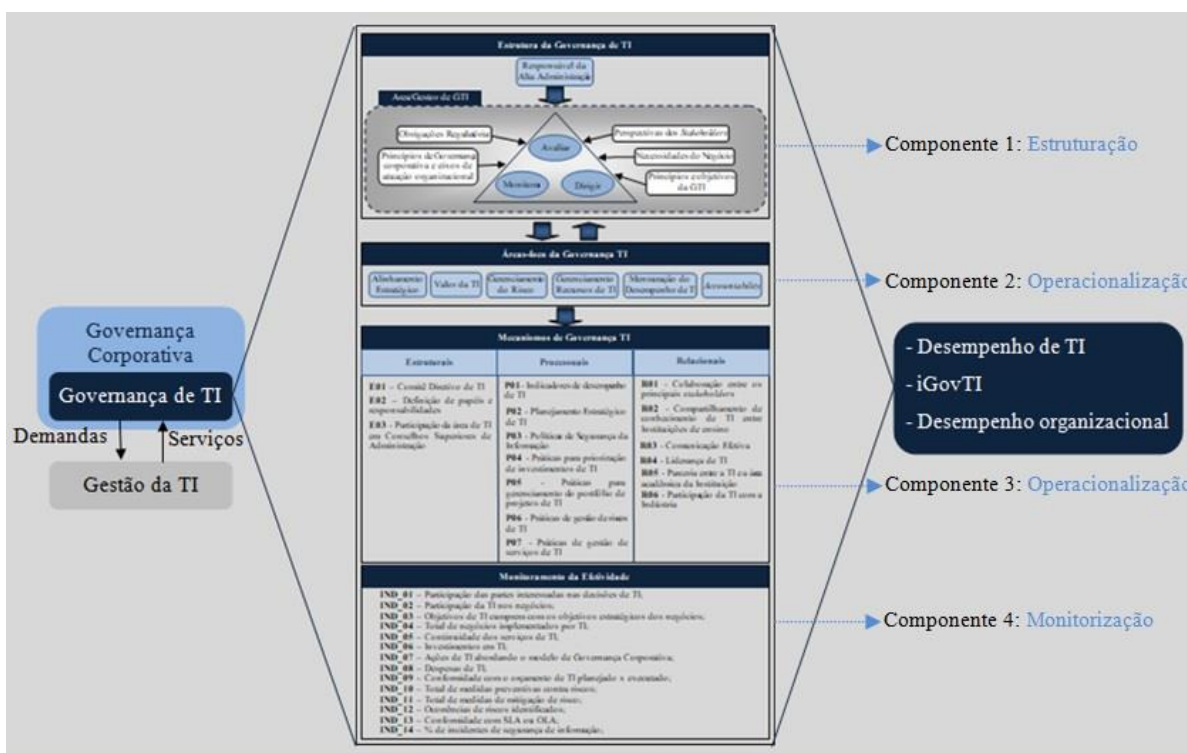(Fonte: elaboração própria)

O modelo proposto, denominado MGTI, é formado por quatro componentes identificados anteriormente na revisão de literatura, sendo agrupados em três blocos, denominados de: (i) Estruturação, (ii) Operacionalização e (iii) Monitorização. A Figura 4 apresenta o modelo desenvolvido com a integração dos seus componentes. Na visão geral do modelo, tem-se o ambiente organizacional, em que estão inseridos diversos aspectos considerados importantes: (i) quanto à posição e o papel da GTI na organização, devendo ficar evidente que a GTI tem a responsabilidade de gerenciar estrategicamente as

demandas de TI e encaminhá-las ao setor responsável pela TI da instituição, o qual deve operacionalizar essas demandas através da realização de seus serviços, de modo a atender os objetivos organizacionais predefinidos pela instituição; (ii) o modelo deve auxiliar a Alta Administração no processo de governar estrategicamente a sua TI, através do alinhamento da área de TI com as demais áreas da instituição; e (iii) por meio do entendimento do papel da GTI e implementação do MGTI, espera-se alcançar como resultados a melhoria do desempenho organizacional e da área de TI, aumentando o valor público proporcionado pela instituição.

Assim, o modelo proposto consiste de um guia para orientar as instituições de ensino quanto às ações a serem realizadas e na identificação dos principais aspectos necessários para implementar uma GTI eficaz. O fato de o modelo estar alinhado às principais áreas-foco e mecanismos de GTI possibilita aos gestores um maior controle sobre os processos organizacionais relacionados à TI, bem como a proposição de ações para melhorar a sua efetividade. Outro ponto a ser ressaltado no modelo é o fato de o mesmo poder ser adaptado de acordo com as especificidades e realidade de qualquer instituição que possui um ambiente organizacional semelhante às instituições analisadas neste estudo. A seguir, descreve-se o objetivo de cada bloco do modelo e a sua aplicabilidade como forma de auxiliar as instituições na definição e adoção do MGTI, de acordo com a sua realidade.

Figura 4: Visão geral do Modelo de Governança de TI

(Fonte:

elaboração própria)

4.1 Bloco Estruturação

O bloco Estruturação tem por objetivo especificar claramente a estrutura e o papel da GTI na instituição. As ações definidas nesse bloco servem de base para orientar como o modelo de GTI será adotado e operacionalizado na Instituição, alinhando-o aos principais objetivos organizacionais. Como forma de auxiliar na definição desse bloco (o qual está ligado à funcionalidade de avaliar o uso atual e futuro da TI), sugere-se a discussão e a definição de alguns componentes apresentados no guia *IT Governance Canvas* (Figura 5).

Em síntese, são destacados três componentes principais: (i) os Fundamentos organizacionais, em que são definidos os fatores relacionados às perspectivas de negócio e que servem de base para o MGTI; (ii) os Direcionadores, em que são determinadas as principais questões estratégicas em relação à área tecnológica, sendo, dessa forma, os responsáveis pelo direcionamento do processo e pela definição dos resultados que atendem às necessidades da organização; e (iii) a Operacionalização, em que são definidos os papéis e as responsabilidades em relação aos principais direitos decisórios de TI, os quais envolvem os princípios de TI, a arquitetura de TI, a infraestrutura de TI, as necessidades de aplicações de negócio e investimento, e a priorização da TI (Weill & Ross, 2016). Com o propósito de dar maior visibilidade à estrutura de GTI definida na Instituição, sugere-se que após a definição desses fatores mais estratégicos, seja criada a Política de Governança de TI.
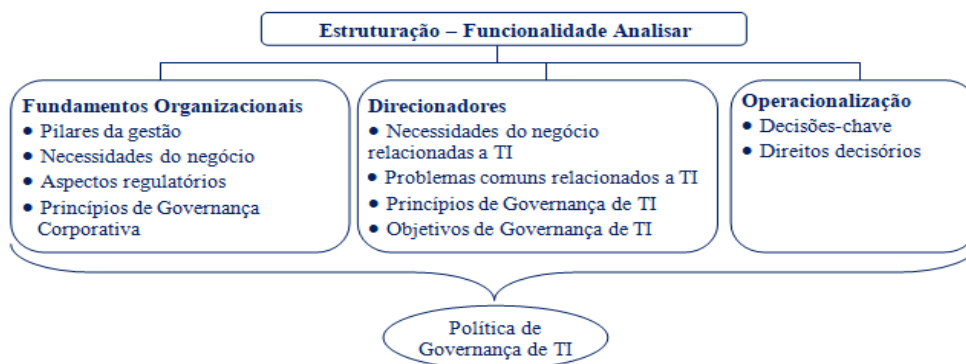

Figura 5: Estruturação da GTI
(Fonte: elaboração própria)

4.2 Bloco Operacionalização

O bloco Operacionalização tem por objetivo definir e operacionalizar as estratégias de alto nível relacionadas às áreas-foco da GTI, de acordo com os seus objetivos organizacionais. Para a definição desse bloco na instituição, o qual está ligado à funcionalidade de dirigir as estratégias para garantir que o uso da TI atenda às diferentes necessidades organizacionais, sugere-se a realização de um diagnóstico sobre a atual situação da Governança de TI na organização. A Figura 6 apresenta uma sugestão de instrumento para auxiliar os gestores na discussão do diagnóstico da GTI, em que se avalia o quão bem estão desenvolvidas as áreas-foco da GTI e o nível de adoção dos mecanismos de GTI presentes na instituição. Desse modo, a organização consegue ter uma visão atualizada de como está a sua Governança de TI, podendo traçar diretrizes para aperfeiçoar as áreas-foco com menor desempenho e, com isso, melhorar o desempenho da área de TI e da instituição como um todo.

Figura 6: Instrumento para diagnóstico da GTI na Instituição

(Fonte:

DIAGNÓSTICO		Nível adoção Mecanismo	Áreas-foco						Desempenho TI	Desempenho Organizacional	iGovTI
			AE	VA	RIS	REC	AC	MP			
Estruturais	E01 - Participação da área de TI em Conselhos Superiores de Administração										
	E02 - Comitê Diretivo de TI										
	E03 - Definição de papéis e responsabilidades										
Processuais	P01 - Indicadores de desempenho de TI										
	P02 - Planejamento Estratégico de TI										
	P03 - Políticas de Segurança de Informação										
	P04 - Práticas para priorização de investimentos de TI										
	P05 - Práticas para gerenciamento do portfólio de projetos de TI										
	P06 - Práticas de gestão de serviços de TI										
	P07 - Práticas de gestão de riscos de TI										
Relacionais	R01 - Colaboração entre os principais *stakeholders*										
	R02 - Compartilhamento de conhecimento de TI entre Instituições de ensino										
	R03 - Comunicação efetiva										
	R04 - Liderança de TI										
	R05 - Parceria entre a TI e a área acadêmica da Instituição										
	R06 - Parceria da TI com a Indústria										
Outros Mecanismos:											

Escala para nível adoção dos Mecanismos: 1=Inexistente; 2=Pouco desenvolvido; 3= Parcialmente desenvolvido; 4=Bem desenvolvido; 5=Extremamente bem desenvolvido

Legenda: AE = Alinhamento Estratégico; VA = Valor da TI; RIS = Gerenciamento de Riscos; REC = Gerenciamento de Recursos; AC = Accountability e MP = Medidas de Peformance

elaboração própria)

4.3 Bloco Monitorização

O bloco Monitorização tem por finalidade definir os principais indicadores para auxiliar os gestores na realização do monitoramento da efetividade da GTI na organização. Considerando-se que esse bloco está ligado à funcionalidade de monitorar o desempenho da GTI em relação às estratégias estabelecidas e, também, à conformidade com as legislações vigentes, sugere-se novamente seguir os passos descritos no guia *IT Governance Canvas* para auxiliar a organização na implementação desse bloco, conforme sintetizado na Figura 7. Primeiramente, é necessário identificar os fatores críticos de sucesso, que nada mais são do que os fatores-chave que, quando bem executados, garantem o alcance dos objetivos organizacionais e o desenvolvimento da instituição. Assim, com base nesses fatores, os gestores podem definir os indicadores mais apropriados para mensurar a efetividade da GTI na organização. Ao final desse processo, sugere-se a elaboração de um Relatório de Efetividade da GTI, como forma de apresentar à Alta Administração as contribuições obtidas através do gerenciamento estratégico da área tecnológica. Na próxima seção são descritos os passos realizados na avaliação e validação do MGTI.
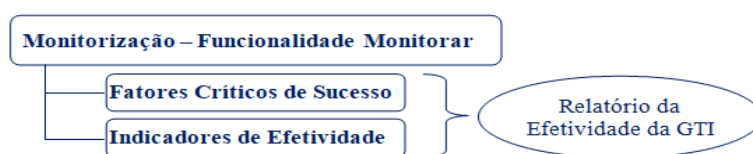

Figura 7: Monitorização da GTI
(Fonte: elaboração própria)

5. Avaliação do Modelo de Governança de TI proposto

A avaliação do modelo é uma etapa crucial do processo de pesquisa baseada na DSR, porque permite demonstrar e medir o comportamento do artefato desenvolvido na solução do problema. Nesta perspectiva, aponta-se que o artefato pode ser avaliado sobre diversos critérios, tais como: funcionalidade, desempenho, usabilidade, adequação à organização e outros atributos de qualidade relevantes (Hevner et al., 2004). Segundo os mesmos autores, um artefato é considerado completo e eficaz quando satisfaz os requisitos e as restrições do problema a ser resolvido. Dessa forma, com o propósito de atender ao *ciclo design* da DSR, optou-se pela realização de uma avaliação descritiva, em que se buscou demonstrar a usabilidade do modelo de GTI desenvolvido a partir da avaliação de pessoas envolvidas no acompanhamento das decisões relacionadas à TI de uma instituição de ensino.

A etapa de avaliação ocorreu em um único ciclo que consistiu na demonstração do modelo proposto, por meio de uma apresentação em que foi feita a simulação da implementação do modelo em uma universidade pública federal, a qual se denominou instituição *Alpha*, a fim de manter a sua confidencialidade. Para isso, foram utilizadas as orientações do guia *IT Governance Canvas*, alguns dados secundários disponibilizados sob a forma de documentos retirados do site da instituição *Alpha* (como Plano de Desenvolvimento Institucional, Plano Diretor de Tecnologia da Informação e Planejamento Estratégico de Tecnologia da Informação) e os resultados obtidos a partir de uma pesquisa *survey* realizada com 89 instituições de ensino (contendo respostas de 245 campi de universidades e institutos federais), a qual identificou a efetividade das áreas-foco e dos mecanismos de GTI dessas instituições, permitindo a realização de análises comparativas entre elas. Ao final, foram realizadas entrevistas semiestruturadas com dois membros do Comitê Gestor de TI da instituição *Alpha*, tendo por objetivo coletar a percepção dos entrevistados quanto à aplicabilidade do MGTI na sua instituição, bem como a identificação de possíveis ajustes e melhorias. Durante as entrevistas foram realizados questionamentos que abordaram aspectos de usabilidade e eficácia do modelo proposto, a exemplo: "Você considera viável implementar esse modelo de GTI na sua Instituição? Por quê?". A Figura 8 ilustra alguns desafios e dificuldades apontadas pelos entrevistados quanto à implementação do modelo, em especial os mecanismos de GTI e indicadores de monitoramento propostos.
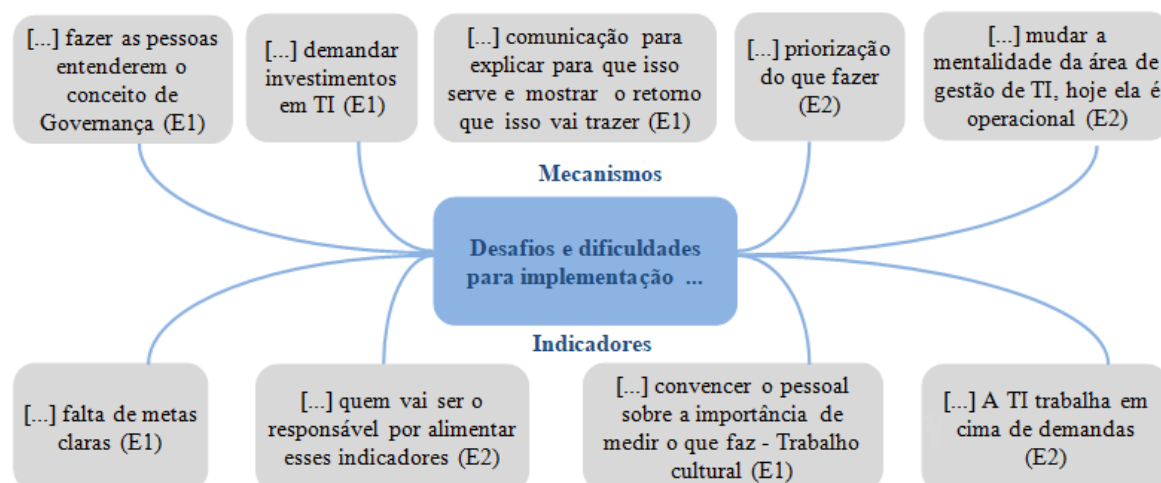
Figura 8: Desafios e dificuldades para implementação de mecanismos e indicadores
(Fonte: elaboração própria)

Os resultados da análise confirmaram a utilidade prática do modelo desenvolvido na instituição, em que foram apontados como pontos positivos (i) a descrição de elementos essenciais para auxiliar no processo de governança da área tecnológica, até então, desconhecidos pelos entrevistados e (ii) a flexibilidade do modelo se adaptar à realidade do ambiente organizacional. É importante destacar que os avaliadores não apontaram melhorias específicas no modelo proposto, pois consideraram o MGTI completo e abrangente. Entretanto, forneceram informações úteis que devem ser consideradas, como as dificuldades apontadas para implementar o modelo, especialmente quanto aos mecanismos e indicadores de desempenho propostos. Algumas dessas constatações foram muito além de simples aspectos relacionados à implementação do modelo, envolvendo questões mais amplas como a necessidade de mudança na idiossincrasia e nas estruturas já estabelecidas nas instituições. Por fim, conclui-se que o MGTI se mostrou uma solução satisfatória para auxiliar as organizações na implementação de uma estrutura de GTI efetiva em ambientes organizacionais multiunidades.

6. Considerações Finais

Este estudo apresentou o desenvolvimento de um modelo de GTI (MGTI) com o objetivo de melhorar a efetividade da GTI de organizações públicas que atuam no arranjo organizacional multiunidades – como é o caso das Instituições Federais de Ensino. O MGTI foi desenvolvido seguindo as diretrizes da *Design Science Research* e fundamentado nos principais aportes teóricos encontrados na literatura sobre a temática investigada, além de considerar as regulamentações que incidem nas organizações do setor público. É importante destacar que o modelo se mostra flexível o suficiente para ser implementado em outras organizações inseridas em um contexto organizacional semelhante ao das instituições aqui estudadas, uma vez que fornece um passo a passo dos principais aspectos a serem abordados na construção e implementação de um modelo de GTI, em que são consideradas as especificidades do ambiente organizacional em que a instituição está inserida.

A etapa de avaliação forneceu evidências que permitiram concluir que o MGTI é uma ferramenta que pode auxiliar a Alta Administração das IFEs na implementação de uma estrutura efetiva de GTI, uma vez que considera os aspectos específicos da organização e integra componentes importantes que auxiliam nas atividades para governar estrategicamente a área de TI da organização. Por outro lado, foi identificado que a principal barreira para a implementação do modelo é a necessidade de "quebrar" paradigmas que estão engessados nas instituições de ensino. A exemplo, em relação ao comportamento e visão dos gestores e servidores quanto à importância da eficácia de um processo de governança na instituição, pois, muitas vezes, as demandas relacionadas à GTI são realizadas somente para atender alguma regulamentação exigida, não passando disso. Nesse sentido, acredita-se ser necessário um maior

acompanhamento dos órgãos reguladores quanto à forma com que a GTI vem sendo desempenhada por essas instituições.

Como contribuições gerenciais, acredita-se que o modelo desenvolvido possa orientar os gestores na melhoria dos seus processos organizacionais associados à gestão de TI, pois a sua implementação permite obter maior controle sobre como a TI vem sendo gerenciada e utilizada pela organização, em termos de investimentos e valor gerado. Para a academia, ressalta-se que o estudo também traz importantes contribuições, seja (i) fornecendo um modelo de GTI para um campo de pesquisa ainda pouco desenvolvido e consolidado e, sobretudo, pela (ii) aplicação da abordagem DSR para desenvolver um artefato, podendo servir de referência para a realização de outros trabalhos acadêmicos que tenham a pretensão de utilizar essa metodologia. Como limitação do estudo, ressalta-se que devido ao contexto da pandemia do COVID19, as etapas referentes aos processos de desenvolvimento e validação do artefato foram realizadas de forma remota, em um único ciclo. Ainda assim, acredita-se que o resultado obtido nesse estudo seja válido, pois atendeu rigorosamente os requisitos das etapas metodológicas da DSR, buscando propor uma solução satisfatória para o problema identificado, no caso, o MGTI. Para pesquisas futuras, sugere-se incluir outras questões relacionadas à GTI não abordadas neste trabalho, como os aspectos de sustentabilidade associados à tecnologia, também conhecida como TI Verde, a fim de complementar o modelo proposto nesse estudo.

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