MOBILE APPLICATIONS AND DIGITAL GOVERNANCE IN BRAZIL: A CASE STUDY OF THE "PIÁ PROJECT" FROM THE STATE OF PARANÁ

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Abstract: This paper aims to study the digital governance experiences in Paraná, Brazil, with emphasis on the use of applications and artificial intelligence in the management of governor Ratinho Júnior from 2019 to 2020. For such, we will perform an analysis of 26 applications used by the Paraná government and developed by Celepar in the context of the PIÁ Project of using Artificial Intelligence applied to electronic government. As a methodology, we performed the analysis of four basic dimensions of the applications, namely (i) the degree of success and permanence, (ii) the diffusion and number of installations, (iii) user ratings, and (iv) responsivity. From the analysis of these four dimensions, we elaborated a good practices index in the use of mobile applications that allows us to identify some good practices of digital governance through the use of applications.

Keywords: Digital Governance; Mobile Government; Applications; Good Practices; Digital Democracy.

1 Introduction[4]

Since at least the beginning of this century, a broad literature on the use of applications in public administration in the digital governance context has arisen (LIMA, 2017; ARAUJO; LEMOS, 2018; ARAUJO, 2019; MATOS, 2020), with a series of new themes emerging in the reflection about digital government, such as smart cities, mobile government, artificial intelligence, and big data, among others. More recently, due especially to the pervasive diffusion of mobile telephony digital tools in various parts of the world, recent studies have shown the permanence and growing interest in the theme of government mobile applications in this new context, with increasing importance in the Brazilian public administration, notwithstanding the theme being the object of systematic analysis in the international literature for some time (BAL;

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BIRICK; SARI, 2015; DAUBS; MANZEROLLE, 2016; ARAUJO, 2019; MATOS, 2020).

It is known that Brazil is among the countries where more time is spent on mobile phones daily (on average 225 min, above the international average), ahead of Japan, Canada, the United States, and the United Kingdom, and Brazilian users increased the volume of application downloads from 2016 to 2019 by 40%, according to recent data from an *App Annie* report (APP ANNIE, 2020). However, despite this growing diffusion, one must observe that the country still presents a scenario of digital exclusion in which the most economically vulnerable population uses mobile phones more than broadband. In 2018, for example, 56% of Internet users used only mobile phones to connect, with the primary reason being the low costs compared to that of personal computers. Another exclusion factor for the low-income population is the difficulties in covering the continuous costs of Internet plans, which are an obstacle to the frequent use of mobile applications, although such barriers are decreasing (CETIC, 2019).

Within this Brazilian context of growing incentives to the use of applications by users and their use in the public administration sphere, we may mention the experience of digital government in Paraná, Brazil. The experience of the Paraná government with the "digital government of Paraná" program, which more recently gained the name of Paraná Artificial Intelligence (PIÁ, from the Portuguese *Paraná Inteligência Artificial*), at a subnational level, stems from the increasing use of new digital governance tools and applications in Brazil. The PIÁ Project is the digital system for accessing the state public administration services, in which various applications are gathered so that, in the self-service condition, users may access the information consultation areas and make requests for services in the exercise of citizenship. Through the electronic address www.governodigital.pr.gov.br[5], users have access to a comprehensive list of state government services ranging from the management of tax payments to the issuance of identity cards and vehicle licensing, besides the state government communications contents, such as campaigns and news.

In this context, despite the increase in studies on the subject, more systematic analyses of the use and, more importantly, of the impacts of the use of applications at a subnational level (state or municipal) are still lacking, as observed by more recent studies (MATOS; LANZA; LARA, 2021). The theme is also relevant for elaborating public policies seeking to improve the use of applications, especially those developed for use in tablets and smartphones, considering that mobile devices are important instruments to facilitate access to public services by citizens, as determined by the previously mentioned data.

Hence, this study aims to perform an analysis of the applications made available to users on the PIÁ Project platform, added to others developed by Celepar and that, together, are on the application platforms Google Play Store and Apple Store. We chose to analyze the applications

[5] According to the access on Nov. 30, 2020.

together because, although some of such applications are not hosted on the PIÁ Project platform, they were also developed by Celepar, being accessed together on the application use platforms.

We will seek to analyze if the applications on the electronic platform contribute to facilitating the access to the offered services and if this demonstrates a strengthening of the democratic model of the government, given the values of accountability, responsibility, and transparency, and, fundamentally, if such conditions are previously considered in the conception of products made available to citizens, with interest in recovering the trust of citizens in government actions, increasing citizen engagement relative to public administration initiatives. Moreover, this study proposes a methodology for analyzing the applications developed to work on mobile platforms (tablets and smartphones) to verify whether or not they are "good practices" that meet the criteria of permanence, social impact, diffusion, good user ratings, and responsivity.

To address these questions, we will follow the following sequence: 1) initially, we will contextualize the theme "digital governance" via mobile applications in Brazil and briefly review the existing scientific literature on the subject, with emphasis on the most recent literature that addresses mobile government experiences at a subnational scale. In this context, we will render explicit the specificity of our focus relative to the other existing studies on the theme; 2) next, we will present our methodology in the context of a reflection about other methodologies employed to assess digital government "good practices"; 3) lastly, we will apply our methodology in the analysis of the main applications connected to the PIÁ Project and developed by Celepar[6], also extracting some general conclusions from the analysis.

Finally, it should be clarified that, as will be made clearer later, for terminology standardization purposes, we employ the expression "mobile government" to characterize the government or digital governance experiences through the use of applications. For reasons of space and given that the purpose of the paper is to expose the results of our empirical research, it will not be possible to go into a more profound conceptual discussion of the specificity of this concept relative to the others such as "mobile digital governance" or even "mobile electronic government". It should also be noted that this is a pilot study that we intend to deepen with the analysis of applications from other government units.

2 Mobile government and the use of applications in the Brazilian context: concepts and review

In Brazil, the use of mobile Internet and mobile devices such as tablets and smartphones has grown at rates higher than the global average in recent years. The use of such devices has

[6] The Paraná Electronic Data Processing Center, created by State Law No. 4945 of October 30, 1964, during the Nei Braga government, is considered the oldest public company in Paraná. It is a privately held public company, the majority shareholder of which is the state of Paraná, created with the specific purpose of providing informatics services to the agencies and entities that integrate the state public administration. It has been headed by Leandro Moura since August 2019.

modified the way people interact with each other and with companies around them, and it also has significant potential to reach government-government, government-company, and government-citizen relationships. The presence of mobility in Brazil is made evident through the growth in the use of mobile Internet and the significant increase in mobile devices every year (SILVA; PINHEIRO, 2019). Araujo and Lemos (2018), for example, concluded that the offering of applications in the public sector indicates, on the one hand, the search for technological updating to place the municipality and the state on the heels of smart city development, and, on the other hand, the intention to expand the public communication power, leading applications to, definitely, become a tool for public communication and also for managing information made available by users, a management that is not always done transparently and through the informed consent of citizens.

According to a previously mentioned report by the Regional Center for Studies for the Development of the Information Society (CETIC) on mobile governments and the use of Information and Communications Technologies (ICTs) in the Brazilian public sector, although there has been little variation in recent years, the use of applications has been increasingly disseminated in the Brazilian public administration, although not at linear growth rates:

> Despite the increasing use of mobile phones among Brazilians to connect to the Internet, the offer of resources for mobile devices among public agencies did not vary from 2017 to 2019. According to Chart 6, the most common resource in both the federal and state spheres was websites adapted to mobile devices or designed in some mobile version. Among the federal agencies, the provision of applications created by the agency itself was also frequent (62%), mentioned by one-third of state public agencies (33%) (CETIC, 2019, p. 101).

On the other hand, in their synthesis about the studies on digital democracy in Brazil and the world, Wilson Gomes situated the field of "digital government" or "digital governance" in one of the three large fields of digital politics, democracy, and State (the "digital State"), alongside other great fields such as "online politics" or "digital democracy" (GOMES, 2019, p. 18). In this context, as Wilson Gomes stated, the application and diffusion of applications and "mobile" devices such as mobile phones pose new challenges for governance and, indirectly, for digital democracy itself, modifying the classical idea of "electronic government" that existed in the age of the classical Web, when Internet connections did not take place through portable mobile devices, which enables pervasive and mobile connectivity:

> [...] it is the idea itself of websites and classical web that comes into question with the two innovations consolidated in this period: the Internet of applications and mobile Internet. The last decade witnessed a new "race to the machines" after the shopping for home computers in the 1990s: the search for portable devices with processing capacity and Internet connections. The connection starts to free itself from home and office computers and becomes portable wherever we move to through portable machines and mobile phones. At last, the expression "personal computer" starts to really make sense. Moreover, having applications as standard Internet use accompanies the

> explosion in mobile device consumption that consolidated in the 2010s at a global level. Some iconic innovations during these years, such as the MacBook Pro (2006), which made the really portable laptop popular, the iPhone (2007), and the Android operating system (2008), only signaled the mainstream in terms of consumption and social adoption of communication technologies (GOMES, 2019, p. 77).

Therefore, it is not a surprise that, with the growing diffusion of black screen mobile applications ("Black Mirrors") around the world and the lowering of Internet access costs, mobile technologies are being incorporated into the everyday life of public administration pervasively (LARA; RODRIGUES; GOSLING, 2017; CETIC, 2019). The reasons why governments use these applications and technologies are related to improving access and delivering government information and services to citizens, companies, and other entities, but also goes through data collection for public policy elaboration purposes through the collection, tracking, and analysis of the "big data" made available by users, for example. As observed in other studies (ARAUJO; LEMOS, 2018) and as we ourselves have observed in the interviews held with managers to elaborate this study, the promotion of "participation" or improvement of digital democracy remains in the background, although it is not irrelevant from the perspective of these managers[7].

Therefore, it is not without reason that the interest in the current theme for some time in the international literature also repercussed in Brazil, giving rise to different works on the subject (MATOS, 2020). To perform a mapping of these works, we searched some databases available on the Internet, such as the Journals Portal of the Brazilian Coordination for the Improvement of Higher Education Personnel (Capes), the Google Scholar search engine, and bibliographic references of the two doctoral works that served as references for this paper (ARAUJO, 2019; MATOS, 2020). More specifically, relative to the search engines, we chose to filter the works that, as mentioned, assessed real initiatives on the use of mobile applications in Brazil, especially at the subnational level but not only at this level, listed through the keywords "m-government", "*governo móvel*", "*governo eletrônico móvel*", and the like, surveyed based on the previously mentioned concepts. With this, we have that the corpus of this review is composed of seven primary works, including scientific papers, dissertations, and theses, specifically focused on analyzing the use of applications in the subnational spheres of the Brazilian government (BOX 1).

[7] For a reproduction of the interviews with PIA project managers and of their perception that the use of applications aimed more at improving digital governance efficiency than promoting "participation", i.e., some type of influence or consultation to citizens in the public policy elaboration process, see the Annexes contained in work by Zacarias (2020).

Box 1 – Corpus of the Bibliographic Review

Original author(s)	Object and objectives
Centeno, Andrade, & Souza (2015)	Investigate the mobile application policy and the applications themselves made available by the state government of São Paulo.
Engrazia & Dutra (2015)	"(...) perform the analysis of the m-government initiative of the state government of Rio Grande do Sul from the classification of the maturity stage of the services available in the RS Móvel application (...)" (Ibid, p. 201).
Lima (2017)	Analyzes the "mobile applications of public interest" available in the Applications Guide of the federal government and the public policies related to the theme.
Araujo & Lemos (2018)	"(...) presents a mapping of the applications for mobile devices made available to citizens by the executive branch of the state government of Bahia and the City Hall of Salvador. We seek to analyze its functionalities, services, sectors, and activities (...)" (Ibid, p. 1).
Guimarães et al. (2019)	"(...) to investigate the premises in its conception, as well as analyze and assess the experience implemented" by the Belo Horizonte City Hall after the launch of the PBH application.
Araujo (2019)	Analyzes the mobile government experience in the city of Salvador by examining 94 mobile device applications used by Brazilian capital city halls from the view of political communication.
Matos Neto (2020)	Maps, investigates, and assesses user perceptions of 203 applications from 3 Brazilian public sector agencies in the three branches (Executive, Legislative, and Judiciary) made available on Google Play.

Souce: Devised by the authors (2020).

It should be noted that the still incipient literature on the theme in Brazil at the subnational scale does not allow one to obtain a representative panorama of regional diversity. However, for the aims of this research, the following brief bibliographic review offers a relevant backdrop supported by empirical evidence and with which it will be possible to dialogue to assess the situation of the use of mobile applications by the state government of Paraná relative to precepts of digital public governance, in addition to underlining some specificities of this study vis-à-vis others already existing on the subject.

Centeno, Andrade, and Souza (2015) highlighted the problems stemming from the "fragmentation" or absence of integration of the various applications that the state government of São Paulo attempted to circumvent in its strategy. To facilitate the dissemination and use of the 41 applications that address state themes, the undersecretariat responsible for managing these tools created a central application ("application of applications") called SP Serviços that enables a

search of the available applications[8]. Even so, there are integration problems, which shows how the continuity and evolution of these policies need to be in sync with the technological and social changes: "[the applications] do not even share the authentication databases, i.e., for each application of the same state government of São Paulo that is accessed, the user-citizen must log in again" (CENTENO; ANDRADE; SOUZA, 2015, p. 67). Lastly, the authors listed recommendations for improving the mobile government of the state of São Paulo, with the construction of an m-government policy formally made official and that may guide the purposes, instruments, and targets of the field in several deadlines standing out in the area of "governance", one of the eight examined by the authors (CENTENO; ANDRADE; SOUZA, 2015, p. 79).

Engrazia and Dutra (2015) examined the M-governo application of the state government of Rio Grande do Sul that centralizes the access to 42 public services in twelve categories that gather various agencies, from public security to the registry of commerce. The conclusion was that most such services (84%) were at the primary maturity stage, i.e., the initial state in which citizens often do not understand the offered functionality. According to the authors, although the amplitude of the application is wide, no services offered by it could be classified at the time as being of governance and engagement with citizens.

In turn, Lima (2017) performed an analysis of applications developed by the federal government from the perspective of what they could do regarding promoting citizenship, presented as an institution based on the online participation in the public sphere with three dimensions: "belonging, the exercise of rights and duties, and participation" (LIMA, 2017, p. 3). Hence, the author analyzed 97 mobile applications, assessing if their functionalities allowed enabling the exercise of rights and duties, if they give access to information of public interest, if they allow political participation and social control, if they serve as efficient communication channels between State and citizens, and if the data collected by the applications are used to base public policies (LIMA, 2017, 92-93). In the understanding of Lima (2017), specific guidelines were lacking within the national plans and policies, the agencies involved did not articulate, and there was uncertainty about responsibilities, besides the low frequency of citizen/government communication channels. To the author, the analyzed applications represented the government needs but not necessarily those of the citizens.

Araujo and Lemos (2018) analyzed 21 applications from the city hall of Salvador and the state of Bahia. The concept that structured the analysis is that of a "smart citizen", understood as a collaborative citizen who provides information and engages with the governments in the process of improving the quality of public policies through digital tools. The authors concluded that the examined applications embodied a "technocratic view" of digital governance, centered more on

[8] This type of application that integrates other applications, also called a SuperApp by some authors, is the focus of analysis of a recent study by Matos, Lanza, and Lara (2021) and has significant similarity to the PIÁ Project. The difference is the emphasis on the Artificial Intelligence concept to promote the application integration used by the PIÁ Project.

the offering of online services and the administrative management of the problems surveyed from the information provided by the citizens than on the attempt to establish dialogical and collaborative management with them.

A similar consideration was recorded in the study by Guimarães et al. (2019) about the experience of the PBH App application, developed by the Belo Horizonte city hall as a new channel to receive demands from citizens. Based on what they determined through documentary research and interviews with municipal managers, the authors pointed out how the application was considered a facilitator of access by citizens but had a reduced impact due to the lack of real integration, the result of the limited technological structure and low adhesion (GUIMARÃES, 2019, p. 10).

The dissertation by Nayra Veras Araujo (2019) investigated the mobile government experience in the city of Salvador from the perspective of political communication, given that, to the author, mobile applications play an important role in the public communication of various political actors, especially city halls, along with other digital media. According to Araujo (2019), the experience demonstrated that the applications were not used as widely as they could be as public communication tools between citizens and municipal management because they were seen, i.e., created, developed, and maintained, as public services provided by the area of information management, not as instruments of communication with citizens. Therefore, although the agency responsible for the management of this area in the Salvador city hall had "governance" in its name (the Electronic Governance Company of Salvador – Cogel), the tools were generally created reactively from the urgent needs glimpsed by the areas (ARAUJO, 2019, p. 187-188).

Lastly, the most recent study by Matos, Lanza, and Lara (2021) should be mentioned, who, developing and deepening previous analysis by Matos (2020) of federal government applications, examined 97 mobile phone applications at the subnational scale in Brazil, dwelling on the examination of what they called "SuperApps", i.e., applications that serve as platforms for others. Given these objectives, the authors made an aggregate and generic analysis of the applications of the 27 Brazilian states, apprehending some of their basic characteristics such as numbers of downloads, types, numbers of ratings and comments, etc.

In this paper, unlike the previous studies, we seek to achieve two objectives: a) initially, to elaborate some indicators that allow us to characterize some "good practices" among all analyzed applications, i.e., those that had more impact and were more responsive and better accepted by users; b) to analyze in-depth a specific "SuperApp" experience, the PIÁ Project of Paraná, from the perspective of digital governance of its usability by citizens, rather than from the viewpoints of political communication or computer science.

Once this brief literature review is done, we may proceed to the presentation of our methodology and some of its main results.

3 Analysis methodology: assessing good practices.

The notion of "good practices" is often used in organization science and public management to designate techniques or experiences deemed efficient in their implementation contexts that may serve as models or parameters to assess the others. Therefore, they establish a reachable normative horizon that already exists in reality (thus, the opposite of an unattainable "utopia") and may serve as a north for implementing other experiences. Its basic characteristics are, therefore, the quality of the implementation, the reproducibility, and the fact that they serve as achievable examples of the concretization of some principles of management and implementation of policies in institutions other than those in which they were originally implemented.

As informed by Wilson Gomes in his prospection of the works on democracy and digital governance, in the world, "there is a respectable and well-documented collection of best practices in several subfields of digital democracy" (GOMES, 2016, p. 40), among which the works focused on democratic governance stand out (WHITSON; DAVIS, 2001; ROWE; BELL, 2005; KOUSSOURIS; CHARALABIDIS; ASKOUNIS, 2011; ALLAH et al., 2014). Among the "good practice" studies mentioned above and carried out at the international scale, we may mention, firstly, the extensive survey performed by Allah et al. (2014). Indeed, the starting point for the authors was the determination by various researchers at the international scale that the quality of digital governance portals affects the degree of use and satisfaction of citizens with the quality of the services provided by them (ALLAH et al., 2014). From this premise, the authors proposed a methodology to assess the "good practices" observed in government portals based on mapping the basic dimensions of organization portals.

In this paper, we develop some ideas contained in these studies, elaborating a mobile government "good practices index" based on the following dimensions:

1) *Degree of success* and impact: as measured by the "permanence", "engagement", and "diffusion" categories;

2) *Social adhesion*: as measured by the number of installations of the applications provided by the platforms.

3) *User Rating*: measured by the ratings from 1 to 5 provided by the Google Play platform.

4) *Responsivity index:* defined by the ratio between the number of comments made in the applications and the number of responses given to the user observations by the developers.

In the next item, we present the results obtained from the application of this methodology.

4 Mobile government in Paraná in the context of the "PIÁ Project"

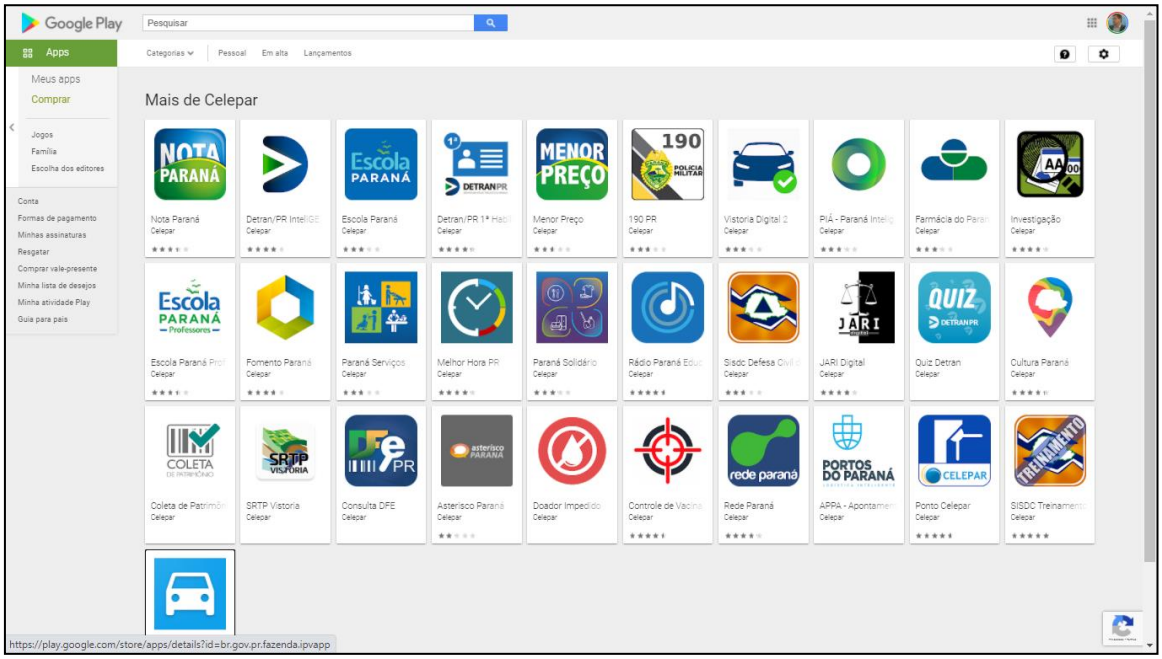
The empirical universe of the research was 26 applications (n = 26) developed within the scope of the PIÁ-Celepar system and made available for use in mobile phones through the Android technology store Google Play Store and the iOS technology store Apple App Store. It is

worth clarifying that, in this paper, an application is understood as a computer program conceived to process data digitally, facilitating the visualization and reducing the execution time of a task by the user that may be downloaded to mobile equipment such as smartphones and tablets. Such digital resources, which are not preinstalled, are generally available on the distribution platforms called application stores. They started to appear in 2008 and are typically operated by the mobile operating system owner, such as the Apple App Store and Google Play. Some applications are free, while others must be purchased. They are generally downloaded from the platform to a destination device but may sometimes be downloaded to laptops or desktops (BRENDZA; HOWARD, 2014).

We chose to center this study around Android technology since it has 93.2% of the Brazilian mobile device market (MATOS, 2020). With this, we seek to verify the presence of concepts applied to digital governance, identifying the criteria predicted by the developers in the exercise of governance through electronic means, with technology and resources of digital mobility (m-Gov). Our basic proposition is that, from this initial universe of 26 applications, a subset of mobile application "good practices" may be defined as those for which a high degree of diffusion or social acceptance is verified, are permanent, spark engagement and repercussion in other media, besides having higher levels of responsivity and user satisfaction, and that such good practices may be measured through the elaboration of quantitative indices.

The 26 mobile device applications currently maintained by the state government of Paraná and that constitute our initial empirical universe of analysis are illustrated in the figure below:

Figure 1 – Celepar applications in the Google Play Store



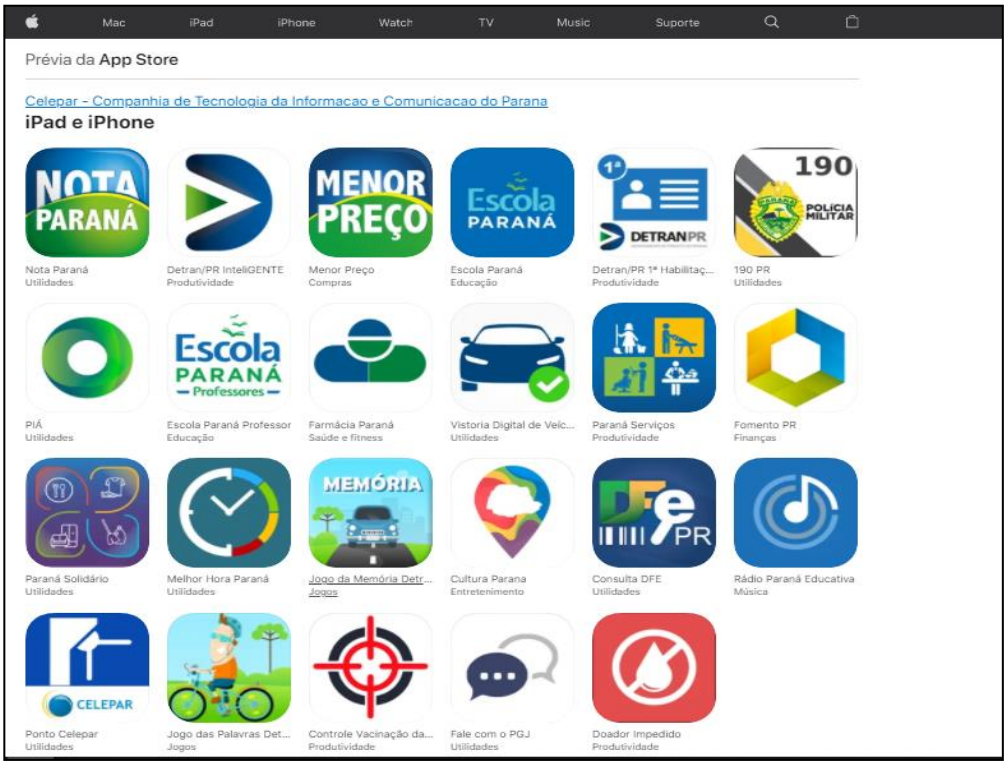
Source: Google Play platform (2021).

In total, 31 applications from the Celepar platform are listed on Google Play. Of these, 26 are of access to the public, and eight are of access exclusive to employees or used for internal government communication, such as the applications "Ponto Celepar" (for registering Celepar employee time cards and controlling their daily activities), "SISDC Treinamento" (for use by municipal civil defense coordinators), "APPA - Apontamentos NC" (application for recording incidents at the Paranaguá Port and its surroundings), "Rede Paraná" (application aiming at the network connection of servants of the state of Paraná and without use record on the platform), "Doador Impedido" (application directed at the Hemotherapy Services of the state of Paraná, aiming to facilitate the consultation of impeded doners), "Asterico Paraná" (application directed at public servants), "Consulta DFE" (application for consultation and procedures), and "Coleta de Patrimônio" (public property inventory application).

A large portion of these applications was inactive or little accessed during the period of this research, not generating relevant impacts. Therefore, only the applications that had the primary objective of serving citizens and were active during the research period (March to September 2020) causing some social impact were analyzed, conditions that initially covered 25 Celepar applications.

Regarding the applications of the state government of Paraná hosted on the App Store platform, they are summarized in the following figure:

Figure 2 – Celepar applications in the Apple App Store



Source: Apple Store (2021).

As one may notice, the number of applications available on the Apple platform is lower than those existing in the Google Play Store, with only 23 applications against the 31 on Google Play. It is possible to take as a hypothesis that this is due to two reasons: a) the Celepar managers opted for the Google Play Store to host their applications directed at the routine internal management of matters referring to the public administration of Paraná; b) the less significant interaction observed on the Apple platform, as we will see later. Another differential of Apple is that it does not provide information on the number of downloads of each application as Google does. Apple does also not offer a summary of the ratings as Google does. It provides the comments chronologically, not offering options to filter them as Google does.

To illustrate the different attributes of the applications, we offer below a table summarizing the characteristics of the applications that exist in the Google Play Store and the Apple App Store.

Table 1 – Attributes and use possibilities of the platforms

Attributes and possibilities	Google Play Store	Apple App Store
Information on the number of downloads	1	0
Chart of the user ratings	1	0
Options for organizing the comments	1	0
Application classification	1	0

Source: Devised by the authors (2021).

In the Google Play Store, the applications above are described as having a general audience rating (content appropriate for all ages) and receive a categorization regarding the nature of their content in the "tools", "corporate", "finance", "productivity", or "education" sections.

The following data are presented according to the order of the categories in the database. The PerigosaMente application is not included because the coders were unable to find it for download in the Play Store.

Table 2 – Data collected from the Google Play Store

No.	**Application**	**Creation date**	**No. of downloads**	**User Ratings**	**No. of ratings**	**User Comments**	**Responses**
1	Copel Mobile	July 2, 2012	500,000	3.4	4,508	1,169	70
2	1 Habilitação-Detran	Apr. 4, 2017	100,000	4.1	942	451	301
3	Bombeiros-Paraná	July 14, 2017	5,000	4.8	44	25	0
4	Consumidor.Gov.Br	Feb. 2, 2017	100,000	2.1	1,210	883	614
5	Cultura-Paraná	May 18, 2017	1,000	4.3	20	8	0
6	Detran Inteligente	May 15, 2019	100,000	4.1	2,132	358	249
7	Emergência Paraná 190	Feb. 10, 2018	100,000	2.7	409	303	191

8	Escola Paraná	Oct. 8, 2017	1,000,000	3.8	7,316	1,863	515
9	Farmácia Do Paraná	Aug. 21, 2018	10,000	3.1	95	34	0
10	Jogo Da Memória	Mar. 28, 2018	5,000	n	n	n	n
11	Jogo Das Palavras	Mar. 28, 2018	100	n	n	n	n
12	Menor Preço	28/11/2016	500,000	3.0	4,828	2,631	2,256
13	Nota Paraná	Feb. 18, 2016	1,000,000	3.4	11,322	3,978	3,844
14	Parana-Serviços	Mar. 19, 2019	10,000	2.8	138	75	32
15	Perigosamente - O Jogo	n	n	n	n	n	n
16	Sanepar Mobile	Dec. 9, 2016	500,000	3.8	1,128	551	117
17	Vistoria-Digital	Feb. 19, 2018	100,000	3.1	72	35	0
18	Pia-Inteligência Artificial	June 27, 2019	50,000	3.0	197	90	1
19	Investigação-Paraná	Oct. 16, 2015	100,000	4.0	899	387	25
20	Escola-Paraná Profes	Feb. 16, 2018	50,000	3.5	322	198	56
21	Fomento Paraná	Dec. 18, 2019	10,000	3.7	10	4	0
22	Melhor Hora	June 16, 2020	1,000	4.1	18	11	9
23	Paraná Solidário	Oct. 14, 2019	5,000	3.0	22	12	0
24	Radio Paraná Educativa	July 1, 2019	1,000	4.6	10	4	0
25	Sisdc Defesa Civil Do Paraná	Mar. 2, 2011	1,000	2.7	35	25	0
26	Controle De Vacinação Da Dengue	n	1,000	4.6	9	5	1

Source: Devised by the authors from the Google Play platform (2020).

This was the basic database we used to compose the good practices indices. We excluded three applications from our analysis since they only worked on the App Store platform and intermittently. With the application creation data, it is possible to identify that, except for the Copel application and SIsdc da Defesa Civil do Paraná, all others were created within the last four years: 2016 (3), 2017 (5), 2018 (4), and 2018 (2).

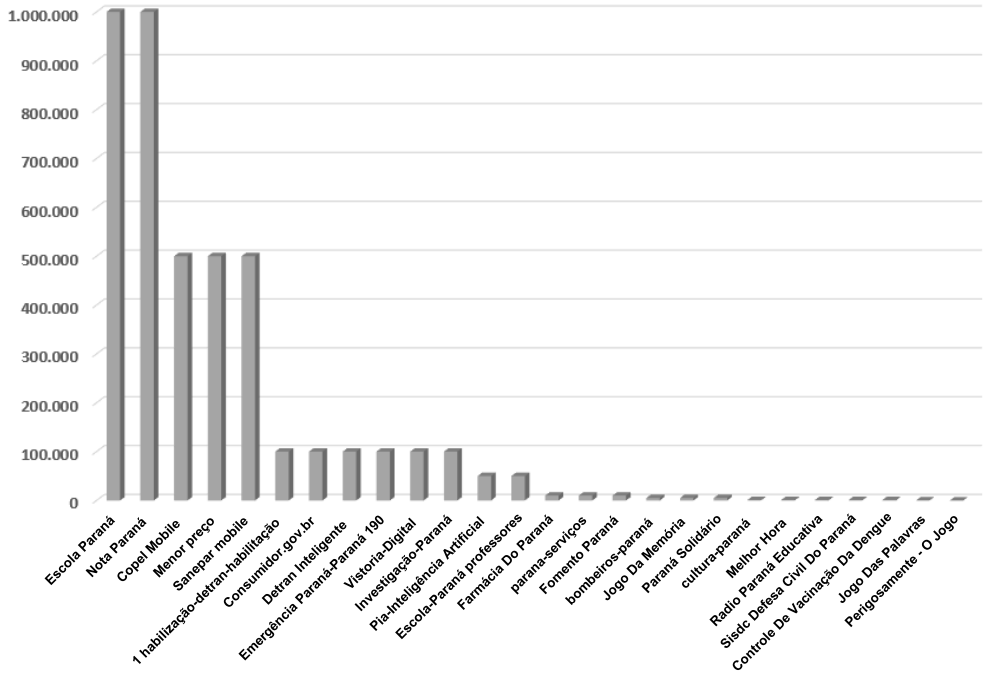
Although there are no precise results about the number of applications on the Google Play Store platform, with the data being presented by download range, the first relevant datum to assess the impacts of the applications is the number of downloads of each application on the Google Play platform, since the Apple App Store does not provide data on the number of downloads of its applications.

As one may observe, two applications stand out for the high number of downloads: "Escola Paraná" (an application that assists the monitoring of enrollments and academic

performance in the state public schools) and "Nota Paraná" (developed to stimulate consumers to demand, at the time of purchase, the delivery of the tax invoice, requesting the inclusion of their Individual Taxpayer Identification Numbers on the document to, hence, accumulate credits and compete for cash prizes).

Next, with over 500,000 downloads, we have "Copel Mobile", "Menor Preço", and "Sanepar Mobile", applications related to the monitoring of accounts and financial matters. In a third group, with over 100,000 downloads, we have "Primeira Habilitação", "Consumidor.gov", "Detran Inteligente", "Emergência Digital", "Investigação Digital", etc. Next come the others, with over 50,000, 10,000, and 1,000 downloads. These numbers form the first dimension of our indicator and are synthesized in the chart below.

Chart 1 – Number of downloads of each application

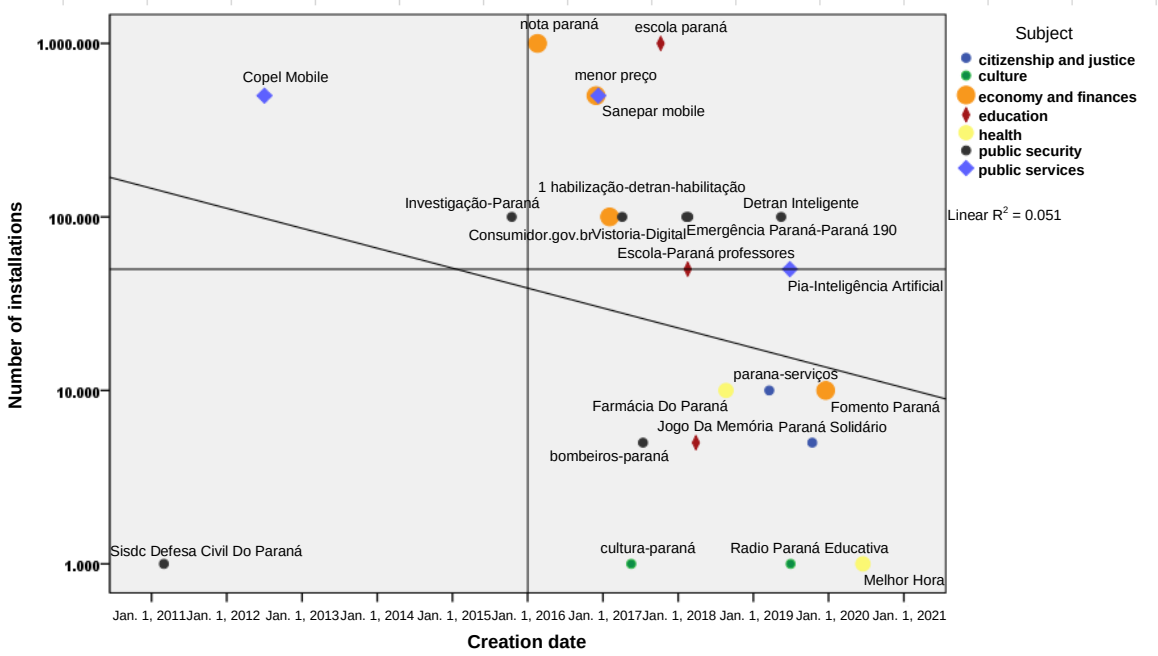


Source: Google Play Store platform (2020).

The second piece of information important for a preliminary analysis of the applications and the elaboration of our "good practices" index is the degree of success and impact of the applications, as we stated earlier, i.e., if these applications are active and had a social impact among their users and on the community of references, standing out in traditional media.

The data on the creation dates and download rates of the applications allow us to introduce the themes of success, failure, survival, and degrees of success of the different applications. Recent studies have drawn attention to the fact that not all digital democracy experiences are durable, with the survival of the initiatives being one of the fundamental criteria to assess them (SAMPAIO et al., 2019). However, we consider it worthwhile to perform a disaggregated analysis of the data as this serves to identify the disparate cases and better visualize the criteria that we use to categorize the applications.

Chart 2 – Association between the creation dates and download rates of the applications



Source: Devised by the authors (2021).

We verified a negative Pearson correlation of -0.3050, which may be considered a moderate negative association, given that a strong correlation is expected between the two phenomena. The dispersion diagram above allows us to reflect on the reasons for this weak association and characterize the disparate cases. In the first quadrant are the applications launched more recently and that were successful, with high downloads rates, such as the classical cases of "Nota Paraná", "Escola Paraná", "Menor Preço", and "Sanepar Mobile". On the other hand, in the second quadrant, we have the cases of applications launched more or less at the same time (i.e., after January 2016) but were less successful with the public, generally applications directed at the thematic areas of education, culture, and public health.

Lastly, in the other quadrants, we have the disparate values, such as "Sisdc Defesa Civil do Paraná" and "Copel Mobile", the first of internal use by Civil Defense servants and, thus, with little impact, and the second being the first broad use application launched by the Paraná government in partnership with the Celepar developers. This chart shows that, despite the relative success among the users, this application remained an isolated case in the state public administration for four years, given that only after January 2016 did the creation of applications begin to be disseminated in state governments.

On the other hand, one may observe that, although the applications may be considered successful since they are still active and spark public engagement, there are different degrees of success among them.

To assess the success and degree of success of the applications, we will use two basic criteria: a) we define an application as successful when it remained active, with updates, being

used by users, and sparking reactions during the entire researched period. It is a little-demanding criterion since the mere permanence of an application already allows it to be characterized as "successful" provided that it sparks a minimum engagement of the population. Applying this criterion, we have that 23 applications may be considered successful, and only three (11.5%) may be considered failures.

b) Another somewhat more "demanding" criterion refers to the "degree of success" of an application. In this sense, we sought to define subcategories that allow us to define a gradient of different levels or degrees of success of an application: i) at a first level, which we denominate "permanence", are the applications that have only survived since their creation dates, without propitiating a high number of downloads, without sparking the engagement of citizens, and without repercussing outside the strict reference group of application users; ii) a second "degree of success" refers to the "mobile governance" experiences that sparked some engagement from the population, either through a high number of ratings or comments on the application pages; iii) lastly, we have a third category that refers to applications that, besides meeting the requirements above, had an impact outside the strict category of platform users, causing a social impact on the broader society through articles in the press, awards, etc. From the application of these criteria, we began mapping applications that could be characterized as mobile government "good practices" of the state of Paraná.

The data on the degree of success of the applications per subject are itemized below, with the respective standardized residuals.

Table 3 – Success of the Celepar applications per thematic area

		Degree of Success				**Total**
		Failure	**Permanence**	**Engagement**	**Impact**	
Citizenship and justice	N	0	2	0	0	2
	%	0.0	100.0	0.0	0.0	100.0
	R	-0.5	1.4	-0.8	-0.6	
Culture	N	0	2	0	0	2
	%	0.0	100.0	0.0	0.0	100.0
	R	-0.5	1.4	-0.8	-0.6	
Economy and finances	N	0	1	1	2	4
	%	0.0	25.0	25.0	50.0	100.0
	R	-0.7	-0.4	-0.3	1.8	
Education	N	3	0	0	2	5
	%	60.0	0.0	0.0	40.0	100.0
	R	3.2	-1.4	-1.3	1.4	
Health	N	0	3	0	0	3
	%	0.0	100.0	0.0	0.0	100.0
	R	-0.6	1.7	-1.0	-0.7	
Public security	N	0	2	5	0	7
	%	0.0	28.6	71.4	0.0	100.0
	R	-0.9	-0.4	1.7	-1.0	

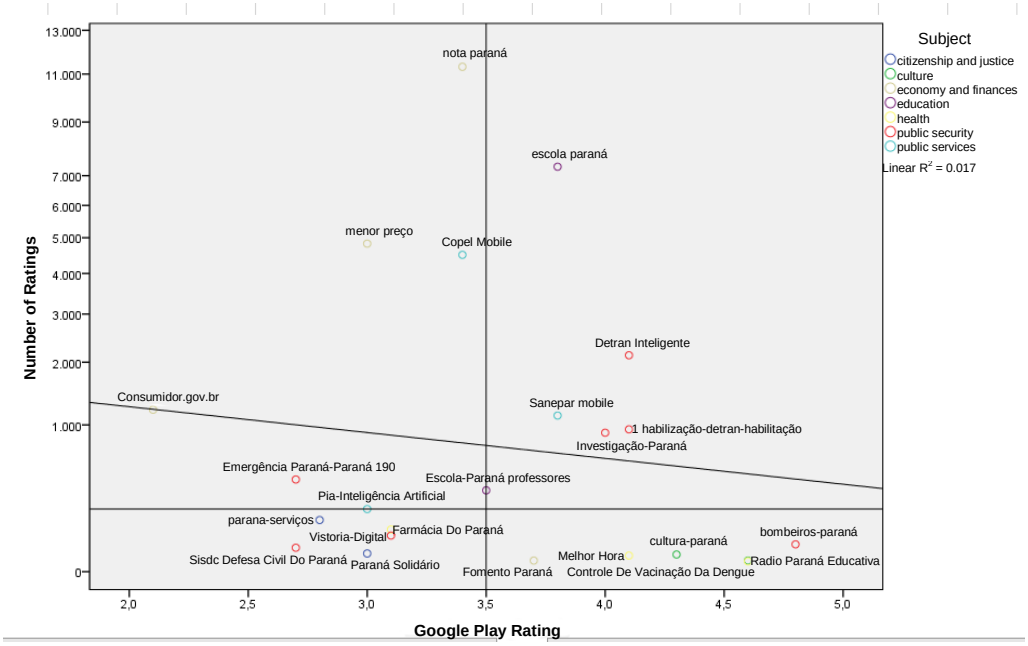
Public services	N	0	0	3	0	3
	%	0.0	0.0	100.0	0.0	100.0
	R	-0.6	-1.1	1.9	-0.7	
Total	N	3	10	9	4	26
	%	11.5	38.5	34.6	15.4	100.0

Source: Devised by the authors (2021).

Of the total 26 applications, three (11.5%) were classified at the failure level, ten (38.5%) at the permanence level, nine (34.6%) at the engagement level, and only four (15.4%) as having a more significant social impact. Regarding the distribution by subject, we verified that the applications with the highest degrees of success are in the sectors of "education" ("Escola Paraná" and "Escola Paraná Professores") and "Economy and Finances" (the "Melhor Preço" and "Nota Paraná" applications). These applications had a significant impact on the collectivity of the state of Paraná, with awards and several mentions in the press and digital media, even leading to many comments on Facebook, for example. On the other hand, the standardized residuals test shows no significant differences among the subjects since none of the areas had an R over 1.9. It should be noted that some applications in the public security area, for example, sparked a high level of engagement, with little impact observed in the press and digital media.

A third dimension in assessing the applications is the degree of user satisfaction with them, as indicated by the "ratings" assigned by the users on the platforms. A disaggregated analysis of the relationship between user ratings and the number of ratings may be visualized in the dispersion diagram below.

Chart 3 – User ratings × number of ratings



Source: Devised by the authors (2021).

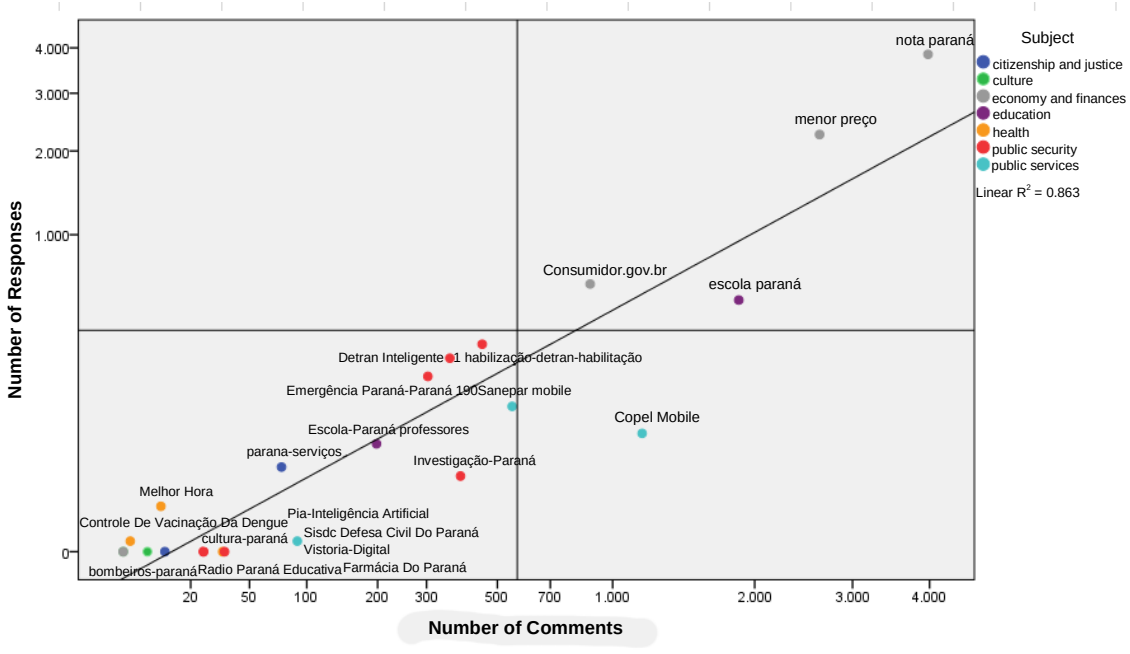
The applications best rated by the users were "Bombeiros-Paraná" (with a 4.5 average

rating by 44 users) and "Rádio Paraná Educativa" (with a 4.5 average rating by 10 users). At the other extreme, we have "Consumidor.gov.br" (with a 2.1 rating by 1,210 users), the application worst rated by users on Google Play. Significantly, it is an application developed by the federal government, not Celepar, despite being hosted on the PIÁ Project portal. Among the applications with a high number of comments and ratings around the average, "Nota Paraná", the prized application developed by Celepar that sparked 11,322 ratings with a 3.4 average, "Menor Preço", and "Copel Mobile" stand out. Lastly, we have well-rated applications that triggered high levels of comments by users, such as "Escola Paraná", "Detran Inteligente", "Habilitação Paraná", Sanepar Mobile", and "Investigação Paraná".

Finally, it should be stressed that these ratings only map one dimension of user interaction with the applications: the formulation of "ratings" by citizens and the "feedback" of the platform through the elaboration and publicization of the rating averages. A "deeper" dimension of the interaction resides in the elaboration of comments by the users, as well as the responses provided to them by the application managers. We will analyze the comments and responses of the applications from the elaboration of a responsivity rate that consists of the ratio between the number of responses and the number of comments.

Regarding the relationship between user comments and responses from developers on the platforms, one may analyze them in a disaggregated manner through the following dispersion diagram.

Chart 4 – Association between comments and responses for the applications



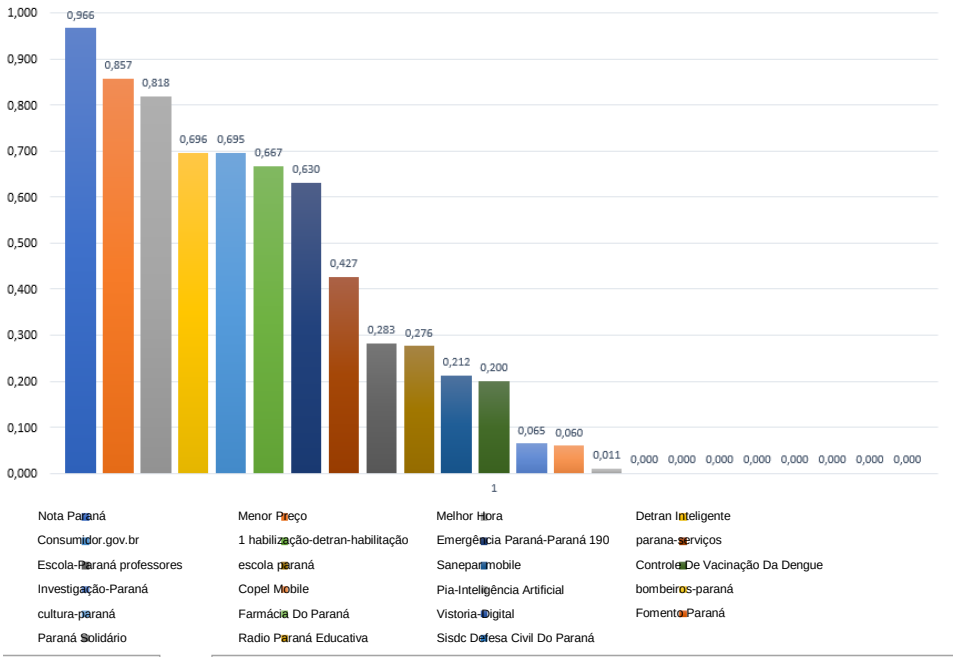
Source: Devised by the authors (2021).

Indeed, the chart above provides us with much important information on the interactions

that exist on the host platforms of the applications. To be concise, let us first observe the existence of a high correlation between the numbers of comments and responses, with an R^2 of 0.863, as expected. Secondly, there is a group of four applications that sparked a high number of interactions: "Nota Paraná" (with 3,978 comments and 3,844 responses), "Menor Preço" (2,631 comments and 2,256 responses), "Escola Paraná" (1,863 comments and 515 responses), and "Consumidor.gov" (833 comments and 614 responses). As we saw for the previous item, this does not necessarily mean that these applications are better rated by users, but rather that there was a more considerable interaction in these digital environments. Now, these interactions are an important repository of information on how users perceive the applications, the difficulties and facilities found during their use, and how the developers respond to them, contributing to improving the quality of the applications and to the occurrence of a collaborative inspection of their operation by citizens.

This relationship between comments from the public and responses from developers may be better visualized through the "responsivity rate", which seeks to apprehend the relationship between the comments made by users and the responses in relative terms, i.e., regardless of the absolute number of comments made. It is important to make this distinction because there may be applications with few comments and a high responsivity rate, as illustrated in the chart below.

Chart 5 – Responsivity rates of the applications



Source: Devised by the authors (2021).

Lastly, one may arrive at the core of our research, which is the characterization of the best practices among the mobile government experiences developed by the Celepar managers. For

such, we defined a "good practices index from the following indicators", normalizing from 0 to 5 (the highest value observed) each of the indicators and making the final result vary from 0 to 5 by applying the following formula:

GPI = Degree of success (0 to 5) + Number of installations (0 to 5) + Rating by evaluators (0 to 5) + Responsivity index (0 to 5) / 2 = index varying from 0 to 5.

Table 4 – Good practices index of the mobile applications in Paraná

	Application name	Success	Installations	Users	Responsivity	GP Index
1	Copel mobile	3.3	2.50	3.40	0.30	2.4
2	1 Habilitação-Detran	3.3	0.50	4.10	3.34	2.8
3	Bombeiros-paraná	1.7	0.03	4.80	0.00	1.6
4	Consumidor.gov.br	1.7	0.50	2.10	3.48	1.9
5	Cultura-paraná	1.7	0.01	4.30	0.00	1.5
6	Detran inteligente	3.3	0.50	4.10	3.48	2.9
7	Emergência paraná-paraná 190	3.3	0.50	2.70	3.15	2.4
8	Escola paraná	5.0	5.00	3.80	1.38	3.8
9	Farmácia Do Paraná	1.7	0.05	3.10	0.00	1.2
10	Menor preço	5.0	2.50	3.00	4.29	3.7
11	Nota paraná	5.0	5.00	3.40	4.83	4.6
12	Parana-Serviços	1.7	0.05	2.80	2.13	1.7
13	Sanepar mobile	3.3	2.50	3.80	1.06	2.7
14	Vistoria-digital	3.3	0.50	3.10	0.00	1.7
15	Pia-inteligência artificial	3.3	0.25	3.00	0.06	1.7
16	Investigação-paraná	3.3	0.50	4.00	0.32	2.0
17	Escola-Paraná professores	5.0	0.25	3.50	1.41	2.5
18	Fomento paraná	3.3	0.05	3.70	0.00	1.8
19	Melhor hora	1.7	0.01	4.10	4.09	2.5
20	Paraná solidário	1.7	0.03	3.00	0.00	1.2
21	Radio paraná educativa	1.7	0.01	4.60	0.00	1.6
22	Sisdc Defesa Civil Do Paraná	1.7	0.01	2.70	0.00	1.1
23	Controle De Vacinação Da Dengue	1.7	0.01	4.60	1.00	1.8

Source: Devised by the authors (2021).

The table above somehow unifies the various analyses performed, seeking to elaborate a "good practices ranking" of the mobile governance experiences developed by Celepar and the state government of Paraná since 2012. The yellow cells indicate a higher score above the average, which allows defining the application as being a good practice.

As an example, in the "success" dimension, four applications had a high degree of success, with permanence, engagement, and social impact. In turn, an application may have a high "degree of success" and a median download index, as it reaches a more specific audience, or a low responsivity level, for example. On the other hand, an application may have an excellent

user ranking on the Google Play Store platform and a low degree of engagement (with few rankings and comments), a low number of installations, and a low or null degree of responsivity. This is the case, for example, of the "Bombeiros Paraná" application, which was the best ranked by the users during the period, with a 4.8 average. However, it only sparked 44 ratings and 25 comments, and there was no feedback from the developers.

The application with the best performance according to our index was "Nota Paraná", which had above-average performance in several dimensions despite having had a lower user rating than other applications less qualified by the index. Many of such ratings were criticism of the application heeded by the developers, thus revealing a collective intelligence development process in the improvement of the platform.

In second place came the "Escola Paraná" application, also with high popularity among the people of Paraná, especially after the beginning of the COVID-19 pandemic in 2020, with the prohibition of in-person classes in the state public education network. This application had a high degree of success, high popularity, and a high average user rating; however, it had low responsivity, with developers not interacting with the users.

In third place came the "Menor Preço" shopping application, which stands out due to the high social impact and high responsivity rate, although its number of installations is lower than the other applications. Lastly, the applications "Detran Inteligente" and "1 Habilitação" by Detran, and "Sanepar Mobile" and "Escola-Paraná Professores" may also be characterized as good practices albeit at a level lower than the others.

5. Conclusions

The measurement of the impacts that applications bring to public administration and the lives of citizens is a complex task that we attempted to undertake by elaborating a simple indicator that took into account several dimensions of applications, with information provided to the public and available to the ordinary citizen. The bibliographic review exposed the series of structural difficulties (technological and personnel-related) and difficulties in the continuity and enhancement, creation, and maintenance of government mobile applications – including with divergences in the understanding of which entities should be responsible for the development of this type of resource, whether the State itself or the private initiative, through the access to open data obtained by the public power (CENTENO; ANDRADE; SOUZA, 2015). However, whomever the developer was, the number of researchers who observed as a governance flaw a loss of opportunity or a communication deficiency between State and citizen is notable (LEMOS; ARAUJO< 2018; ARAUJO, 2019; GUIMARÃES; ALMEIDA, 2019). This absence of interaction was also one of the elements gathered in the interviews with managers of the mobile applications of the state government of Paraná, given that it was made clear that the user views are not exactly at the core of the development and enhancement of these tools, which may even

be a factor to consider in an occasional attempt to understand the complaints about functionality contained in the analyzed comments.

On the other hand, the goodwill of citizens, who gladly accept public governance initiatives that allow them to solve problems and have more facilitated access to public services, has also been registered by the literature. Matos Neto (2020) pointed out how the average user ranking for federal branch applications analyzed by him was 3.75, equivalent to a concept of "satisfactory, almost good" considering a scale from 1 to 5, on which each score may be read as the following sequence: "terrible", "bad", "regular or "satisfactory", "good", and "great". The author stressed that the comments that received higher scores are those that exalt the applications as useful, easy to use, and practical. In the case of the state of Paraná that we analyzed, this average ranking is a little lower for Google Play users (3.60) and lower to the point of changing concepts for App Store users (2.85), which in general complain of the low offering of products for them and the lower responsivity. Considering the users of Google Play, which is the platform with the most applications of the Paraná government, the average rating repeats the situation of "satisfactory, almost good", which is a not at all insignificant negligible feat for a universe of 4.25 million downloads.

Another point that merits prominence is perhaps a face of the application that appears little to users: the capacity to collect data generated by the system. These applications certainly maintain a database with information on users that is fundamental to improving public management. There is a lack of transparency in the use of such information, and issues of surveillance, privacy, and personal data protection seem to still be in the background. In the reviewed scientific literature, the lack of specific rules established through appropriate legal supports is one of the problems verified by the authors relative to the transparency in using data and also leads to a discontinuity of initiatives that ends up not being rare because, after all, it means a minor negative impact on the manager goals. Regarding the legislation, a Digital Policy Committee connected to the Chief of Staff and created by state decree (Decree No. 786/2019) with the "purpose of optimizing procedures, improving the provision of state public services to citizens and the society" has been acting in Paraná since March 2019 (PARANÁ, 2019). The intention is for the executive secretariat of the committee to coordinate "the elaboration of the digital transformation strategy of the State Government of Paraná". However, the decree does not mention the tools that will come to be used nor establishes the timelapse in which the committee activity goals must be met.

The study of the cases registered here is important to the development of public policies within the state sphere mediated by the use and implementation of new ICTs, as well as generates substrates for reflections on the new frontier announced by Brazilian governments, including that of Paraná, with the use of artificial intelligence resources for managing mobile applications. This work also aimed to suggest some normative parameters to assess these good practices in

governance from the viewpoint of the common citizen who uses these tools and easily intelligible by the tool managers. Other research questions extracted from the dialogue with the literature and from the data we collected in the analysis of the comments and interviews with managers will be addressed in other studies within the scope of this investigation.

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