Exploring Mobile Civic Technologies in Brazil - A Thematic Analysis

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A thesis submitted to McGill University in partial fulfillment of the requirements for the degree of Doctor of Philosophy in Information Studies

Montreal, Quebec, Canada

May 9th, 2022

Abstract

Mobile Civic Technologies (MCTs) refer to the mobile technologies created to mediate information flow, civic engagement and address local issues. MCTs have allowed citizens, public and private agencies to interact and inform government and other decision makers about local issues as well as to enable citizens to report these problems in real-time to raise awareness and possibly solve them. During the time this research was conducted, there was an explosion of apps aiming to address civic matters and there were no existing frameworks to systematically classify Mobile Civic Technologies (MCTs). This research aimed to address this gap by validating an existing framework called the Technology Enabled Participatory Platforms for Civic Engagement (TEPPCE). By exploring the Mobile Civic Technologies (MCTs) that mediate information and knowledge flows among stakeholders (citizens, public and private sectors) in Brazilian cities. To do so, thematic analysis was the method chosen to better understand 90 MCTs in Brazil. The data was collected from Google Play, mobile software repository and supplemented by triangulation with secondary sources to answer the following research questions (RQs): RQ 1. What are the objectives of the platforms? RQ. 2. Which interactions that happen when these MCTs are used and RQ. 3. What are the technology features of these apps. The findings from the application of this method culminated in themes to answer the RQs. The research contributed conceptually for the area of Digital Civics; designed a workflow for applying thematic analysis when faced with limited resources and explore the information and knowledge flows that occur when participating via MCTs. It also contributes with description of the specific issues that these platforms aimed to address. The findings show that while these MCTs reflect the themes in the TEPPCE framework, they also possess differences and do not reflect all the characteristics from that model. Therefore, the findings suggest that the TEPPCE framework for CTs does not fully reflect the characteristics of the data corpus collected for the Brazilian MCTs. This research has implications for the TEPPCE framework in technology enabled civic engagement and provides scholarly and practical contributions for characterizing Brazilian MCTs in the Digital Civics, Community Informatics (CI) research fields. TEPPCE had not yet been applied in contexts other than the USA and validating this may help future researchers in the Digital Civics domain.

Résumé

Les technologies civiques mobiles (MCT) font référence aux technologies mobiles créées pour favoriser l'engagement civique et résoudre les problèmes locaux. Les MCT ont permis aux citoyens, aux agences publiques et privées d'interagir et d'informer le gouvernement et d'autres décideurs sur les problèmes locaux, ainsi que de permettre aux citoyens de signaler ces problèmes en temps réel pour les sensibiliser et éventuellement les résoudre. Tout au long de cette recherche, il y a eu une explosion d'applications visant à répondre aux questions civiques et il n´existait aucun cadre pour classer systématiquement les Technologies Civiques Mobiles (MCTs). Cette recherche se proposait de combler cette lacune en validant un cadre de classification existant appelé les Plates-formes Technologiques pour l'Engagement Civique (TEPPCE). Elle a été effectuée en explorant les Technologies Civiques Mobiles (MCTs) qui assurent la médiation des flux d'informations et de connaissances entre les parties concernées (citoyens, secteur public et secteur privé) dans les villes brésiliennes. Afin de répondre à cet objectif, l'analyse thématique a été la méthode choisie pour mieux comprendre et classer 90 MTCs au Brésil. Les données ont été collectées à partir de Google Play, fournisseur de logiciels mobiles, et complétées par une triangulation avec des sources secondaires pour répondre aux questions de recherche (QR) suivantes: QR 1. Quels sont les objectifs des plateformes, QR 2. Quelles interactions se produisent lorsque ces MCTs sont utilisées et QR. 3. Quelles sont les caractéristiques technologiques de ces applications. Les résultats de l'application de cette méthode ont abouti à un schéma de classification composé de themes répondant aux QR. La recherche a également contribué de façon conceptuelle au domaine du Civisme Numérique et a conçu un flux de travail pour l´application d´analyses thématiques face à des ressources limitées. Un autre résultat a été l'exploration des informations et l´apport de connaissances lors de la participation via les MCTs. Et enfin, une description des problèmes spécifiques que ces plateformes visaient à résoudre. Les résultats montrent que, bien que ces MCTs reflétaient les thèmes du cadre TEPPCE, ils présentaient également des différences et ne reflétaient pas toutes les caractéristiques de ce modèle. Par conséquent, les résultats suggèrent que le cadre TEPPCE pour les CTs ne reflète pas pleinement les caractéristiques du data corpus collecté pour les MCTs brésiliens. Cette recherche a des implications pour le cadre TEPPCE concernant l'engagement civique motivé par la technologie et a apporté sa contribution académique et pratique pour caractériser les technologies civiques mobiles brésiliennes dans les domaines de la recherche numérique civique, informatique communautaire et gestion des connaissances gouvernementales. Les TEPPCE n'avaient pas encore étés appliquées dans des contextes autres que les États-Unis et leur validation pourrait aider les futurs chercheurs dans le domaine du civisme numérique.

Sumário
Tecnologias cívicas móveis (TCMs ou MCTs) referem-se às tecnologias móveis criadas para mediar o engajamento cívico e abordar questões locais. Os MCTs permitiram que cidadãos, agências públicas e privadas interagissem e informassem o governo e outros tomadores de decisão sobre questões locais, bem como permitiram que os cidadãos relatassem esses problemas em tempo real para conscientizá-los e possivelmente resolvê-los. Durante o tempo em que essa pesquisa foi realizada, houve uma explosão de aplicativos com o objetivo de abordar questões cívicas e não havia estudos existentes que sistematizassem as Tecnologias Civis Móveis (TCMs). Esta pesquisa teve como objetivo abordar essa lacuna, validando uma estrutura de classificação existente chamada Plataformas Tecnologias para a Participacao Civica (TEPPCE). Explorando as TCMs que mediam fluxos de informações e conhecimentos entre as partes interessadas (cidadãos, setores público e privado) nas cidades brasileiras. Para tanto, a análise temática foi o método escolhido para melhor compreender e classificar 90 MCTs no Brasil. Os dados foram coletados no Google Play, repositório de software móvel e complementados por triangulação com fontes secundárias para responder às seguintes perguntas de pesquisa (PPs): PPs 1. Quais são os objetivos das plataformas, PP 2. Quais interações acontecem quando esses MCTs são usados e PP. 3. Quais são os recursos de tecnologia desses aplicativos. Os achados da aplicação desse método culminaram em um esquema de classificação composto por temas respondendo aos PPs. A pesquisa também contribuiu conceitualmente para a área de Digital Civics; e projetou um fluxo de trabalho para aplicar a análise temática diante de recursos limitados. Outro resultado foi uma exploração dos fluxos de informação e conhecimento que ocorreram ao participar via TCMs. E, finalmente, uma descrição dos problemas específicos que essas plataformas pretendiam solucionar. As descobertas mostram que, embora esses TCMs refletissem os temas na estrutura da TEPPCE, eles também possuíam diferenças e não refletiam todas as características desse modelo. Portanto, os resultados sugerem que a estrutura do TEPPCE para TCs não reflete completamente as características do corpus de dados coletados para os TCMs brasileiros. Esta pesquisa tem implicações para a estrutura do TEPPCE no envolvimento cívico habilitado por tecnologia e fornece contribuições acadêmicas e práticas para caracterizar as tecnologias cívicas móveis brasileiras nos campos de pesquisa cívica digital, informática da comunidade e gerenciamento de conhecimento governamental. O TEPPCE ainda não havia sido aplicado em contextos além dos EUA, e validar isso pode ajudar futuros pesquisadores no domínio Digital Civics.

Acknowledgements

I would like to thank my supervisor, Dr. Kimiz L. Dalkir for accepting me as a student, for her constant support, for providing the materials and infrastructure that were crucial for this research, for giving valuable insight and revising the thesis in detail through all phases of the work. I am fortunate to have had the opportunity to study at McGill's School of Information Studies. The faculty and staff have always been helpful. Special thanks to Ms. Kathryn Hubbard, Mrs. Caterina Venetico and Ms. Shannon Sullivan for their constant encouragement, support, and patience to deal with all the documents and deadlines. I would also like to thank my PhD cohort, Afroza Sultana, Robert D. Fergusson, Dr. Jesse Dinnen, Dr. Taciana Pontual, Dr. Jonathan Dorey, Carrie Dai, Dr. Daniel Steele, Amanda Watson and Dr. Irene Kitimbo. They have contributed immensely – thank you for the conversations, ideas, collaborations, and support. Most of my work was done in the cold weather in Canada and I could not forget that Nadine Beauchemin, Renata Hochelber, Michal Cukier, Kaitlyn Steen, Saulo Cavalcante, Lucia Chung and Victor Burnett – would always bring warmth and loving support in good and difficult times. They are the family I've adopted in Canada. A very special thanks to my loving and hard-working parents Armando and Elenita who came from frugal backgrounds and have been my most important sources of inspiration and strength. From an early age they taught me the value of hard work and perseverance. I owe my love of learning to them. They have given me the opportunity to see the world. Thank you to Regan Ax and Sophia for the loving support during the stressful times of thesis editing and submission.

Merci à vous tous. Thank you to all of you.

Preface

I would like to thank Coordenação de Aperfeicoamento de Pessoal de Nível Superior (CAPES) that funded this dissertation through the Doctoral research scholarship program. I would also like to acknowledge all the researchers that before me provided the research upon which this dissertation was written and for the feedback from my doctoral committee that helped to improve this work. Unless otherwise cited, this dissertation is original scholarship for which I am the only author.

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Chapter 1 - Introduction

Civic Technologies (CTs) are the Information and Communication Technologies (ICTs) created to support formal and informal aspects of government and public services (Boehner & Disalvo, 2016); develop virtual relationships between citizens and the state (Gilman, 2015), raise awareness and possibly solve problems in cities (such as reporting potholes, misplaced garbage, violent situations.) by exchanging information and knowledge between citizens, businesses, interest groups and governments (Desouza & Bhagwatwar, 2014). Mobile Civic Technologies (MCTs) refer to the mobile technologies created to mediate information flow, civic engagement and address local issues. MCTs have allowed citizens, public and private agencies to interact and inform government and other decision makers about local issues as well as to enable citizens to report these problems in real-time to raise awareness and possibly solve them.

Citizens have voiced their needs and desires for opportunities to engage in their local communities and cities. Their opinions and actions form a large quantity of data, information and knowledge that can be used to understand citizens and to support their needs. CTs have been used to help citizens voice their concerns about local issues and changes in their cities (Boehner & Disalvo, 2016).

For example, In 2012, an 11-year-old girl, Bia from Rio de Janeiro, Brazil created a campaign in a local CT called “Panela de Pressao” requesting that local authorities not to demolish her school. It was going to be demolished because of its proximity to the Maracana stadium. As the World Cup was to be held in Rio in 2014, the governor wanted to demolish the school and replace it with a parking lot. Over a year after Bia created her campaign, students, parents and teachers at the school mobilized thousands of people from Rio in social networks

to prevent the local government from demolishing the school. The result was that the school is still there today. This is an interesting campaign because it included a variety of citizens such as students ranging in age from 8 to 11 years old, their parents, the local community, and their teachers (MeuRio, 2016). Global affairs Canada (2015) notes that CTs have put knowledge and information in the hands of citizens and further enabled them to hold their governments accountable and helped public and civil societies attend to people's needs more quickly, widely, and efficiently.

To better understand the development and applications of CTs, several studies have been carried out by researchers to understand the nature of citizen engagement in the decision-making of local governments (Hansen & Reinau, 2006; Cordoba-Pachon, 2009; Desouza & Bhagwatwar 2014, Macintosh & Whyte 2006). And this subject continues to increase in popularity as cities grow (Desouza & Bhagwatwar 2014; Hagen et. al, 2015). However, conceptual, and theoretical knowledge about the nature of CTs in Information Sciences is "limited and there is a need to develop frameworks and classifications that would help analyze these emerging platforms better." (Desouza & Bhagwatwar, 2014. p.27).

More recently mobile devices such as smartphones and tablets have been used to address civic matters. These mobile devices offer technological convergence and combination of different technologies in one device such as Camera, Global positioning Systems (GPS), Microphone, Messaging, Networking capabilities and Sensors. These have been included as technology features in mobile software applications called Applications or Apps to inform local governments of issues and problems in real-time (Berkowitz & Gagnon, 2017). For example, cameras are used to register local issues such as potholes and location sensors such as GPS and Gyroscope are used to locate local issues as well as to detect environmental states and changes in real-time.

Mobile Civic Technologies (MCTs) represent these ICTs, they are the hardware devices and software platforms created with to mediate data, information, and knowledge flows, facilitate civic engagement and address local issues. These ICTs have enabled collecting, storing, analyzing, visualizing, and sharing of information, knowledge, and expertise to create solutions for urban issues. MCTs have allowed citizens, public and private agencies to interact and inform government and other decision makers about local issues as well as to enable citizens to report these problems in real-time to raise awareness and possibly solve them.

Since the early 2010's, mobile apps were created to address civic issues because they provide interesting opportunities for civic engagement. This is because, their built-in features such as camera, Global Positioning Systems (GPS), messaging and social media have enabled citizens to send feedback about civic issues and the quality of government services in real time. The widespread availability of these apps, together with the few rigorous scientific research, have become a challenge for researchers, practitioners and users when determining which is the most appropriate app or set of apps to use for specific civic purposes because little is known about the nature of these apps (Omnydar, 2017, Global affairs Canada, 2015; Stempeck, 2016).

Urban challenges are constantly evolving and the conversion of technologies and combination of features that these mobile devices carry offer interesting opportunities. This technological convergence has also created optimism and hope regarding the use of mobile Civic Technologies for civic engagement and urban management. However, little was known about Mobile Civic Technologies (MCTs) and there is still a need to explore them separately from other types of CTs (Gun, 2021). However, many researchers, governments, and businesses have developed their own apps, and learning more information about the features, flows and objectives these MCTs may help when designing new apps.

Previous research has examined the objectives of CTs, however there was gap in the literature, that focused on MCTs because most studies had focused on desktop web portals created for civic purposes (Zuckerman, 2012, Vlachokyriakos et al., 2016; Hou, 2018) . This research addresses an emerging and under explored-research gap in the literature about MCTs and Community Informatics and may form a basis for more research to further our understanding about the nature of these ICTs

1.1. Research problem

When I started this PhD, in 2012 mobile apps were being built to address urban issues. However, there were no classifications or frameworks at the time that focused and addressed smartphone or mobile civic apps, there are still very few (Gun & Pak, 2020). The technological convergence afforded by mobile devices, were being used to report urban issues in a different way that in a browser used on a desktop computer. This is because mobile devices can be carried everywhere (they are ubiquitous) and information and data can be transferred in real-time. During the ten years of my PhD research these types of apps exploded, perhaps due to the novelty or because of the technological convergence and capabilities of these devices. However, there were few classifications that explored Mobile Civic Apps. The studies found at the time, explored mostly desktop browser web portals (Linders, 2012; Desouza & Bhagwatwar, 2014; Gun & Pak, 2020).

MCTs were built for mobile devices and made available for users on software repositories called App-Stores. During the time of this research, the two mostly used App-Stores were the Google Android Playstore and Apple IOS Appstore. The classification scheme from the Google Playstore, did not include a section on civic apps and it still doesn't. However, there is a wealth of data and information in these software repositories that were under explored. For example, the description of the apps explains what these apps aim to do. E-titulo app for

example, explained that it helps people find the location to vote and to use the app as a document. Classifying is useful, because we put things into groups, disorganized information that are not part of a category, that are similar. This is the essence of information studies. There were no taxonomies of MCTs when I started this research.

This research aims to address this gap by exploring the types of MCTs that have been created in Brazil. Brazil was chosen as the location for this study because: a) Brazil has a large population (211,8 million in Jul 2020 – IBGE, 2021) and because of this, there was explosion in the number of civic mobile applications developed in Brazil and for the Brazilian population; b) Mobile devices are a large part of Brazilian life, in 2021 there were 242 million mobile devices in use in Brazil (FGV, 2021); c) Brazil is It is a relatively young democracy (just over 30 years) and interesting civic innovations have come from there, such as participatory budgeting; d) Brazil is a large developing nation and often, public services have failed to reach some areas, MCTs have helped governments learn more about these areas, when citizens are given a channel to report local issues, participate in developing and voting for policies and providing online government services. And e) I am from Brazil, and I am familiar with the context and as a native speaker of Portuguese; this facilitates access and interpretation of information regarding Brazilian MCTs.

1.2. Research Area

This dissertation is in Information Studies (IS), it is an interdisciplinary area. In IS researchers and practitioners seek to organize, collect, classify, analyze, manipulate, access, disseminate, use, and preserve information and knowledge (McGill University, 2021; University of Amsterdam, 2021). This research aims to collect, analyze, and classify the information available about MCTs in Brazil by creating a Taxonomy of these ICTs. Another

important focus of IS, is to examine interactions between people, organizations, and information systems, to understand, create, replace, or improve, information systems. (McGill University, 2021; University of Amsterdam, 2021). By understanding more about these ICTs, researchers and practitioners can improve upon the existing tools.

This dissertation is an interdisciplinary study in IS research field, it is located at the intersection of Community-Informatics (CI), Knowledge Management (KM) and Digital Civics (DC), which are research areas in the Information Studies.

Digital Civics is an emerging interdisciplinary research area that aims to understand how ICTs are supporting models of service delivery, urban organization and civic activity in cities. DC focuses on Civic Technologies (CTs) and Mobile Civic Technologies (MCTs). "In this paradigm, civic action is co-produced and jointly owned by means of data, information, knowledge flows and dialogues between stakeholders emerging interdisciplinary highly interdisciplinary research touches on several disciplines" such as CI, HCI, KM, Geography, Political Science and does not yet have an established niche (Zucharman, 2012; Cridge, 2016).

Community Informatics (CI) is a research area within Information Studies, where researchers investigate how ICTs are used to support local economic development, social justice, political empowerment, and other goals related to community development. It is close to but originated inside the Information Studies field (Gurnstein, 2007; Williams et al, 2012). It also has a focus on Social Informatics (SI) but differs from it because SI has focused on business and government settings. Community informatics looks at a third realm of social activity, the community, and interactions (Williams et al, 2012). This research hopes to contribute to CI because MCTs support the interactions between civil communities, businesses, the non-for-profit sectors, and government.

An important objective of Knowledge Management KM is for the appropriate knowledge, to be in the right place, at the right time, to the people who need it. Therefore, the flow of knowledge is important (Nissen & Levitt, 2002; Borghoff & Pareschi, 1998). This is also a topic within community informatics as it is an area that has investigated technologies applied to civic matters and community development. Also in the field of KM, is The notion of Knowledge based urban development (KBUD) Is a model that encourages knowledge production and circulation in cities. It has been regarded as an attempt to enhance knowledge transfer between institutions to created added value and foster problem-solving. It focuses on knowledge intensive institutions such as government, businesses and universities and knowledge-based institutions as the important sources of added value to cities (Yigitcanlar et al., 2018).

1.3. Research Objective and Questions

In context presented in previous sections, the objective of this research was to explore the Brazilian MCTs, in Brazil. The research questions were examined based on three topics found in the literature: the first lens focused on the objectives of the apps. This topic aimed to explore the types of civic issues that these apps had been built for and how they could address the urban issues. This topic was chosen because previous work had not identified the types of civic issues that civic apps were aiming to address or how the app developers claimed these apps could help address these local issues. App do Cidadao, for example, aimed to unify local government services and made e-documents available for citizens (Appendix A). The scope of the second topic was to explore the kinds of interactions that could occur when these apps were deployed. Research Question 2.a. identified the stakeholders that would participate as well as what information and knowledge flows happened. For example, the App do Cidadao, enabled a citizen to government (C2G. Pages 164 and 195) flow of data, information and codified

knowledge and classified the apps according to the TEPPCE (Table 4, page 60). Finally, the third topic identified and classified the technology features that these apps enabled on the mobile devices. App do Cidadao, for example enabled the use of the Global Positioning System (GPS

The purpose of this research was to explore the mobile Civic Technologies (MCTs) that mediate information and knowledge flows among stakeholders (citizens, public and private sectors) in Brazilian cities. The aim was to answer the following Research questions (RQs):

Research Question 1: Question of What and How (Explores the objectives)

1.a. What civic issues do these platforms address?

1.b. How do they claim to address these issues?

Research question 2: Question of Who, What and How (Explores the Interactions that happen when these platforms are used)

2.a. Who are the actors (Stakeholders), what are the information and codified knowledge flows that occur when these platforms are used?

2.b. What types of engagement do these MCTs aim to address?

Research Question 3: Question of What (Explores the technologies deployed in these platforms)

3a. What are the technology features of these platforms that enable these information and knowledge flows?

1.4. Thesis outline

To achieve the goal of this research, Thematic Analysis (TA), was the method used to examine MCTs in Brazil. To do so, qualitative data was collected from 90 MCTs from the Goggle Android Playstore software repository. The data collected were analyzed using coding data reduction techniques for identifying patterns, categories and finding the relationships

between them. Then triangulation was used as a method of validating the findings from the application of the method (Miles & Huberman, 1994; Kitimbo, 2015). Formal interviews were then conducted with (n=8) stake holders of these MCTs to gather more data and confirm the findings.

Chapter 2 includes a literature review and the background for this research, the definition of the basic concepts, the place of the TEPPCE framework within the broader DC and CI literature and the choice of the TEPPCE as a guiding conceptual framework for the study. Chapter 3 will present the Theoretical framework of this research. Chapter 4, the methodology for each phase of the study, including the relevant literature justifying the methodological choices and the steps taken to ensure Rigor of this research. In chapter four, the results are presented by answering the research questions. Chapter 5 presents the results. Chapter 6, a summary of the findings and reflects on the research journey by including a summary of the major steps and describes the final research outcome and finally, Chapter 7, the discussion and concludes the research by reviewing the contributions of the findings to the body of knowledge, the limitations and areas for future studies. Relevant documentation is referenced throughout the text and can be found in the appendices.

Chapter 2 - Literature Review

In this section the relevant literature for this study is presented with the background to this research area, and the interdisciplinary nature of the field of digital civics as well as shedding light on its origins. Different disciplines such as Information Studies, Computer Science, Urban Planning and Political Science have shown interest in Digital Civics. Then the different approaches used to explore Civic Technologies and explores the conceptual definitions important for this research, more specifically Digital Civics (DC), Civic Technologies (CTs), Mobile Civics (MC), the features of mobile applications, Google Play Store. Finally, the research context and theoretical framework that will guide this research.

2.1. Mobile Civic Technologies (MCTs)

Mobile Civic Technologies (MCTs) refer to the Mobile Information and Communication Technologies (ICTs) such as smartphones, tablets, and smartwatches, that support and facilitate information sharing, reporting, collaboration, communication, action, engagement and/or participation in public matters (Olivier & Wright, 2015; Peixoto & Sifry, 2017; Corbett & LeDantec, 2018). They are a subset of Civic Technologies (CTs), which is a broader term used to categorize hardware and software used to support public matters and aspects of communities such as resolution of local issues.

Mobile devices such as smartphones, tablets and smart watches are based on software applications, commonly referred to as apps (applications) and platforms. They also combine different hardware in one device (such as camera, global positioning system, phone, microphone, Liquid-Cristal Display screens and Touchscreen) which support aspects of

information sharing and collaboration. This combination of hardware and software has been referred to as a technological convergence. Jenkins (2011) argues that technological convergence enables different information to be transmitted systematically across multiple delivery channels.

Before, technology convergence, these technologies were used in separate devices and were unrelated (Roco, 2002). For example, Global Positioning System (GPS) devices were used separately and would be employed to aid in mapping locations (Sui, Elwood & Goodchild, 2012). Groupware software such as electronic calendars, content management systems, and document management systems were developed on desktop environments to enabled people to share knowledge and expertise (Johansen, 1988). And touchscreen devices such as palm pilots and surfaces were often explored as means to bridge age gaps, handicaps and facilitate use of ICTs. Different sensor devices (such as microphones and thermometers) were used to detect urban issues such as noise pollution or sudden changes in temperatures (Burke, et al, 2006).

MCTs have this different hardware built in them, they are compact devices and can be taken anywhere, they enable network connectivity, are connected to the internet, and phone carriers and they are ubiquitous. MCTs offer interesting avenues to explore because at any place and at any time, citizens can interact and share their knowledge about situations in real time, which poses opportunities (engagement, collaboration, information sharing), but also risks such as breaches in personal privacy and issues of surveillance (privacy and surveillance concerns are discussed in section 2.8 of this chapter).

Gun and Pak (2020) studied 25 European and American CTs, classified them and concluded that mobile platforms must be studied separately from web-based platforms because they offer different advantages and limitations. For example, when reporting local issues smartphone MCTs succeed when adding placemarks, descriptive text, adding geolocated

photos, voting and ranking. However, more complex functions such as designing 3D objects where not possible to due to physical and infrastructural limits such as screen size, processor, and memory capacities (p. 202).

Mobile applications, platforms or apps are software developed by third-party stakeholders that have specific aims, requirements, and capabilities. These platforms enable users to use interfaces of content with features such as navigating, searching, rating, commenting, sharing, and publishing content and information. They are designed to run on certain devices and are stored and distributed in software repositories called App Stores available in online app marketplaces such as Google Play (Android Operating System), iPhone Appstore (iOS operating system), Windows (some are offered for free and others at a cost).

2.2. Google Play Software Repository

These marketplaces include classification systems that enable users to query and view information about each app, they can select the app they desire and download an installation of the app (Rahman, 2013). However, the Appstores such as Google Playstore, do not list categories that characterize civic tech or Mobile Civic Tech and there are no lists of features that can qualify civic technologies in these software repositories.

When developing mobile applications, it is important to consider the different operating systems and device types. In the context of MCTs with the objective of enabling technology-mediated civics, an important consideration is how much the operating system has been adopted in the desired context (de Reuver, Stein & Hampe, 2013). For example, in Brazil, iPhones are considerably less used compared to Android devices, which occupy 94.2% (Kanter, 2018) of the market in that country. For this reason, Google Play Store was the software repository used to collect the data for this research (Figure 1).

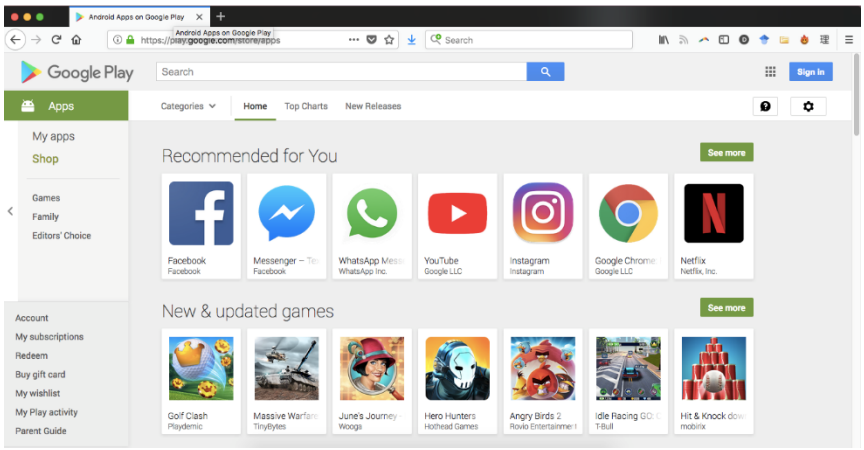


Figure 1: Google Playstore langing page

The Android Playstore publicly displays rich sources of information for analysis including information regarding the ratings users give apps after downloading and using them, app descriptions and number of downloads. This offers both qualitative and quantitative data about the objectives of the apps, their features and information about the downloads. The full list in the google Playstore is explained in Appendix D. However, there are no categories related to Civic Technologies.

This readily available information about the apps is a novel occurrence in software repositories because they offer a combination of information about user experience, technical information, and user perceptions. For example, the Google Playstore publicly displays sales information, app descriptions and features in one place. Therefore, combining these types of inter-related pieces of information can provide interesting research opportunities and insights about the nature of these platforms (Appendix D).

Mining, analyzing, and classifying Appstore data can inform and support future app development (Harman, Jia & Zhang, 2012). It is important to note however, that these repositories are proprietary and the data publicly available is limited. Even if not providing the source codes, app stores can offer rich information (qualitative and quantitative) about the

nature of the apps. They can inform us about their technical features (such as GPS and messaging.), descriptions, pricing, customer perceptions (ratings and number of downloads) and customer reviews (users' perceptions of the apps) which provides an interesting opportunity for analysis. Harman, Jia & Zhang, (2012) suggest that this is particularly interesting because this diverse set of data has not been available in other software repositories. They further notice that this information can be useful to support new app development because it can contribute insights about features for developing new apps.

Harman, Jia & Zhang, (2012) claimed to be the first work that mined Appstore data and analyzed non-technical user and business information. They addressed three types of information that were provided in the Blackberry Appstores: technical (features), user perceptions (through ratings and number of downloads) and business (price). They distinguished Appstore data into three categories of data and information: Perspective (of the developer and user); Business and Technical. User data and information refers to user contribution in the form of user ratings, tags, and reviews; Business informs about price, number of downloads, size of apps and personalized recommendations based on previous user behavior.

The technical or features presents information about the permissions to use hardware and software features provided by these devices. This is a rich amount of data enables multiple forms of analysis and investigation where one repository offers inter-related data, offering opportunities for analysis and understanding the relationship between categories and apps. This kind of analysis may be useful for developers, policymakers and citizens that can consider which features are crucial and which are not.

For example, Sharma and Bashir, (2020) analyzed 50 apps in the Google play store, made specifically address the COVID-19 outbreak. They found that technological features the

apps used were Global positioning System (GPS) that helped provide live maps and updates of confirmed cases, gave real-time location-based alerts; and Notification systems that monitored and controlled home isolation and quarantine, reporting to governments directly, self-reporting of symptoms and providing information and education about COVID-19.

2.3. Information studies

Information Studies (IS) is an interdisciplinary field where researchers and practitioners seek to organize, collect, classify, analyze, manipulate, access, disseminate, use, and preserve information and knowledge. An important focus is examining interactions between people, organizations, and information systems, to understand, create, replace, or improve, information systems. (McGill University, 2021; University of Amsterdam, 2021).

Here, information refers to the data that has been analyzed by the sender of the data (Dalkir, 2017). " Information is the sharing of factual material, updates on projects and events, and data for planning and analysis. Knowledge represents opinions, expertise, and know-how that are shared on events, artifacts, and systems being considered by the community on the platform" (Desouza & Bhagwatwar, 2014 p. 31).

Knowledge refers to the opinions, know-how and expertise of the agents (Dalkir, 2005). It may become embedded in the solutions exchanged in the CTs such as when the citizens know-how is used to provide solutions to the problems discussed. In other words, citizens can contribute with their opinions on a CT. These opinions, shared in the form of written words, text, videos and recordings are a result of their knowledge and expertise we call this codified knowledge (Desouza & Bhagwatwar, 2014).

The flows of information and knowledge happen between stakeholder who use the CTs. The flows can happen between citizens (citizen to citizen), between governments and citizens

and businesses and non-for profit and amongst these different stakeholders. " Information and knowledge flows can be centered on deliberations (i.e., discussion of issues) and participation (i.e., making decisions through tools such as voting, rating, etc.) or centered on specific local issues" (Desouza & Bhagwatwar, 2014 p. 31) .

Classification systems are "the primary intellectual technologies or organizing principles used by LIS professionals" (Rubin ,2017). Chan (2007, p.309), defines classification as “the process of organizing knowledge into some systematic order” (As cited by Rubin, 2017 p.307).

To classify, is to categorize or distinguish objects and ideas into meaningful groups. Classifying, helps us to make sense of the world (Trudeau & Guastavino, 2018). For Hedden (2010), taxonomies are classifications or categorization systems used to support indexing, retrieval, and organization of information. "Taxonomies are semantic classification schemes that provide a knowledge map of its domain. To meet these criteria, a taxonomy should be comprehensive, predictable and navigable" (Lambe, 2007 as cited in Trudeau & Guastavino, 2018 p. 2488),

2.3.1. Taxonomies

Taxonomies are a type of classification system that organizes concepts in facets, hierarchies and/or dependencies (Dalkir, 2017 p.527). Taxonomies are used to organize data, information and knowledge and make it easier to be found. In other words, they help users to re-use, find content and differentiate between dissimilar items (Putkey, 2012).

> A taxonomy is a classification scheme that groups related items together, often names the types of relationships concepts have to one another and provides some notion of more general categories versus examples or specific instances of a category.

Dalkir (2017 p.151)

To build a taxonomy, the data needs to be audited and labels or codes attached to them (Putkey, 2012). They are built by identifying, defining, comparing, and grouping elements (Lambe, 2007 as cited in Dalkir, 2017 p.151). Faceted taxonomies are used to organize information in a systematic order.

Facets are the controlled vocabularies that are divided into several subsets, lists of terms and different categories to represent different aspects of information for example, facets can be people, places, dates, and. Faceted taxonomies help information retrieval, when users search for a selection or combination of multiple facets laws (Hedden, 2010 p. 76).

2.3.2. Multifaceted Taxonomies

Multifaceted taxonomies or poly-hierarchies have more than one facet. Facets are the classification rules, used to define a category. In multifaceted taxonomies, a facet is different and distinguishable from the other for example: countries, colors and pricing are clearly distinguishable from one another (Dalkir2017 p.152). They are helpful ways to organize data because they are flexible and can deal with messy, overlapping, ill-defined nature of the mobile civic apps. Another benefit is that in scenarios that are constantly evolving, such as those of Mobile applications (which go through several updates and changes, often several times in one year), facets are relatively easy to add, remove, or modify to accommodate changes in the classification scheme.

2.3.3. Civic Tech Taxonomies

Recent studies have aimed to better understand the objectives of these platforms by mapping and characterizing their purposes and uses. They analyzed platform descriptions provided by their developers and creators (Gun, 2020; Skaržauskienė & Mačiulienė, 2020).

These studies are important because the characteristics of these platforms were under-explored. For example, Gun (2020) explored civic tech platforms and their use by stakeholders. He analyzed the written reports on the platforms produced by the developers and cross-checked them by analyzing and using them. He then, interviewed 7 project developers to clarify issues their analysis was unable to elucidate.

Skaržauskienė & Mačiulienė (2020) explored three aspects of civic tech platforms: objectives, actors, and how solutions were co-created when mediated by these platforms. They collected and analyzed the written data from 614 publicly available web sources about them. The data was then coded and analyzed using content analysis. They identified 7 main goals: to improve quality of life, to improve government functions, to address environmental sustainability, to promote accountability and transparency, to solve social problems, foster stronger democracies and build stronger communities (Skaržauskienė & Mačiulienė 2020. p. 07). They then identified the actors involved such as businesses, citizens and communities, government, and non-governmental organizations. They concluded that the platforms were directed towards governments and citizens, rarely to businesses and NGOs. The final lens by which they analyzed the platforms were the methods employed to reach the goals that the developers and creators described. They found three main methods for achieving these goals: (1) by creating ICT solutions (software, mobile applications, and other technological solutions), (2) by employing data (data and information collection and management) and (3) maintaining networks and communities. They found that platforms developed and maintained by citizens, were the most represented group. This suggests that citizens were creating ICT solutions for problems that the public sector had not addressed. The platforms created by governments often lacked feedback mechanisms, the authors conclude that this reduced the effectiveness of these platforms.

Table 1. Studies aiming towards understanding Civic Technologies

Study	Method	n=	Outcome	Properties Examined	Platform Types
Zuckerman, (2012)	Qualitative	n. a	Civic Engagement Matrix	Scale of citizen engagement: Thick (long term) and Thin (momentary) engagement through Civic Tech	Platforms that enable thin engagement (momentary engagement) and thick engagement (long term participation)
Desouza & Bhagwatwar (2014)	Grounded theory	25	Technology Enabled Participatory platforms for Civic Engagement (TEPPCE) taxonomy	They updated a well-established theory of participation – Arnstein's Ladder of participation (from 1969) in the context of citizen participation mediated by technologies. Technology enabled Participation, Actors, Data, Information and Knowledge flows, Goals,	Classifies CTs and provides a four-mode taxonomy for technology mediated civic engagement based on the flows, the participation, the technology, and the objectives
Omnydar, (2017)	Mixed method	21	Multi-faceted taxonomy	Civic Tech and social Movements, Type of engagement that the platform enabled	Scale and/or Growth, Grassroots Activity, Sustained Engagement, Shared Vision, Identity and Collective Action,
Peixoto, & Sifry, (2017).	Systematic, Grounded theory	23	Taxonomy	Actors, Design, Participation, Technology, Effects, Goals of the ICT, Public Policies	Synchronous (platforms that enable real-time user feedback (p.52) and platforms
Simon, Bass, Boelman & Mulgan (2017)	Case Studies (Secondary sources)	13	Taxonomy	Objectives of the platforms & type of citizen involvement	Types of platforms / objectives of the platforms. Platforms for: Informing Citizens, Issue framing, Citizens Providing Information

The scope of this research adopts the concept of Civic Technologies (CTs) in the research area of Digital Civics (DC). The definitions of CTs incorporate the spectrum of technologies that aim to address civic matters and concerns such as voting, access to government services and information. Civic Technologies have appeared in the form of e-governmental portals, grassroots online websites, and blogs and in desktop social media environments and more recently have been developed in mobile devices such as smartphones. The definitions and motivation for choosing mobile devices as the platforms for this investigation are explored in the next section.

2.3.4. Community Informatics (CI)

Community Informatics (CI) research has existed since the late 1990s and it is concerned with the relationship between people and technology. Its focus resides on solving

community problems, which are articulated by citizens at the political, social, and cultural levels (Stillman, 2009).

> "Community Informatics pays attention to physical communities and the design and implementation of technologies and applications, which enhance and promote their objectives. CI begins with ICT, as providing resources and tools that communities and their members can use for local economic, cultural, and civic development, community health and environmental initiatives among others."

(Gurstein 2000: p. 2)

CI is a discipline that aims to investigate the implementation of ICT projects in local communities (such as a city, neighborhood, district, networks of local structures and organizations) including its information infrastructure. However, in CI, there is an ongoing debate concerning the need for a stronger theoretical basis and the need to further investigate the body of thinking in established theories (Stillman, 2009). Therefore, the one of the objectives of this thesis, to validate and extend an existing theoretical framework coincides with this need identified by Stillman, 2009.

Smartphones and tablets (mobile devices) have been responsible for profound changes in collaborative technologies and encompass several daily activities, at work, in public and private life. Furthermore, the sales of mobile devices have surpassed the number of desktop and laptops and might replace the former computing devices (Wallace, Oji & Anslow, 2017).

When data and information flows, happen in cloud computing and mobile platforms, they require infrastructures that allow for limited access to end users and researchers (such Google, Apple, Microsoft). Wallace, Oji & Anslow, (2017) argue that this has limited researcher's capability to collect data, design new platforms and test hypothesis because most of the data belongs to the owners of such infrastructures. This has thus created a shift in the

type of research conducted in the CSCW field towards more descriptive models. For example, to perform this analysis, there was only access to publicly available data from the google Playstore, the metadata was not available for analysis.

2.4. CT and MCT Capabilities

2.4.1. E-governance

E-governance (electronic governance) was a term introduced in the early 2000's to describe government structures that are complemented with ICT in which citizens are more involved in decision-making processes and planning (Anttiroiko 2004; Lee-Geiller and Lee, 2019). It happens when government services, information exchange and communication between actors (governments, citizens and businesses or interest groups) happen online and are mediated by Information and Communication Technologies (ICTs) (Heeks, 2001). The main premise is that e-governance systems can deliver government services in a convenient, efficient, and transparent manner (Garson, 2009). Lee-Geiller and Lee (2019. p. 212) define e-governance as instruments that afford government and citizens to interact continuously with each other, by integrating information and knowledge exchange and using ICTs in decision-making and problem-solving processes. It is based on democratic principles such as transparency, accountability, and collaboration.

Simon, Bass, Boelman & Mulgan, (2017) distinguished, two main ways to define e-governance and democracy in the digital age, a maximalist definition, and a minimalist definition. In the maximalist definition of digital democracy, citizens are envisioned as stakeholders who collaborate and participate with governments and can make decisions (citizen power) about their local environments. In the minimalist paradigm ICTs are used as tools to give citizens access to governmental information and allow for information and knowledge

exchange between them. This can be done through online consultations and access to online services (e-government services). This minimalist paradigm falls within the e-government tool category. Digital democracy experiments have shown that ICTs have been important in enabling people to engage and exchange information and codified knowledge between municipalities, citizens, and governments. Governments in several countries such as Canada, Brazil, United Kingdom and France have experimented with ICT tools that enable citizens to propose legislation (Simon, Bass, Boelman & Mulgan, 2017)

To better understand the concept of e-governance, it is helpful to distinguish between government and governance. For Anttiroikko (2004), government relates to traditional and institutionally oriented policy processes. Taylor (1998) defends that the government forges relationships with citizens in formal and constitutional terms, in which the relationship between citizens and government as occur in settled and agreed boundaries (i.e., certainty).

Governments are the formal institutions and agents that perform governmental functions. They have traditionally made decisions and implemented them. On the other hand, governance are the dynamic and network-based approaches to policy and decision-making processes. It refers to the ways and tools used to govern with the intent of representing the actors involved, creating policy networks and partnership-based relations (Anttiroikko, 2004, p. 26; Stoker, 1998, p. 17; Jessop, 1998). Governance changed the shift from traditional governmental hierarchies to networks, multi-level partnerships between and deliberative information and knowledge sharing between governments, businesses, citizens, and other organizations. In other words, governance aims to promote interaction between the actors involved. This caused expectations that governance could help to solve policy questions that governments were unable to address. However, governance has resulted in complex

relationships, which have led to "confusion and dilemma", leading to a decline of citizen trust in governments (Taylor, 1998 p.144).

E-governance is different than “e-government” because in the latter, ICT is used by governments to modernize their systems and support public services (Gilman, 2017). ICTs have facilitated interaction between the stakeholders (Castells, 1989; Desouza and Bhagwatwar, 2014). This was coined e-transformation in governance or electronic governance. Which relates to how ICTs are used to develop governance practices, ICT-enabled practices, change the governance. While e-government initiatives are funded and developed by the governments themselves, e-governance includes citizens, businesses, and interest-groups in planning and decision-making.

Anttiroikko (2004) spoke about the failure in e-governance exercises. In his perspective it was because, the early attempts to promote e-governance were rigid and unidimensional. These attempts where based on the idea that it would be imperative to involve market forces and civil society as “partners” to legitimate government operations. For e-governance to work, there is a need for a government that can provide "flexible, responsive, and transparent public agency with focused regulatory, developmental, and coordinating functions" (as cited in Argyriades, 2002, p. 36).

Heeks (2001) accessed e-governance initiatives in Chile, Honduras, India, and the Philippines. He concluded that most e-governance failed, especially in developing countries due to a lack of e-readiness (ICT infrastructure and government ability to use ICT). Another reason for their failure was lack of monitoring and evaluation after e-governance systems were implemented. He also found that failure happened when systems were implemented but then immediately abandoned.

For Ratneshwar (et al., 2010), e-governance tools should aim to provide fast and convenient public services to citizens on a day-to-day, 24/7 basis. According to Jha and Bose (2013), developed countries, have already moved towards governance systems that aim to improve citizens experiences. Sakus (2001) and Allen (et al., 2001) agree that the e-governance experiences in developed economies have shown that decentralized power (such as empowering citizens and organizations) are facilitators for e-governance.

While developed countries have also implemented e-government strategies, emerging economies (like India, Brazil, and Sub-Saharan Africa) have traditionally hierarchical and centralized government leadership styles, with developing local administration, corruption, high levels of over-staffing with low pay scales and unmotivated and unqualified staff (Lideres do amanha, 2020; Marques, 2012; Jha & Bose, 2013; Schuppan, 2009; Constantino, 2015; Wescott, 1999). Jha and Bose (2013) argue that loss of privacy and security of personal data are issues that arise when transiting from centralized to decentralized e-governance.

In other words, the solutions used for developed countries may not apply to developing nations because additional effort is necessary when implementing exercising e-governance and implementing e-government. However, stating that e-governance fails in developing countries because of state failures or lack of capacity is also an oversimplification. Schuppan (2009) argues that context-oriented approaches are more likely to succeed when implementing e-government: "different administrative contexts and rationalities must be taken into an account when implementing e-government projects and strategies (p.01).

E-governance are important goals of CT and MCTs and this section aimed to contextualize these technologies within previous studies that focused on technology mediated civic engagement and public administration. However, the focus of this dissertation is not to investigate the degrees of e-governance with CT/MCT.

2.4.2. Networks, governance and civic engagement

The rise of networks and ICTs have brought opportunities and challenges to governance. They have been regarded as catalysts to transform citizens and interest groups from passive to active co-creators of policies (Singh 2013; Gilman, 2017, Skaržauskiene & Maciuliene, 2020; Cazacu, Hansen & Schouten, 2020). The 2000's were surrounded by optimistic discourses surrounded ICT mediated participation.

During the first and second decades of the 2000's several debates around digital technologies in the public sphere focused on the potentials of ICTs to strengthen democracy, encourage participation and empower citizens (Castells, 2012; Castells, 2015, Rumbul, 2015). Fuchs (2012) called these *techno-optimistic* positions where authors, only consider the positive impacts of ICTs because some considered ICTs, as a panacea that would resolve all political issues.

For example, Trippi (2004) argued that "The Internet is the most democratizing innovation we've ever seen – more so than even the printing press." (as cited in Gilman, 2017. p. 744). Sociologist, Manuel Castells (1996), believed that ICTs and the internet would centralize communication, liberate individuals to shape their autonomy, empower citizens and transform politics, which would ultimately lead to social change. According to Castells, this would happen when citizens combined online and offline actions and networked social movements which would lead take effects in government agendas and increase accountability. VanLaer & Van Aelst (2010) defended that the internet facilitates the existing social movements because it creates new tools for activism and easily reaches more people, faster.

These views caused skepticism and the limitations of ICTs for transforming the public sector were then put into light. Scholars in political science and international relations were

contested the overly optimistic views surrounding ICT mediated participation because ICT optimists tended to overlook the political interests and institutions (Fung, Russon & Shkabatur, 2013. p.30).

These discussions about ICT mediated participation have also been criticized for not engaging with a representative samples of participants (e.g., Graham & Wright, 2014, Graham, 2008; 2012); not encouraging interaction between individuals with contrasting ideas and beliefs (Zuckerman, 2014; Pariser, 2012; Adamic & Glance, 2005; Sunstein, 2002); putting technology ahead of discussions; ignoring societies' multidimensional nature (Fuchs, 2012; Jones, 1998); and ignoring state surveillance and digital divide (Deller, 2016)

Nelimarkka (2014, p.3) believes that an important challenge in civic tech is for participants with diverging viewpoints to engage in peer assessment of contributions or deliberate on issues. Rumbul (2015) argues that often there is the assumption that people will engage simply by installing the ICT infrastructure furthermore, this is not the case.

Another challenge faced by Civic Tech is adapting these ICTs to represent and address different citizen's needs. Rumbol (2019) argued that governments often provide highly structured and formal bureaucratic forms of engagement with citizens which impede meaningful engagement. In her study with city councils in the United Kingdom, Rumbol concluded that citizens who approach city councils with certain information needs may be satisfied with their levels of engagement, but citizens with more complex needs would benefit from a more holistic approach. This is because, deep civic engagement needs to engage with citizens by asking them what problems they have an inviting them to contribute with ideas on how to solve these issues. Promoting prescriptive and restrictive participation such as responding to surveys or questions are insufficient to promote deep engagement (Rumbol, 2015; Dutil et al, 2008). Furthermore, efficient engagement should happen with accessible and

inclusive language that enables a wide range of citizens to collaborate (Coleman & Gotze, 2003; Lukensmeyer & Torres, 2006). Rumbol (2015) argues that for digital engagement tools to promote meaningful participation, they should be accessible, inclusive and should facilitate information-sharing.

The rise of networks has included citizens and helped them to inform governments and the civil society about local issues. CT and MCT platforms that aim to create stronger communities provide the tools to create and mobilize networks and online communities. For example, platforms that address issues of public transport have created networks of individuals who contribute with information about local security issues. Waze is a mobile app that helps users to find the best route to where they wish to go. These users can share information about what is happening in these locations in real-time if there is a road accident or if there are muggings in dangerous locations. They provide important safety information that enhance mobility and safety.

2.4.3. Technology Mediated Participation and Civic Tech

There seems to be a widespread disillusionment with existing democratic institutions and declining trust in elected officials is pervasive (Nye, 1997; Harding, Knowles, Davies & Rouncefield, 2015). This has resulted in the creation of populist movements and emerging political parties that explicitly advocate for decision-making with increased citizen involvement. For example, The Podemos political party in Spain (Tormey & Feenstra, 2015), The Five Star Movement (M5S) in Italy (Mosca, 2014) and the Pirate Party in Germany and Scandinavia (Simon, Bass, Boelman & Mulgan, 2017).

In this context, participatory governance efforts have moved towards the spotlight over the last decade. As some governments seem to be aware of their shortcomings and have tried

mitigating issues such as lack of trust and tried to improve citizen satisfaction. Public sectors around the world have invested in ways to encourage the civil society to participate. For example, some have provided repositories of open government data for citizens to analyze and re-use to address local issues to develop their own solutions (Thiel, Fröhlich., Baldauf, & Caldwell, 2018). Others have promoted competitive hackathons to jointly create solutions as well as informing citizens about ongoing plans in cities. The overall aim of these efforts has been to improve satisfaction and quality of life (Pateman 1970; Thiel, Fröhlich., Baldauf, & Caldwell, 2018).

Practitioners and scholars have experimented with ICT developments such as websites, forums, social media, and smartphone applications, instead of only relying on traditional forms of public participation to attempt to alleviate common barriers to engagement such as location or time. These experiments have often been referred to as e-participation (Hansen & Reinau, 2006; Conroy & Evans-Cowley 2006; Sæbø, Rose & Flak, 2008; Cordoba-Pachon, 2009; Wilson, Tewdwr-Jones & Comber, 2017) and more recently have also been referred to as a research area called Digital Civics (Zuckerman, 2012; Oliver & Wright, 2015; Peixoto & Sifry 2017; Vlachokyriakos, Crivellaro, Le Dantec, Gordon, Simon, Bass, Boelman & Mulgan, 2017; Emmer & Kunst, 2018; Corbett & Le Dantec, 2018)

Since the early 2000's, e-participation scholars and practitioners have attempted to describe how ICTs mediate citizen involvement and contribute to policy-making efforts. In this paradigm, ICTs are viewed as enablers to connection because citizens can easily communicate with the elected governors. Scholars seem to agree that the first e-participation ICTs used for citizen engagement were Geographic Information Systems (GIS) (Linders, 2012; Thiel, Fröhlich, Baldauf, & Caldwell, 2018). They were called Public Participation GIS (Sieber, 2006). PPGIS are important for this research area because they enabled citizens to participate

by informing local administration about problems or issues in certain locations (citizens opinions on where to build a new parks or bike lanes as well as for disaster mitigation for example). This first generation of engagement tools provided citizens with information about their city's developments and usually enabled ways for citizens to provide feedback on a location. However, they have been labeled as promoting top-down form of engagement, where governments have control over the process of citizen participation (Macintosh & Whyte, 2006; Linders, 2012).

Browser e-participation applications as well as earlier Public Participation GIS (PPGIS) were accessible only by means of computer software – that is, they were place-bound. A citizen would have to login to a computer to be able to use the participation systems and provide information about their cities. This is where smartphones and other mobile devices (such as tablets, smart watches, smart glasses) become interesting for the context of e-participation. These devices are portable and are rich in features such as Global Positioning Systems (GPS), camera, accelerometers, sensors, which have offered interesting opportunities for real-time citizen engagement.

Omnydar, (2016) describe Civic Tech as "any technology that is used to empower citizens or help make government more accessible, efficient, and effective." They contend that Civic Tech may deepen citizen engagement. Similarly, Peixoto & Sifry, (2017) characterized them as ICT platforms that allow citizens to voice their opinions with the intent of improving public services.

Civic Tech has been defined in several ways. For example, Omnydar, (2015) defines CT as any technology that empowers citizens and supports government service provision with the intent of delivering and improving these services. They contextualize these technologies as mediators if civic activities such as: engagement, grassroots movements, shared vision,

collective action, and shared identity, usually done voluntarily which can be organized by non-profit groups, governments, and businesses. Stempeck, (2015), from Microsoft provided a high-level definition of Civic Tech: “the use of technology for the public good”.

CTs can be built to collectively address solutions to social or technological urban problems; to raise awareness about social issues (such as in the example of the school in Rio de Janeiro- p. 18) or improve aspects of governance (accountability, budgeting, transparency, and participation); the city's infrastructure (such as accessibility and sustainability); and service, delivery (such as digital documents and eGovernment). CTs often involve communication and collaboration among stakeholders (citizens, governments, and the private sector) who are in cities and interact with each other by exchanging information and resources. Moreover, CTs may support citizen participation by offering tools that facilitate information[1] and knowledge[2] flows, which can happen between the same kinds of stakeholder (between citizens) or across several stakeholders (between citizens and governments and private sector).

CTs can be in the form of a websites, portals, blogs, mobile applications, or electronic voting devices. CT websites and portals can inform about civic issues and/or offer civic features such as voting, polls and comments sections have been used to increase the information flows between governments, citizens, and corporations, enable collaboration and in some cases citizen engagement. And more recently, mobile devices have been used for civic activities, mobile Civic Tech (MCTs) refer the mobile applications created in smartphones, tablets, wearable devices such as smart-watches and smart glasses.

1 Here, information refers to the data that has been analyzed by the sender of the data (Dalkir, 2017), as well as the civic facts such as updates about issues or events and data to support planning and projects (Desouza & Bhagwatwar, 2014).
2 In this research we approach knowledge as the opinions, know-how and expertise of the agents (Dalkir, 2005). For example, knowledge may become embedded in the solutions exchanged in the CTs such as when the citizens know-how is used to provide solutions to the problems discussed (Desouza & Bhagwatwar, 2014. p.31).

2.4.4. Online versus offline participation

Online platforms can enable different forms of participation, in different activities and at different levels (Wright, 2012; Wright & Street, 2007; Towne & Herbsleb, 2012; Nelimarkka 2014). For example, wright and Street (2007) argue that online moderation and deliberative polls support engagement in discussion forums. Karlsson (2011) observed that participation such as engaging in deliberative communication in online platforms, can positively contribute to whether an individual will consider another participant's views.

However, traditional forms of participation are still in use and are quite popular. They complement CTs and MCTs. For example, Gun and Pak (2020) studied 25 CTs and MCTs, in Europe. After their analysis, 76% of the platforms benefited from offline participation such as face-to-face interviews, group discussions, design meetings (charrettes), referendum and workshops. (p.202). They analyzed the written reports from civic technology developers on mobile and web-based platforms to evaluate design empowerment of 25 civic technologies in Europe. They aimed determine how these platforms empowered or restricted citizens engagement, as well as the factors that could facilitate better participation practices. Then conducted interviews with 7 project developers to clarify issues that their content analysis was unable to elucidate. They concluded that the most CTs (n=19) included citizens to report local issues and provide feedback, however, they did not provide the functionalities the users needed to provide that feedback. This was an interesting study, but it did not specify what kind of local issues these platforms aimed to address. Another interesting result from Gun and Pak (2020) was that from 25 CTs they analyzed, only 3 allowed citizens to design their own solutions, however, they did not provide citizens with feedback about their designs and solutions.

Graeff (2018) argued that civic technology and social media creators have the obligation "to design for citizen empowerment and ensure they are advancing empowering processes and outcomes for citizens by evaluating whether their platforms are actually serving

this mission". And that "technology used for civic engagement should be understood as stewards of democracy with an ethical obligation to serve the public good" (p. 18).

2.5. Participation and engagement

Civic participation includes citizens in planning decisions and outcomes in issues of public concern to increase their levels of social and political empowerment (Arnstein, 1969; Davidoff, 1965; Laurian, 2004; Checkoway & Aldana, 2012). It is an umbrella term which has been used interchangeably with the terms: public participation (Nabatachi, 2015), citizen participation, civic engagement (McNeil, 2016; Desouza and Bhagwatwar, 2014), and citizen involvement (Rumbol, 2018, Gilman, 2017). For Nabatachi (2015), it refers to the activities, tactics and tools used to include the public's needs, concerns and ideas into public matters and issues. Day (1997) argues the citizen participation is a contested concept and it as an “Achilles' heel” or a “wicked” problem because it appears in the literature in different forms (as cited in Fathejalali, & Jain, 2019. p201).

McNeil (2016) defined participation as people's right to: “(1) define the public good; (2) determine policies that aim for the common good, and (3) reform or replace institutions that do not serve that good” (p.02). In this perspective, citizen participation may increase transparency, trust in governments, government legitimacy and increase the frequency as well as the quality of government responsiveness. She asserts that citizen participation is a fundamental principal in a democracy because in this system of government, elected leaders have an obligation (not discretion) to respond to citizen’s needs. Furthermore, citizens have the right and responsibility to ensure that their government provides services according to the people's needs and interests. In this perspective, citizen participation refers to governments, citizens and private sector sharing information and knowledge then using them to communicate

and act (such as providing feedback to governments and reporting problems). Citizen participation can occur at many levels, including the community, municipal, sector or national and international levels (for example, regional or global social movements such as the occupy movements).

She argued that the goal of civic participation is to improve services offered by governments and/or improving upon or changing policies as well as the accountability of governments and service providers. The World Bank defines citizen participation as the "two-way interaction between citizens and governments or the private sector that give citizens a stake in decision-making, with the objective of improving development outcomes" (McNeil, 2016). In this definition, the need for governments to be responsive to citizens' needs is emphasized. Here, the information is not only provided by governments but can also be created by citizens, who have knowledge about their surroundings and share information between themselves.

According to McNeil (2016) participation is a concept that has existed for as long as humanity. Politics and government models such as republic, democracy, monarchy, oligarchy and tyranny have been discussed since classic antiquity between the 8th century BC and the 6th century AD by philosophers such as Aristotle in Politics, (Aristotle, 4th-century BC), Plato in the Republic, (Plato, 375 BC) and the Illuminism philosophers such as Hobbes in the Leviathan (Hobbes, 1668), Rousseau in the Social Contract (Rousseau, 1762) and Tocqueville in Democracy in America (Tocqueville, 1840). They have been a focus of discussion and study in history, philosophy, and political science.

For Williams (1976) civic participation is as old as the institutionalized city. It began with voluntary citizen groups who wanted to improve local issues and beautify the cities (as cited in Day, 1997. p. 423). In the United States of America (USA), formally mandated

participation was institutionalized in 1954 with the Urban Renewal Act (Day, 1997). At that time, the mechanism available for civic participation were the organized citizen advisory boards composed of seven to fifteen citizen leaders. In Brazil, participation in political processes were formalized with the Federal Constitution in 1988. (CF-88). The mechanisms included were, referendums and plebiscites (Moisés, 2010), citizen councils and advisory boards (Chaia e Tótora, 2002) and rights to perform protests, marches and strikes (Postill, 2018; Santos, 2019). Later, Brazil became the birthplace of "participatory budgeting", deliberation between citizens, the public and private sectors to decide on where to allocate public budgets (Baiocchi, 2018).

Before the 1960's, participation was viewed as a technocratic process where professionals and politicians were the only actors involved. Citizens were excluded from the planning processes. During the 1960s, scholars and practitioners included a discussion about the importance of civic engagement in decision-making processes and planning (Davidoff, 1973; Arnstein, 1969 & Damer & Hague, 1971). Davidoff (1973) disseminated the discourse surrounding civic engagement with the theory of advocacy planning (Fathejalali, & Jain, 2019). According to him, before the 1960s, planning occurred in a top-down manner, only including government and public servants, but it did not include citizens in the process. He considered this traditional form of planning as undemocratic and authoritative because institutions would make decisions concerning citizens without consulting with them, excluding vulnerable and lower socioeconomic stakeholders. He defended that allowing citizens to participate in the planning processes could raise public awareness and allow lower socio-economic groups to be represented by engaging with them and supporting their needs. In this thought, citizens are good planners because they can develop plans according to their needs. Secondly, involving both citizens and planners would lead to conflict, competition, and deliberation, which in

Davidoff's (1965) thought would increase their honesty. Third, when citizens are included in the planning processes, they can provide feedback to planners which then creates a positive environment towards constructive planning and participation. Damer & Hague (1971), added to the discussion of public participation by noting that citizens were also demanding to be included in planning and decision-making: "The fact that there is evidence that increasing numbers among the public demand power to make such contributions has not been faced." (Damer & Hague, 1971. p. 231).

By the end of the 1960s, Arstein (1969) created the "Ladder of Citizen Participation" and argued that civic engagement should ultimately lead to citizen power (Figure 1). She created a hierarchical classification composed of eight ascending levels of citizen engagement from no participation (no power), leading to citizen participation (citizen power). It is one of the most cited and influential models in public participation, by October 24th, 2021, had been cited by 25,537 in other scholarly articles accessing civic engagement (Scholar, 2021).

Critiques to Arnstein's taxonomy typically address the over-simplification of such a complex phenomenon - power; It does not consider the dynamics which are involved in real-world participatory events; and because Arnstein's typology is hierarchical, the lower levels of civic engagement are interpreted as inferior to the higher levels. However, in some instances the lower levels of participation may lead to positive outcomes. For example, efforts to inform citizens of their rights, may lead to civic organization and possible empowerment (Organizing Engagement, 2021).

She considered the lower levels of participation (manipulation and therapy) to be inadequate and unsatisfactory as there is no participation. The first level of participation starts at the level named Degrees of Tokenism which is composed of: Informing, Consultation, and Placation. The highest level of the ladder, the Degrees of Citizen Power is represented by

Partnership, Delegated Power and Citizen Control. Arnstein's ladder can therefore be considered a normative representation of participation as it goes from low to no participation, to limited levels of power, and finally towards degrees of actual citizen power.

Arnstein's 1969 taxonomy remains considerably relevant. For example, Desouza and Bhagwatwar, (2014) updated Arnstein's ladder in the context of ICT mediated civic engagement. They analyzed Civic Technologies (CTs) in populated cities in the USA because they defended that ICTs could be tools used to promote civic engagement (such as when citizens used applications to report a pothole to the local governments).

Figure 2: Adapted from Arnstein's Eight Rungs Ladder of Participation (Arnstein, 1969. p 217)

2.5.1. Participation taxonomies

Arnstein's ladder also inspired other scholars to build upon her taxonomy and work towards classifications and other multidimensional conceptualizations of participation (Gun, 2020; Scheufele & Nisbet, 2002) and hierarchies of political participation (Rocha, 1997; Connor, 1998;). For example, Verba, Schlozman, and Brady (1995) conceptualized civic participation into four dimensions. The first regarded the frequency of voting in local and

national elections. The second included civic participation in political campaigns, volunteering, or contributing money. The third dimension happened when citizens contacted the local, state, and national officials. And the fourth dimension were activities where cooperation between multi-stake-holder groups (citizens, public sector, businesses, and non-for-profit) or organizational activities (as cited in Scheufele and Nisbet, 2002, p.56).

Connor (1998) developed the 'new ladder of participation, a taxonomy that aimed to address public controversy in a systematic way. This new ladder started with Education as the lowest level of civic engagement. For Connor, avoiding public controversies should start by first informing citizens. The next level was Information Feedback, where after being informed, citizens are invited to give their opinions this he suggested feedback surveys as a tool for this. Followed by consultation with citizens to find additional solutions that are technically sound and economically viable to the issues in question. The techniques for consultation included open houses, planning workshops, advisory groups, and reference centers. On the next levels of the new ladder, Connor argued that organizations need to be involved in joint planning to achieve resolution of the issues raised. If this does not achieve resolution, mediation is then the next step of the ladder. And in the cases where there is an imbalance of power, litigation is the next step in the ladder. However, this is a slow and expensive method of conflict-resolution.

The last rung of Connor's ladder is resolution and prevention, where the stakeholders may need to re-evaluate their organizational culture to adapt to the needs of current social environments. One shortcoming of this framework is that the four upper-levels of the ladder (joint planning, litigation, mediation and resolution, prevention), belong to the leaders, governments, and planners. Connor did not specify how citizens have power in the upper rungs of this ladder (Connor, 1988, p. 256),

Close to a decade later, Rocha (1997) added to the hierarchical debate of power and civic engagement with the ‘ladder of empowerment’. This was an important paper because it described the interrelationships between collective and individual means of empowerment, because for her, "all empowerment is not equal" (Rocha, 2007. p. 31). In her ladder, the steps moved from less to more power, as did Arnstein's (1969) and Connor's (1988) ladders. On the lowest rung, are individual forms of empowerment (atomistic individual power, embedded individual power) moving towards community empowerment (mediated empowerment, socio-political empowerment, and political empowerment). The lowest levels of the ladder represent the individual and its goal is to achieve individual efficacy. Empowerment at an individual level, "is conceptually modeled after mental treatment process and aims to provide empowerment tools such as coping skills and increasing individual vocational or physical capacity" (Rocha, 1997. p. 34). In the middle of the ladder, empowerment is mediated by a professional individual or community group to support an individual's decision-making. On the following levels of the ladder, Rocha includes the importance of community as a catalyst for collaborative action through knowledge-creation and acquisition. She follow's Rubin's (1994) argument, that political empowerment happens when the community (individuals, groups, and organizations) are all included. However, Rocha argues that there are conflicting expectations regarding power in communities. For example, administrators view that empowerment happens by providing technical solutions and information. But individuals and families may view empowerment as adaptive solutions such as listening to their needs and educating them on how to reflect and contribute with solutions to the issues they raise. Rocha's ladder of empowerment provides a model for individual and collective participation, in which individual participation stays at the lower levels of power, and collective participation leads to more power.

Gilman (2017) added to Connor's (1988) idea of collaboration between stakeholders, spoke about multi-sector partnerships, when addressing citizen participation. For him, civic engagement should be in the form of partnerships between citizens, public-private, business, non-for-profit, civic, and political actors to work together on civic problems. His thoughts were aligned with Moore's "public value" (Moore, 1995), which accesses how organizations contribute to society. For Moore, the public sector or governments are not the only ones who can contribute to the common good because various stakeholders can accomplish more than what a single sector can do (Gilman, 2017; Bryson, Crosby, and Stone 2006).

In 1999, the International Association for Public Participation's (IAP2) developed the 'spectrum of public participation' as educational material for planning and for developing solutions or platforms for complex problems (IAP2, 2007; Nelimarkka, 2014, Organizing Engagement, 2021). It is a hierarchical matrix used to help identify levels of participation in planning for the public good. This model proposes five levels of action for participation to happen: inform, consult, involve, collaborate, and power. Inform is the lowest level of engagement and it aims to provide information to the citizens to help them understand the problems. Consult is on the second level of the spectrum and elicits feedback from the public, about decisions. The third level is Involve, where citizens are invited to share their concerns and needs. the aim is to ensure that governments consider stake-holder concerns. The fourth level is Collaborate. Here the stakeholders work together and deliberate about each aspect of the decision. They are given space to propose new solutions. Organizing Engagement (2021) point that there may be challenges to collaboration, when leaders use their position of power to exploit or disempower their stakeholders. The fifth level is Empower. In this level, the decisions offered by the stakeholders are implemented. The message passed on to the stakeholders is: "We will implement what you decide"

Later, Desouza & Bhagwatwar (2014) developed comprehensive taxonomy of different facets of Civic Technologies (the Agents, the Technology Features, and the Levels of engagement they could afford. They also Updated Arnstein's hierarchical taxonomy and found 4 modes of civic engagement that could correspond to similar forms of engagement Anstein identified. Mode 1 referred to citizen-centric and citizen-sourced data, where citizens deliberate about local issues and generate ideas to solve problems in their neighborhoods. Mode 2 are citizen-centric and government data. Where governments provide data and information, then citizens seek the information they need. Mode 3 are the government-centric and citizen sourced data, where citizens and governments exchange ideas about the issues in question. The last mode 4 is where the highest level of participation occurs. They call this, "Government-centric and citizen developed solutions". In this mode, citizens and governments collaborate to design solutions to local issues. Figure 3 summarizes the taxonomies and theories created to characterize participation.

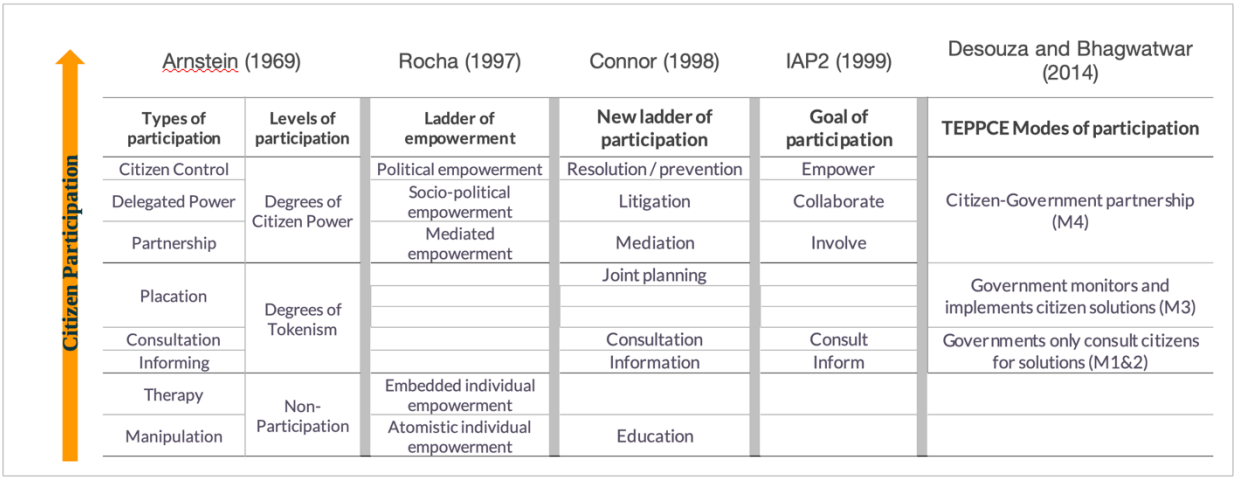


Figure 3: Taxonomies of participation

Nabatachi (2015. p.02) classified participation into three categories, conventional, thin, and thick participation. Conventional participation is the most common form of participation promoted by government officials, they are usually prescribed by law and are organized in

systematic, organized steps with notifications, audiences' rooms, and strict pre-set agendas. For example, conventional public meetings and advisory committees. These are often the most controversial forms of participation and often lead to the erosion of trust on government officials. Nabatachi argues that this happens because these tactics are outdated, inefficient, and unproductive. To counter-act this problem, better systems, laws, and designs need to be put in place. The second category is thin participation. These refer to tactics, tools and platforms that allow several individuals to submit ideas and receive information. This form if participation can occur synchronously (face-to-face) such as are surveys, petitions, and polls; or asynchronously (in different places at different times through online crowdsourcing ideation, mapping, wikis, and social media. The third category is thick participation, the most intensive and time-consuming, where many people discuss, learn and act together. These can be participatory budgeting, citizen's juries, and study circles.

Hierarchical empowerment taxonomies of participation (Arnstein, 1969; Connor, 1998; Rocha, 1997) have been contested. For Gün and Pak (2020, p.192) and Pak and Verbeke (2014) empowerment is "not sufficient to explain the specific independent practices of citizens or organizations". They argue that the Affordances of an environment were also important elements to be considered. Affordances, refer to what the environment offers, provides, or furnishes to users. Affordances lead users to a course of action (Gibson, 1979, p.127). Senbel and Church (2011) built a framework based on the Theory of affordances called design empowerment which was a hierarchical framework from lower design empowerment to higher design empowerment where the lowest level was information (1), inspiration (2), ideation (3), inclusion (4), integration (5) and the highest, level independence (6).

Chapter 3- Theoretical framework

This chapter includes information about the Digital Civics research area and explains the theoretical framework for this study.

3.1. Digital Civics

Digital Civics is an interdisciplinary research area, in which scholars and practitioners aim to understand how ICTs are supporting models of service delivery, urban organization and citizen empowerment in cities (Olivier & Wright, 2015; Omnydar, 2016; Vlachokyriakos, et al. 2016; Peixoto & Sifry, 2017; Corbett & LeDantec, 2018). In this paradigm, political action is co-produced and jointly owned by means of information, knowledge flows and dialogues between stakeholders.

In this context, ICTs serve as mediators for the information and knowledge flows. The main goal in the field is towards a better understanding of emergent paradigms for urban public service provision, in which citizens; the private and public sectors interact using ICTs (Olivier & Wright, 2015). The overarching idea is that these participatory platforms can offer ways for citizens to play active roles in shaping policies, agenda-setting as well as promoting transparency and accountability. Furthermore, these platforms foster alternative forms of interaction between governments and citizens thereby potentially creating different configurations of relationships between governments and citizens (Boyte, 2010; Olivier & Wright, 2015).

For example, Hackethons characterize such configurations because they are collaborative problem-solving projects involving grassroots, private companies, and governments to develop solutions for urban challenges (Briscoe, 2014). These solutions have often been prototypes of mobile applications developed collaboratively with volunteers of the

civil society and support of government and businesses. Nevertheless, civic engagement in the context of digital civics goes beyond the notion of volunteering. In this context, citizens become actors in commissioning urban services. Which was a vision that considered digital technologies as mechanisms that could potentially reconfigure power relations between citizens, communities, and the state (Olivier & Wright, 2015; Vlachokyriakos, et al., 2016). "We now call this endeavor digital civics, as it uses digital technologies to truly empower citizens." (Olivier & Wright, 2015, p. 2).

Research that has related to themes of digital civics has existed for over 15 years but has been gaining momentum since 2009, due to several worldwide crises such as the Honduran Resistance Movement that used CTs to protest the 2009 "coup d'état". This was considered one of the first of a subsequent wave of international revolts organized with the help of ICTs[3] (Vasquez, 2014).

In the years preceding 2009 the Hondurans were deeply dissatisfied with the repressive and censored political landscape, without institutionalized citizen participation, political dialog, and Civic Technologies. To address these issues, the Honduran civil society joined forces through a protest movement called National Front of Popular Resistance (NFPR) to demand a new constitution. NFPR began civic innovation practices by mobilizing networks of civil society organizations with the help of ICT resources to mobilize, build coalitions, inform, lobby, and communicate. At the time, the ICTs used by NFPR were social media such as YouTube, Facebook, Twitter, websites, email, cell phones, smartphones, radio, television, chat, and SMS (Hagen et. Al, 2015; Vasquez, 2014).

3 In 2008, Anti-austerity protests in Ireland; 2010 Arab Spring in Tunisia, Egypt, Yemen, Bahrain, Syria, Libya, Kuwait, Lebanon, Oman, Morocco, Jordan and Saudi Arabia, Sudan and Mauritania; 2011, Occupy wall street movement USA; and 2011, Los Indignados the 15M Movement in Spain; 2013, Black lives matter (BLM) United States; 2013, June Journeys or Brazilian Spring – Protests in Brazil against raises in public transport, police brutality and corruption. 2014, Venezuelan protests due to high levels of urban violence, inflation and lack of basic goods; 2015-2016 protests in Brazil against corruption denouncing President Dilma Rousseff (Vasquez, 2014).

In 2012, Professor Zuckerman from the Center for Civic Media at Massachusetts Institute Technology (MIT) noticed the increase of technology mediated forms of civic activities and wrote a blog entry about his thoughts on participatory civics. This was possibly the first time the term Digital Civics was mentioned (Zuckerman, 2012). He noted that the concept of citizen has traditionally consisted of the idea of an "informed citizen" which implies that a citizen's role is to understand current issues and therefore participate by voting for their representatives, voting for legislations, contacting their representatives when something is wrong and through referendum. He then suggested that there has been a shift in paradigm, from an informed citizen model to a "rights-based" model of citizenship where citizens have the opportunity and need to monitor governments. He defined this as "Participatory Civics".

In this view, Participatory Civics is characterized by a citizen's interest in finding solutions to their local issues and receiving feedback on their engagement in what they wish to influence. This view implies that citizens wish to have an active role in society because they have been brought up with participatory means of communications and thus have been able to convey their opinions and perspectives to broad audiences through blogs, and social media. This has provided citizens with a sense of how many other people share the same thoughts and political ideas about their cities. Furthermore, Digital Civics has to do with the fact that people are motivated to participate because of specific passions and not necessarily by their interest in political movements (Zuckerman, 2012).

In 2014, the United Kingdom's Centre for Doctoral Training in Digital Civics was created with the aim of researching and developing Civic Technologies that were designed for citizens. The objective was to work with the local communities concerning matters of education, public care, social care, and local democracy. In 2016 the SIG CHI conference hosted a workshop to discuss the possible influence of the field of Human Computer Interaction in

developing and improving Civic Technologies (Vlachokyriakos, et al, 2016). Then in 2018 researchers in the field of Digital Civics came together in Montreal, Canada and formed a community of research that I was invited to join.

Several studies that have examined topics relevant to digital civics. digital civics may not have been used in all these interdisciplinary studies help to characterize the area of Digital civics:

Table 2. Terms

Term	Examples	Definition
Digital Civics	Zuckerman, (2012); Vlachokyriakos, et al. (2016); Corbett & LeDantec, (2018)	Research area aiming to understand how ICTs support models of service delivery, urban organization, and citizen empowerment
Digital Democracy	Simon, Bass, Boelman & Mulgan (2017 p.11)	"The practice of democracy using digital tools and technologies"
E-participation	Hansen & Reinau, (2006); Conroy & Evans-Cowley (2006); Sæbø, Rose & Flak, (2008); Cordoba-Pachon, (2009)	ICT enabled participation – refers to a form of participation.
Participatory Civic Technologies	Olivier & Wright, (2015), Peixoto & Sifry, (2017)	Civic technologies that involve engagement and participation
Participatory Politics Enabled by Digital Media	Kahne & Cohen, (2012)	The use of digital media to engage in political discussion or share civic media.
Participatory Civics	Zuckerman, (2012)	Shift from the informed citizen toward a monitorial citizen by use of ICTs
Technology Mediated Civic Engagement	Desouza & Bhagwatwar (2014)	Platforms created to advance and solve social and policy issues. They enable creation, sourcing, analysis, visualization and sharing of information and knowledge

These definitions have in common, the use of ICTs to mediate interactions between citizens, the public and private sectors, thus increasing the data, information, and knowledge flows between these stakeholders.

Digital Civics is an emerging interdisciplinary area of research within the field of Information Sciences that can be situated at the intersection of: Community Informatics (Stillman, 2009; Gurstein 2000; Mukahergee 2010); Communications (Zuckerman, 2013);

Computer Supported Cooperative Work (CSCW), which focuses on developing, using, or deploying collaborative technologies as well as supporting and understanding the interactions between technologies and socio-political dynamics. Traditionally, CSCW work focused on small groups, but the social dynamics of computing have evolved, and the spectrum of coordinated activity has expanded to larger social systems as technology use has shifted from desktop computing to portable, mobile, and wearable devices, this has been coined the Post-PC era (2006 to date) (Wallace, Oji & Anslow, 201.). Other disciplines include Human Computer Interaction (HCI) (Vlachokyriakos, Crivellaro, Le Dantec, Gordon, Wright, & Olivier, 2016; Corbett & LeDantec, 2018) and Knowledge Management (Mandarano, Meenar, & Steins, 2010; Yigitcanlar, 2018). In addition, it benefits from research in public policy (Linders, D. 2012), governance, geography (Sieber, 2006; Nuojua, 2009, Bugs et al. 2010; Thiel, Fröhlich, Baldauf & Caldwell, 2018), and urban informatics (Nascimento, 2010; Wilson, Tewdwr-Jones & Comber, 2017; Silva & Loureiro, 2015).

3.1.1. From Civic Technologies (CTs) to Mobile Civic Technologies

Civic Technologies (CTs) and Civic tech can be used interchangeably as it is generally understood as technologies which involve collaboration, communication, action, engagement and/or participation in public matters (Olivier & Wright, 2015; Peixoto & Sifry, 2017; Corbett & LeDantec, 2018). Omnydar, (2016) describe Civic Tech as “any technology that is used to empower citizens or help make government more accessible, efficient, and effective.” They contend that Civic Tech may deepen citizen engagement. Similarly, Peixoto & Sifry, (2017) characterized them as ICT platforms that allow citizens to voice their opinions with the intent of improving public services.

Civic Tech has been defined in several ways. For example, Omnydar, (2015) defines CT as any technology that empowers citizens and supports government service provision with the intent of delivering and improving these services. They contextualize these technologies as mediators if civic activities such as: engagement, grassroots movements, shared vision, collective action, and shared identity, usually done voluntarily which can be organized by non-profit groups, governments, and businesses. Stempeck, (2015), from Microsoft provided a high-level definition of Civic Tech: "the use of technology for the public good".

CTs can be built to collectively address solutions to social or technological urban problems; to raise awareness about social issues (such as in the example of the school in Rio de Janeiro- p. 18) or improve aspects of governance (accountability, budgeting, transparency, and participation); the city's infrastructure (such as accessibility and sustainability); and service, delivery (such as digital documents and eGovernment). CTs often involve communication and collaboration among stakeholders (citizens, governments, and the private sector) who are in cities and interact with each other by exchanging information and resources. Moreover, CT may support citizen participation by offering tools that facilitate information[4] and knowledge[5] flows, which can happen between the same kinds of stakeholder (between citizens) or across several stakeholders (between citizens and governments, private sector and interest groups and non-governmental groups).

CTs can be in the form of a websites, portals, blogs, mobile applications, or electronic voting devices. CT websites and portals can inform about civic issues and/or offer civic features such as voting, polls and comments sections have been used to increase the information flows

4 Here, information refers to the data that has been analyzed by the sender of the data (Dalkir, 2017), as well as the civic facts such as updates about issues or events and data to support planning and projects (Desouza & Bhagwatwar, 2014).
5 In this research we approach knowledge as the opinions, know-how and expertise of the agents (Dalkir, 2005). For example, knowledge may become embedded in the solutions exchanged in the CTs such as when the citizens know-how is used to provide solutions to the problems discussed (Desouza & Bhagwatwar, 2014. p.31).

between governments, citizens, and corporations, enable collaboration and in some cases citizen engagement. And more recently, mobile devices have been used for civic activities, mobile Civic Tech (MCTs) refer the mobile applications created in smartphones, tablets, wearable devices such as smart-watches and smart glasses.

Simon, Bass, Boelman & Mulgan (2017) advocate that emerging Civic Technologies may potentially invigorate democratic institutions because local government seem keen to engage citizens in their developments. However, they also admit that it might be too soon to understand their impact. Furthermore, the information and knowledge flows that happen between citizens and governments when using Civic Technologies often happen in short-term engagements. For example, a citizen can report the location of garbage placed in an area it should not be in each neighborhood in real time (SeeClickFix app). This makes it challenging to measure the impact of this form of citizen participation mediated by these technologies at the time this research was conducted. Table 3. Summarizes recent scholarship that explored CTs, the research methods used to classify and explore these technologies and the outcomes and contributions to the DC research area.

3.1.2. History of mobile apps or platforms

In 2006, Smartphones didn't exist, and downloadable apps only appeared one year later, in 2007 when Apple launched the iPhone. The year of 2007 was an important year for smartphone platforms. In the first month of that year, the iPhone was launched into the world market and by the end of that year, it had sold over 4.7 million units. It was ground-breaking because it was a fully touchscreen device. In April 2011, Apple had the largest market share (36%) in terms of revenue. (Arthur, 2012; Berkowski, 2014).

Later in November of that same year, Google announced that the Android operating system would be open source and therefore free to use and modify. In that same month, the

first Android phone (G1) was available in the market. It had limited touch-screen capabilities but also offered a slide-out keyboard. It was only in 2010 that android phones were shipped with fully capable touchscreen capabilities. In July 2011, Android had 43% of the smartphone market (Arthur, C., 2012). Smartphones gained popularity because of the technologic convergences they enabled as well as allowing the people who used them the possibility to develop applications and make them available for purchase in online software repositories and marketplaces such as the Apple app store and the Google Playstore.

Android is a Linux based operating system developed by Google for mobile devices, smartphones, and computers. The software is developed using java programming language libraries and the apps developed for android can access hardware of mobile devices (phone, camera, microphone.); data and information about the user (contacts, history, messages.) by employing its API (Application Programming Interface) (Rahman, 2013).

It's an open development platform that enables anyone with the appropriate know-how to develop their app and showcase them on Google Play, the official open app repository for Android apps (Google Play, 2018). Google Play provides information about users rating about the apps, number of downloads, description, price, app version, system requirements (Android version that can run a particular app) and features of the apps (Appendix D: Playstore Data).

3.1.3. Mobile Features and Sensors

They offer a multimedia features such cameras, sound input and output devices and video, which has enabled people to record elements of their daily lives and enabled other users to search for this kind of data which has been made available through social media. They are equipped with sensors such as GPS, location detection, direction, movement, temperature, touch, light, noise, (Crestani, Mizzaro, & Scagnetto 2017). This is important because these

devices are immersed in real world contexts, moreover they are location and context aware. This has enabled different ways of technology mediated civic involvement, reporting and engagement from those performed in desktop computers. For example, location metadata available on images can inform of where a photo was taken and what was in the image, and this can be useful for security officials and to address issues such as displaced garbage.

Moreover, mobile devices are not isolated in nature, Bluetooth, wireless and cloud computing enables these devices to communicate and integrate their data with desktop computers, wearable devices (such as watches, glasses, and armbands) which can monitor human motions and gestures. All these features and sensors offer opportunities as well as challenges. This is a nascent field of inquiry and will possibly become an interesting topic in the following years (Crestani, Mizzaro, & Scagnetto 2017).

Sensors are hardware and software built-in mobile devices. They are used to detect environmental states and changes such as location (GPS and Gyroscope), light (ambient light sensor), temperature (thermometer), humidity, gas substances, and sound (Microphone), distances (accelerometer and pedometer) (Cho, 2020; Geeks for Geeks, 2020).

MCTs have deployed sensors such as the Global Positioning System (GPS), to determine and report on the precise location of local issues. Some examples from the data-corpus of this thesis are CittaMobi app, which uses the GPS to help passengers find the precise location of the next bus. OTT app uses the GPS to determine the precise location where gun violence occurs in real-time. Quick Response (QR) codes have been used to help lost tourists find their locations when GPS was not available in remote locations and national parks (Lorenzi, Vaidya, Chun, Shafiq & Atluri, (2014). More recently, during the COVID-19 pandemic, proximity sensors have been used to ensure social distancing and potentially reduce the spread of the virus (Bian, Zhou & Lukowicz, 2020; Mohapatra & Rath, 2020)

The table3 bellow lists the sensors available on mobile devices (Priyadarshini, 2018; Cho, 2020). It summarizes the functions of these sensors, if they are or not used in MCTs, if there are applications for addressing local issues and how they are used in MCTs based on examples of scholarly research available at this time.

Table 3. Mobile device sensors

Sensor Name	Function	Is it used in MCTs	Uses and example
Accelerometer	Detects acceleration, vibration, and tilt	Yes	Generally used when taking pictures.
Air Humidity	Measures the humidity in the air	Future	Could be used to alert citizens of potentially dangerous levels of humidity in the air (for example in desert and extremely dry locations such as Brasilia, the Brazilian capital)
Ambient light sensor	Detects the level of light in the location	No	To date, could not locate
Barcode and QR code	Detects reflected light from barcodes to retrieve information contained in Bar codes and Quick Response (QR) codes.	Yes	According to Lorenzi, Vaidya, Chun, Shafiq & Atluri, (2014 p.7), QR codes, facilitate data entry and management for local governments. For example. It can be used as a Way pointing system when navigating the park trails and if visitors get lost and can't find the next trail QR codes, may be used in the events of a GPS failure or loss of cell signal.
Geiger Counter	Measures radiation levels around device's location	Not in the data-corpus	
Gyroscope	Provides data about the device's orientation	No	
GPS	Global positioning systems (GPS) sends and receives satellite signals to determine the device's precise location.	Yes	In MCT local Issue reporting apps, Research Question 1.a. the GPS can be used to provide the precise location of shootings for example, the app OTT uses the GPS to detect the location of gun shootings.
Heart rate sensor	Light emitting diodes and the optical sensors find waves that they reflect, measuring pulse rates.	No	Commonly used in fitness apps. Could not find an example used for MCTs.
Proximity sensor	Detects how close the Mobile device is to another object	Yes	In MCT health apps, it can be used to enable alarms to ensure social distancing in pandemic situations. The objective was to contain further infections (Bian, Zhou & Lukowicz, 2020; Mohapatra & Rath, 2020). Generally, uses the infrared Light Emitting Diode (LED) to disable the touchscreen of the device, when making phone calls.
Microphone	Is a sound sensor used to measure and detect sound levels	Yes	Santini, Ostermaier, & Adelmann, (2009) and Garg, Lim, & Lee (2019) explored methods to calibrate smartphone microphones to detect noise pollution. Noise pollution is a concern in large cities and MCTs, could provide governments noise-pollution data to address this problem.
Pedometer	With the help of the accelerometer, it counts the steps of the user	No	To date, I could not find examples or studies where the pedometers are used as features in the MCTs
Thermometer	Measures the temperature of the device. Prevents the smartphone from overheating. Some can also measure the temperature of the location where the device is.	No	To date, I could not find examples or studies where the thermometers are used as features in the MCTs

Sensor Name	Function	Is it used in MCTs	Uses and example
Touchscreen Sensors	Display that allows control of the device's information.	Yes	All apps use touchscreen

E-participation are the civic participation activities (such as voting, town-hall meetings, deliberations, ideation) supported by ICTs. Interesting opportunities have emerged during the transition from e-Participation to m-participation. Mobile engagement is not a simple extension for e-Participation but rather a platform that enables creation of different services due to the combination of features it supports (de Reuver, Stein & Hampe, 2013). Initially, M-government platforms enabled one-way information flows, which did not include interactive elements such as social media integration, which would not be considered participatory. In the early 2000s, these platforms primarily included features such as SMS, emergency alerts, job-postings, and parking services (Barns, 2020).

3.1.4. Civic Tech: privacy, surveillance, and trust

Several authors agree that shifting civic services online, can lead to privacy concerns (Martínez-Pérez, De La Torre-Díez & López-Coronado, 2015; Zubboff, 2019; Morozov, 2019; Singer & Choe, 2020 as cited in Sharma & Bashir 2020) In Zuboff's (2019) The Age of Surveillance Capitalism, personal data is sold as commodities to companies that aim to manipulate the public. She warns about the dangers of a market, where businesses buy and sell predictions of human features for profit and considers this as a threat to human freedom and autonomy, indispensable to modern democracies. Her view is of a dystopia, where citizens are controlled totalitarian surveillance capitalists. Van de Donk and Tops (1992) also shared the deep pessimistic thoughts about electronic relationships between governments and citizens and defended those technologies were catalysts for social control

Zubboff (2019) also warns about the humanitarian risks involved when companies like Google or Facebook claim to "restructure and solve the world's problems" (Morozov, 2019).

By creating technological disruptions that serve a "social good", she claims that these companies have lobbied and safe-guarded themselves against public scrutiny. Zubboff (2019) also warns of the lobbying Google and Facebook do, to "kill online privacy protection, limit regulations, weaken or block privacy-enhancing legislation, and thwart every attempt to circumscribe their practices" (p. 105).

The logic of surveillance capitalism makes sense, when analyzing mobile apps. Because these apps often request access to sensitive data, such as the location, constantly tracking the activities of the users. In 2015, Martínez-Pérez, De La Torre-Díez and López-Coronado explored the features of mobile health apps and found security breaches in the distribution of these apps. They analyzed the existing European and American health laws and the literature about the topic to provide recommendations to guide app developers and researcher when developing mHealth apps that support privacy rights of citizens. They concluded that the existing European and American laws did not focus specifically on the privacy of mHealth apps and were either "too open or too old" (Martínez-Pérez, De La Torre-Díez and López-Coronado, 2015 p. 6). Suggesting that legislations needed to be updated to address the privacy concerns of mHealth apps. This is also a suggestion from Zubboff (2019 p. 485), because legislation "can shift the tide of public opinion against unexpected sources of oppression and injustice"

During the COVID-19 pandemic, governments of South Korea, China, Israel, and Singapore, launched tracking apps to control the pandemic. These digital surveillance apps seem to be effective ways to contain the spread of the virus, but they pose risks to privacy rights of citizens. Sharma and Bashir, (2020) analyzed 50 COVID-19 apps from the Google Play Store and found that most of them (n=30) required access to sensitive data in users' mobile devices such as contacts, photos, media, files, location data, camera, device ID, call

information, WIFI connection, the microphone, full network access, Google service configuration, to change network connectivity and audio settings. Some apps even stated that they will collect information about the person's age, email address, phone number and postal code; the device's location, unique device identifiers, mobile IP address and operating system; and the types of browsers used on the mobile device. Only 16 of the 50 apps indicated that the user's data was encrypted or made anonymous, (Sharma & Bashir, 2020 p. 1165). Martínez-Pérez, De La Torre-Díez and López-Coronado (2015) suggested using an encryption key of 192 or 256 bits, to improve security and confidentiality.

Sharma & Bashir (2020) warns us about the privacy access of mobile, more specifically mHealth. But these concerns can also be extended to the notion of civil rights, as proposed by Cahn (2020) "We could so easily end up in a situation where we empower local, state or federal government to take measures in response to this pandemic that fundamentally change the scope of American civil rights" (Singer & Choe, 2020 as cited in Sharma and Bashir 2020 p.1166).

3.1.5. Systems

To better understand CTs, it is useful to understand what systems are. Systems represent the elements that interact or work together to form a complex whole that operate in unison. Systems have boundaries, but they can also be influenced by their environment (Joslyn & Turchin, 1993; System, n.d.). Figure 4 illustrates the elements of a system.

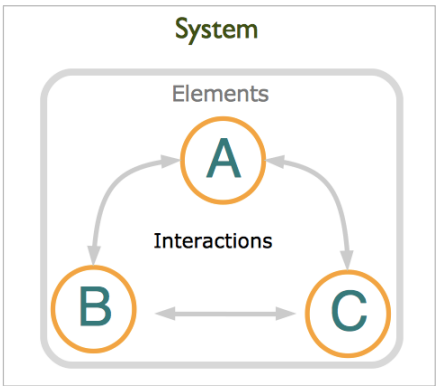


Figure 4: Illustration of a system

Systems theory is therefore a useful conceptual approach to describe MCTs. In Systems theory, the world is viewed as a complex system of systems with interconnected parts. Furthermore, in a complex world, it is always possible to find different types of organization, which can be described by concepts and principles. The systems' approach emphasizes the interactions and connectedness of the different components within the system as well as the interactions of external elements with that system (Heylighen, Joslyn, & Turchin, 1999).

For system theorists, there are two types of systems: closed systems and open systems (Bertalanffy, 1968). Open systems interact among their internal elements and the external elements in the environment. On the other hand, closed systems are studied in isolation from their environment. CTs are therefore open systems that have external interactions. These interactions between the system and the environment are separated by boundaries and have two components, inputs, and outputs. Input refers to the elements that enter the system from the outside and output, the elements that leave the system (Figure 5). The output is usually different from the input because systems as not just passive but active mechanisms (Heylighen, 1998).

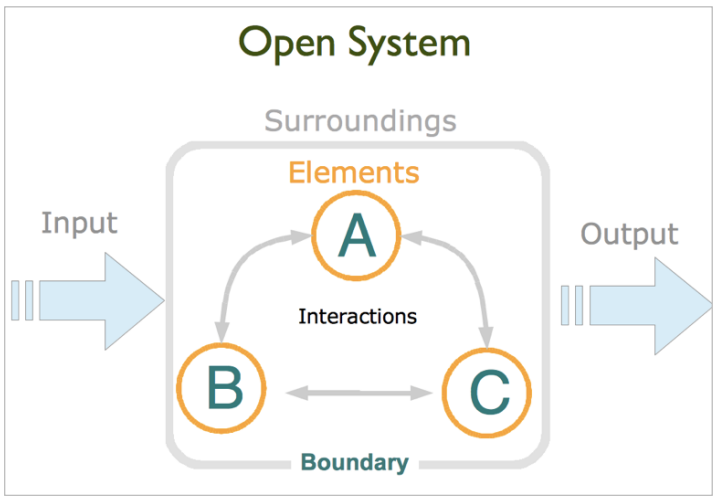


Figure 5: Illustration of open systems

CTs are systems, they are open systems, and as such, they have a set of components, which interact amongst themselves and with its environment to function (Heylighen, 1998).

Systems Theory recommends that a system should not be studied in isolation but from the perspective of regularly interacting components or interrelating groups of activities (Bertalanffy, 1968). Figure 6 (Interaction of CT System Components) shows the components which interact in CT systems: Agents, Attractors, Participation Medium, Technological Capabilities Flows and Goals. (Desouza & Bhagwatwar, 2014; Ramage & Shipp, 2009; Churchman, 1971; Bertalanffy, 1968;). Each is described in further detail below:

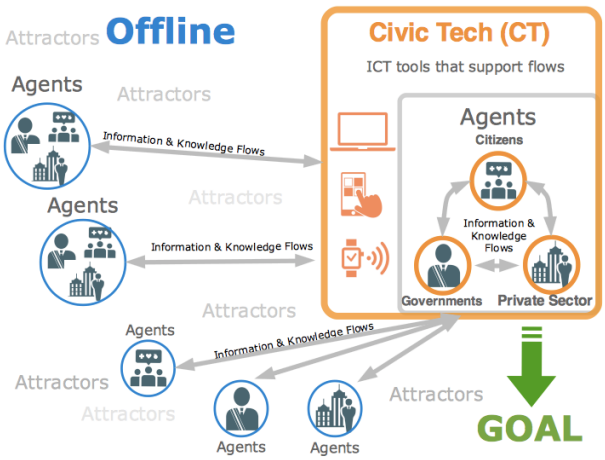


Figure 6: Interaction of components in the CT (adapted from Desouza & Bhagwatwar, 2014 p. 30)

Each CT has its own set of technical capabilities which support the flows of information and knowledge. These help the agents share information, debate their ideas, vote on policies, and give feedback about the participatory projects as well as on the CT. For example, messaging and social networking capabilities support information flows between stakeholders, GPS tracking helps to physically locate where issues occur, and access multimedia (such as photos, microphone and camera) allow stakeholders accurately document local issues using images, sound and videos.

3.2. Theoretical Taxonomy of CTs

“Theories are adopted because they enable and guide a researcher to analyze, explain, predict and prescribe a phenomenon in its context.” (Twinomurinz & Johnson, 2015. p. 01). After reviewing the literature in digital civics, it was found that exploring the objectives, flows of data, information and codified knowledge and technological feature of the apps where the three main topics that were under explored in the literature and there was a need for further frameworks that could classify and clarify MCTs. For example, Desouza and Bhagwatwar, (2014. P.27) explain that: "The limited theoretical understanding of technology-enabled participatory platforms calls for a need to develop frameworks and classifications that would help analyze these emerging platforms better". When building a typology for civic collaboration in the digital sphere, Linders, (2012 p. 447) argued about the utility in building classifications for civic technologies: "In building such a framework, a concrete typology – meaning a classification scheme that groups items with shared characteristics into a finite set of types – is essential for determining where observed phenomena!". This research started in 2012 and in 2016, Civic tech was "taking off" (Stempeck, 2016). Moreover, the frameworks, classifications and taxonomies available at the time were insufficient to characterize CTs and MCTs.

Traditional forms of civic engagement (such as town-hall meetings, regular voting and contacting officials) had been well documented. There was a need to further understand the nature of technology enabled civic engagement (Desouza & Bhagwatwar, 2014). This was a framework that built on existing studies in Digital Civics and focused on the objectives, the interactions and technology features of Civic Technologies – more specifically, Mobile Civic Tech (MCTs).

Table 4 illustrates the Technology-Enabled Participatory Platforms for Civic Engagement (TEPPCE) framework . It mapped the state of CTs in the USA and can help us to

understand the flows of data, information and codified knowledge (8. Data, Information and knowledge flows and 11. Agents); the Objectives (5. Goals, 6. Attractors) of the CTs and their Technology features (7. Medium, 9. technology features,) and levels of Civic Engagement (6. Engagement). This framework was used as a deductive starting point to find themes in the Brazilian MCTs and was replicated and extended to the data corpus collected for this research.

Table 4. TEPPCE Framework

#	Themes	Definition	Codes and categories found
1	City	The city that the platform was developed and used	Various cities
2	Platform name	Platform name	Various Names
3	Founders	Organization or person that created the application	Various Organizations
4	Year	Year the application was created	Various years
5	Goal	Is a description of the aim of using the CT.	information, collaborate, engage, citizen input, vote for ideas.
6	Attractors	Problems and opportunities that stimulate citizens to participate, for example: Local Issues, Information Access and Sharing.	Local issues; Information access and sharing; monetary incentives.
7	Medium	Tool and way in which these technologies enabled civic engagement.	Online only, Online & Offline
8	Data, Information and Knowledge Flows	Information and knowledge flows support civic engagement activity.	Citizen to citizen (C2C); Government to Citizen (G2C)
9	Technological Features	The technological features enable the flow of information and knowledge between the agents	Maps, Real-time feeds; Discussion boards; voting informational website
10	Engagement	Modes of technology mediated engagement	Mode 1 (M1): Citizen Centric and Citizen Sourced data; Mode 2 (M2): Citizen Centric government Open data; Mode 3 (M3): Government-centric citizen-sourced data; Mode 04 (M4): Government-centric Citizen-developed solutions
11	Agents	Stakeholders that participate on the platform.	Citizens and Government

The following sections define the themes from the TEPPCE framework and explain their use to address the Brazilian MCTs.

3.4.1. Objectives: Local Issues and Attractors

Desouza and Bhagwatwar (2014) define attractors as the events or issues that prompt the citizens, governments, and the private sector to use the CT. This is an important aspect of the conceptual framework, and it allows understanding of the motivations to use the CTs. The main attractor identified in the TEPPCE were local issues and specific problems or even opportunities that attract agents to participate on the CT. These were local issues such as misplaced garbage, accessibility issues that incite the stakeholders to participate and use CTs to exchange ideas, discuss policies or mobilize collective movements that happen offline.

Attractors in the TEPPCE also included provided by the CT can be an attractor as there are agents who are interested in data mining. They can participate by contributing data, but they can also analyze this data. And finally, the network stakeholders that participate and contribute were also regarded as attractors because these are the key people who influence others to participate using CTs to contribute their opinions.

3.4.2. Goals

Refer to the way these CTs promote civic engagement or allows citizens to communicate with government. For example, the platform SpeakUpAustin, allows for citizens to post ideas of projects in the city, deliberate in existing ones as well as voting on the projects they regard as important. As SpeakUpAustin allows for communications, voting and deliberation, other platforms provide tools to raise awareness, promote transparency, improve social or infrastructural issues as well to support decision-making (Desouza & Bhagwatwar, 2014).

3.4.3. Interactions: Stakeholders or Agents

The CTs support interaction between the stakeholders that use these ICTs. The stakeholders or agents refer to the citizens (civilians and non-governmental organizations, businesses and private organizations). They create and exchange information and knowledge about the issues in cities to try to resolve them and interact amongst each other using CTs to exchange information as well as services.

Citizens and the Civil Society are the individuals who live in cities and are entitled to rights, privileges, and protection. They are civilians distinguished from a specialized servant of the state (Citizen, n.d). They can be understood as clients of governments and private institutions (McNeil, 2016) and represent non-governmental organizations (NGOs) and institutions that act in the interest of citizens and do not aim for profit (Cohen & Arato, 1994. p.ix).

Public Sector, or local government represents the governing bodies responsible for managing cities, in other words, the administration of a city, county, municipality or district where the representatives are elected by those who live there. Local government can be used interchangeably with province, public sector, department, county, prefecture, district, city, township, town, borough, parish, municipal government, municipality, shire, village, and local service district (Longworth, 2006).

Businesses or Private Sector (P): represent the organizations that are run by individuals and companies for profit and that are not owned or operated by the government (Private Sector. n.d).

Non-Governmental Organizations (NGOs) and Interest groups (IG) are groups formed by the civil society and are not associated with the government (Willets, 2001). Interest groups (I) represent citizen groups with shared concerns, who aim to influence public policy. The term

interest groups has been used interchangeably with advocacy groups, pressure groups or associations (Gozetto 2000; Thomas, 2021).

3.4.4. Flows

CTs offer a way to facilitate data, information, and knowledge flows to support civic participation. Data represent the facts that are directly observable or verifiable (Dalkir, 2017. p.517); Information refers to data that has been analyzed (Dalkir, 2017. p. 519). Such as the events about participatory projects that facilitate planning and analysis (Desouza & Bhagwatwar, 2014) and Knowledge refers to the: "opinions, expertise, and know-how that are shared on events, artefacts, and systems being considered by the community on the platform. Knowledge can be embedded into solutions that are exchanged on the platform. For example, citizens can share solutions that are the products of the application of their knowledge and expertise" (Desouza & Bhagwatwar, 2014 p. 31). Knowledge therefore represents a basis for intelligent, competent behavior in all levels of society (individual, group, and organizations) (Dalkir, 2005).

For Wenger (1998) knowledge is an aspect of participation. He describes participation as "the process of being active participants in the practices of social communities and constructing identities in relation to these communities" (Wenger, 1998. p. 04). In other words, participation is both personal and social, therefore it refers to the individual's social experience in social communities and his/her active involvement in society. Wenger, (1998) goes on to explain that his view of participation encompasses the processes of actively participating in the practices of social communities as well as constructing identities in relation to these communities to produce a sense of belonging.

These flows of data, information and knowledge can happen among one type of stakeholder (among citizens – citizen to citizen) or amongst multiple stakeholders (between

governments and citizens – government to citizen and government to private) (Desouza & Bhagwatwar, 2014).

3.4.5. Engagement

To answer the question of what level of civic engagement current CTs enable, Desouza & Bhagwatwar (2014) analyzed CTs in the 25 most populated cities of the USA and classified the platforms within the context of Arstein's ladder (Figure 7). They developed a taxonomy that classifies the levels of participation and represents the information flow between agents that the 25 CTs foster into 4 modes (for example: From citizen to citizens, citizen to government.). Mode 1 refers to the lowest level of participation whereas mode 4 is the highest. Figure 7summarizes the classification framework, and each mode is explained.

Mode 1: Citizen-Centric and Citizen-Sourced Data

These are CTs built and maintained by citizens. In this mode, citizens discuss local issues and generate ideas to solve problems in their neighborhoods by using CTs. Therefore, knowledge is created by the citizens and then shared with public and private organizations that then decide what to do with that information. If applied to the Arnstein's Ladder of Participation, Mode 1 would fit under the tokenism-consultation level, which represents a limited interaction between citizens and governments – not an ideal form of participation (Arnstein, 1969).

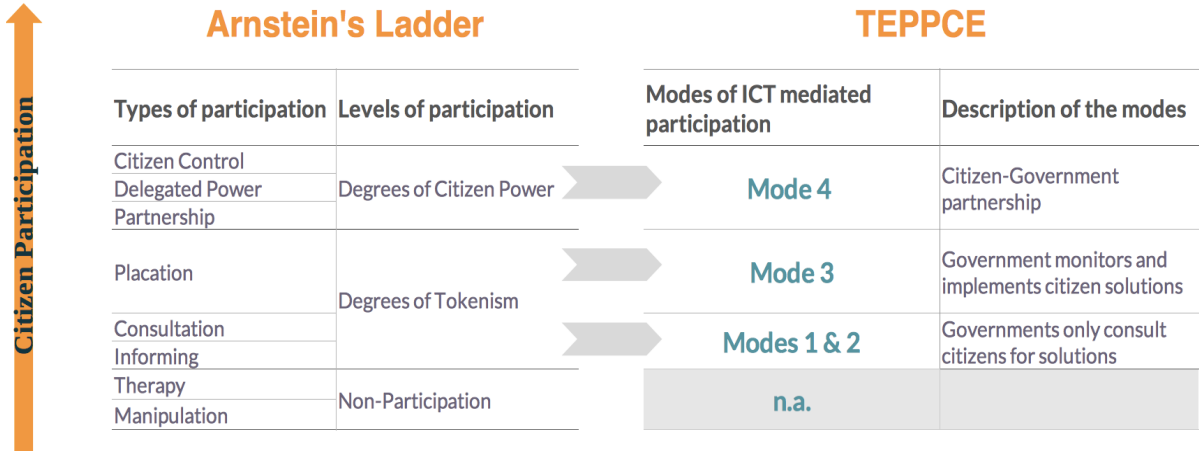


Figure 7: Adapted from Desouza & Bhagwatwar (2014, p.45)

Mode 2: Citizen-Centric and Government Open Data

Also, citizen centric, but the data is provided by governments, then citizens seek the information they need, sometimes providing feedback, comments, or suggestions. This is usually done with unused government data (either for lack of funds or personnel) that is made available to citizens to find solutions for the problems in their neighborhoods. Nevertheless, Mode 2 can also be considered a tokenism-consultation level of participation because the public agencies make the final decisions.

Mode 3: Government-Centric and Citizen-Sourced data

In this mode, public agencies and citizens are near-equal agents and the information flow occurs in both directions. In mode 3, both actors are motivated by the common goal of resolving a local problem. In this case, public agencies informed the citizens and later, citizens provide their insights and knowledge as well as communicating amongst each other. For Desouza & Bhagwatwar, (2014), mode 3 involves a higher level of participation and can be represented by the tokenism-placation level in Arnstein's ladder of participation.

Mode 4: Government-Centric and Citizen-Developed Solutions

Requires participation from all agents where collective citizen intelligence is leveraged to design solutions for the problems that were identified earlier. It is different from mode 3 because the outputs are actual solutions (such as mobile applications). For Desouza & Bhagwatwar, (2014) mode 4 is the most participative and corresponds to the citizen power-partnership level in Arnstein's Typology.

3.4.6. The Technology

Mobile Civic Technologies provide ubiquitous, real-time, and mobile forms of civic engagement. This can offer advantages, but also risks for civic activities. For example, people carry their phones, make purchases, listen to music, and find their way around. This means that they can engage at any time because mobile devices had become ubiquitous and some hurdles that limited citizens' abilities to engage with ICTs had significantly reduced. In parallel, the technical and financial divides between those who can afford the technology and those who cannot has also been decreased (Reuver, Stein & Hampe, 2013). This has enabled the development and mainstream use of large mobile platforms such as uber, google maps, Facebook, and WhatsApp. These are examples of large proprietary apps that have enabled and shift in paradigms for urban mobility, civic communication, and organization (Barns, 2020).

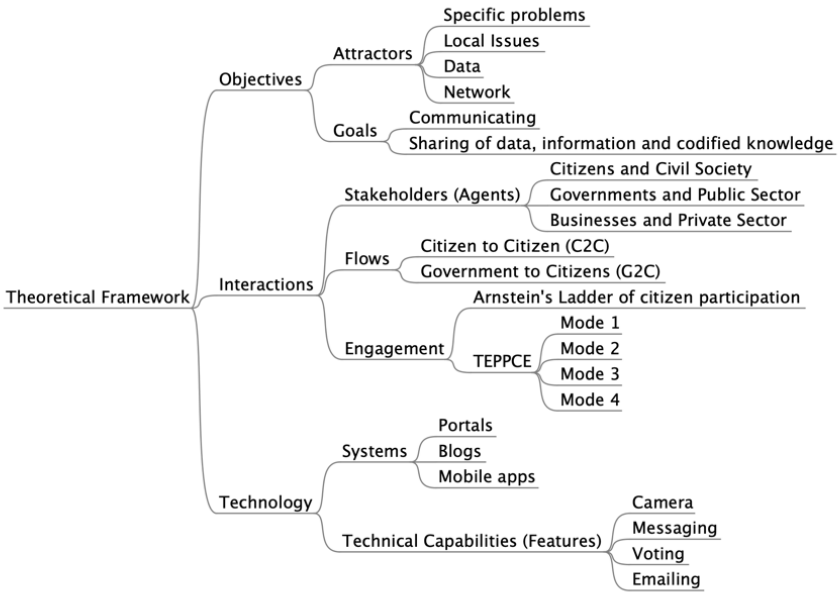


Figure 8: Theoretical Framework

The theoretical framework on Figure 8 was designed to help answer the research questions based on concepts that influence the understanding of MCTs according to the literature reviewed as well as helping to guide this research (Labaree, 2009). Each of the concepts in the framework was explained in this chapter and contextualized in the context of other studies (Table 3). In the next chapter the methodology used to validate and extend the TEPPCE framework is explained.

The first topic refers to the objectives of these technologies. Previous research had only touched upon the subject but did not carefully identify what these ICTs aimed to address specifically. For example, the TEPPCE framework only identified these as local issues but did not identify what kind of local issues these apps aimed to address (Desouza and Bhagwatwar, 2014).

The second issue regarded the interactions that happened when these apps are used. This is a relevant question within the information studies scholarship, more specifically in Knowledge Management (KM) because an important objective in KM is for the appropriate knowledge, to be in the right place, at the right time, to the people who need it. Therefore, the

flow of knowledge is important (Nissen & Levitt, 2002; Borghoff & Pareschi, 1998). This is also a topic within community informatics as it is an area that has investigated technologies applied to civic matters and community development.

Last, the third topic related to the technology and the features that were used. When this research design was proposed, there were no classifications of frameworks that specifically focused on mobile Civic Technologies. The following table 5 resumes the literature regarding the topics discussed above.

This research is rooted in a specific theory, the TEPPCE framework which accessed the Civic Technologies in cities in the USA. The purpose of this chapter was to connect the reader with existing knowledge about the field of Digital Civics and Civic Technologies that would inform the objectives of this research. It includes a framework that specifies the scope of this research (objectives, interactions, and technology) based on the review of the literature pertinent to the objective of this thesis which was to explore the Brazilian MCTs.

3.3. Research questions

Research Question 1: Question of What and How (Explores the objectives)

1.a. What civic issues do these platforms address?

1.b. How do they claim to address these issues?

Research question 2: Question of Who, What and How (Explores the Interactions that happen when these platforms are used)

2.a. Who are the actors (Stakeholders), what are the information and codified knowledge flows that occur when these platforms are used?

2.b. What types of engagement do these MCTs aim to address?

Research Question 3: Question of What (Explores the technologies deployed in these platforms)

3a. What are the technology features of these platforms that enable these information and knowledge flows?

3.4. Summary

Several studies have been carried out by researchers to understand the nature of technology mediated civic engagement for addressing urban issues. However, conceptual, and theoretical knowledge about the nature of CTs is limited to date, few studies no found that focused exclusively on Mobile Civic Technologies (Evans-Cowley & Kubinski, 2015). Several studies have focused on web-based civic technologies and CTs (Desouza and Bhagwatwar 2014; Gun, 2021). Furthermore, after an exhaustive review of the literature, it was also found that there were gaps in exploring and three main topics related to CTs: the objectives of the CTs, the Flows of Information, Data and Codified Knowledge and the Technologies. Figure 8 and illustrates the theoretical framework.

Chapter 4- Methodology

4.1. Introduction

This chapter outlines how the data was acquired to respond to the research questions. The aim of this chapter is to describe the steps taken to collect the data, the data sampling process, and the steps for analysis of the data.

This was exploratory qualitative research that aimed to understand more about the MCTs that were being developed and used in Brazil. At the time this research was designed, there were no lists of MCTs or pre-existing categories in the Appstores. The TEPPCE framework is helpful because it mapped the state of CTs and MCTs in the USA. It can therefore help us to understand the landscape of technology mediated engagement. The method used to arrive at the TEPPCE framework was qualitative. This framework was a deductive starting point used for the MCTs in Brazil.

> For those more familiar with quantitative research techniques, the methods used in qualitative research may, at first look, seem ineffective. However, it is important to realize that qualitative research is not trying to answer the same questions that are asked in quantitative research. For those more familiar with quantitative research techniques, the methods used in qualitative research may, at first look, seem ineffective. However, it is important to realize that qualitative research is not trying to answer the same questions that are asked in quantitative research. In short, in comparison to quantitative, qualitative research focuses on words rather than numbers, depth rather than breadth. Its methods are exploratory; they seek to unearth the opinions, thoughts, and feelings of respondents. It is most commonly used to help inform new concepts, theories and products
>
> (OnePoll, 2017. p.01)

This was exploratory research that aimed to explore the phenomena that was new at the time this research was designed. An advantage of using a qualitative method is The literature indicated that there was a need to develop frameworks and to understand more about the nature of these technologies. The TEPPCE was evaluated as an appropriate model to replicate, because it was able to show a panorama of these apps in the USA. Quantitative studies focus on quantifying the data, it was unknown how many Brazilian MCTs could be found. This research started in 2012, a time when these MCTs were beginning to gain momentum in production and development in Brazil it was an ongoing phenomenon and very little was known about these apps. It was unknown how many MCTs could be found. Now, in 2022 however, many MCTs have gained maturity, this opens new avenues to use different approaches, especially positivist approaches.

Due to the interdisciplinary nature of this research area, topic and my interdisciplinary research background, After the data was collected, it was suggested, then attempted to use cluster analysis on the data-corpus. Cluster analysis is typically used in statistical data analysis. the aim of Thematic analysis is to code data into similar patterns, categories and themes and clustering helps to see pieces of a larger puzzle. I tried to answer this, by including the data from my dissertation to a database in Waikato Environment for Knowledge Analysis (Weka), with a clustering algorithm for my data-corpus. I couldn't work with the output from those numbers because the results were binary Yes/No. Clustering is usually applied in non-binary data. However, in the findings chapter I speak about the apps that clustered several app features together.

Several methods and different data sources were used to collect data for this study and help answer the research questions. First, the MCT app descriptions available in the Google Playstore (n=90) were selected as part of the primary data. These were collected based on a

selection criterion outlined in section 4.4.1. Second, documental sources (n=270) were selected for to triangulate the information from the 90 app descriptions. They were selected by performing a search query on Google search engine to find documents related to each MCT. The documents selected to be read and triangulated were news reports about the MCTs, Scholarly articles, social media videos and screen captures of the apps. The apps were also emulated to test if they worked and if there were more exploratory data to be gathered through this method. These were the secondary data and are described in more detail on section 4.4.2. Last, formal interviews were made with 9 informants. They were recruited by the email contact details available on the app description of the app stores. All of the 90 app developers were contacted but only 9 were able to participate in the interviews. Section 4.4.3 describes the interview procedure in detail.

The remaining parts of this chapter includes the descriptions of the data corpus, mobile apps, secondary data selected and the informants for the survey. The workflow for data science (GUO, 2012) that was adapted to help illustrate how the application of the method. Then the steps taken to ensure the rigor (section 4.8) of the research are discussed such as reliability, validity, and the ethical concerns, including those involved with information privacy.

4.2. Study area

In its recent history, Brazil[6] has been through extensive democratization and progress towards economic stability (period called the sixth republic, from 1985 to present). After two decades of military dictatorship (1964 to 1985), the mid 1980's were a new hopeful beginning

6 Brazil is a federal system with 26 states and a federal district, the government is divided into federal, state, and municipalities. A municipal government can pass its own laws, as long as it does not conflict with state or federal laws. Municipal governments are separately elected and follow the guidelines and laws as set out by their province. However, they are allowed to pass additional acts that are unique to them. In Brazil, there is no minimum or maximum population requirement for municipalities or local governments (Governo federal, n.d.).

for Brazilians where democratic innovations such as participatory budgeting flourished. The hardships endured during the non-democratic years were transformed into ideas that shaped the democratic experiments in the years to come. This resulted in attempts to create an accountable and responsive democratic state. The democratic innovations such as participatory budgeting, sectorial policy councils and conferences at every tier of government, are considered vessels for expressions of citizenship and democracy in Brazil (Cornwall, 2008). After the beginning of the sixth republic, the Brazilian political system became a liberal representative democracy, which fostered a greater breadth of opportunities for citizen participation. However, the inequalities of income, wellbeing and power have also been maintained. Social movements have struggled towards diminishing these problems (Barros et al. 2007; Cornwall, 2008), which led traditionally excluded people to demand basic services. This resulted in significant democratization of access to services in several of the Brazilian cities during the beginning of the 2000s, such as improvements in universal medical care and significant reductions in mortality rates (Cornwall, 2007).

Its historical struggles, its large population (206,154,820 in Jul 2016 – IBGE, 2016), its civic innovations and the fact that it is a relatively young democracy (just over 30 years) make Brazil an interesting country to be explored. Another reason for choosing to study this country is because I am from Brazil. I am familiar with the context and as a native speaker of Portuguese; this will facilitate access and interpretation of information regarding Brazilian MCTs.

4.3. Data Collection and Sampling

There were several methods of collecting data in this research, including 1) MCT App descriptions from on the landing page of each MCT app in the Google Playstore 2) Secondary data collection regarding each MCT app news reports, scholarly articles social media videos, screen captures of each of the MCTs and the app itself to be emulated in an emulation software

for triangulation and 3) Formal interviews with relevant actors for the MCTs. All the data-corpus was available in the Portuguese language and was collected by the principal researcher. As a native Portuguese speaker and familiar with the Brazilian context, thus was able to analyze and interpret the written content, which was available on the app descriptions and secondary sources.

4.3.1. MCT App descriptions

Publicly available written descriptions about 90 MCTs were extracted from the landing page of each app in the Google Playstore. Figure xx illustrate how the landing page of one of the selected MCTs, COLAB looks like below.

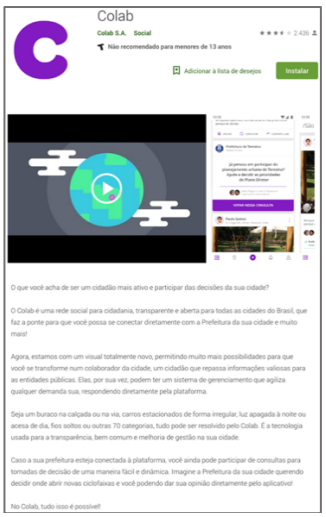


Figure 9: Google Play Landing page MCT description of COLAB app

These apps were available for the Android operating system and were chosen because at the time, 94.2% of mobile devices in Brazil, could be deployed in that operating system. The app descriptions are provided by the stakeholders that developed or designed the apps and they reflect their understanding about the terms used. Therefore, the quality of this information can be contested because these descriptions often reflect the app owner and developer aspirations for the MCT. Nevertheless, it is not the objective of this dissertation to access the quality of

the app descriptions, but rather to access the characteristics of these MCTs and to respond the research questions proposed in this research.

The main criteria for collecting the data corpus of Brazilian MCTs were to search for app descriptions that included information about civics and local issues. Some of the main keywords related to CT in these descriptions were citizenship, civics, e-documents, and participatory app. The following section about the application of the method (section 3.5) explains the MCT app description criteria in detail. All the original app descriptions that were part of the data-corpus used in this dissertation are available at the following web address: https://bit.ly/3FQ3dL4.

4.3.2. Secondary data

Evidence that could substantiate the MCT app descriptions were derived from various sources including local news reports, web pages, scholarly articles social media videos, screen captures of each of the MCTs and the app itself to be emulated in an emulation software. A total of 270 documental sources were read, analyzed, and triangulated to corroborate the findings from the MCT app descriptions. Again, only publicly available sources were selected as part of this data collection. The detailed explanation of the criteria for selecting these secondary sources are explained in the following section 3.5 of this dissertation. Only a selection of these documents is presented in this work, to highlight the key findings and examples relevant to the research questions for this research. All the secondary sources for each of the MCTs selected for this study are available in the following web address: https://bit.ly/3FQ3dL4.

4.3.3. Formal Interviews

Formal interviews (n=9) were conducted in the McGill University approved telecommunication platform Microsoft Teams. The informants were composed of developers

and directors of the MCTs and were recruited in July 2021 following McGill Ethics board (REB 2) approval on June 28, 2021 (Appendix J). All interviews were conducted over three months from August to October 2021. The interviews were conducted following a scheduling timeline set by the informants. The formal interviews (n=9) were developed to be triangulated with the data from the Primary (app descriptions) and Secondary Data (documental sources). The interviews protocol served as guides for the interview, which was a survey made in an open format (informants were given freedom to elaborate on the questions). The questions were formulated so as to triangulate the findings from the previous part of the study and were intended to inform the three research questions. They were conducted over the McGill University's approved telecommunication platform, Microsoft Teams. They represented the following apps: Cittamobi, Hemogram, As Diferentonas, Cade o Meu Onibus, Zona Azul facil, Onde tem tiroteio (OTT), Tarifa taxi POA, 156 POA and E-titulo).

The informants were recruited in July 2021 following McGill Ethics board (REB 2) approval on June 28, 2021. The interviews were conducted with the stakeholders that developed, used, and owned the MCT. Their contact information was available on the landing page of the app description in the google Playstore. This was the contact information used to invite the informants to take part in the study. They were informants identified themselves as taking part in different roles in the MCTs.

All interviews were conducted over three months from August to October 2021 following an opportunistic scheduling timeline set by the informants. The recruitment of the informants happened three years after the MCT data collection for the data-corpus that was analyzed in this dissertation. There were benefits and problems because of this time frame. The benefit from taking this time to conduct the interviews was that I was able to gather information about the evolution of these apps as well as collecting anecdotal evidence about the informants'

perceptions about the impacts of these apps. However, there were several setbacks to this new study.

First, many of the MCTs no longer existed and the teams that developed them had already been dissolved. Furthermore, Brazil was going through the second worst global effects of the COVID-19 pandemic and many people had lost their jobs (falling behind the USA). These perhaps resulted in a low turn-over for the interviews. Stakeholders from the 90 selected MCTs were contacted at least twice by email but I was able to perform 9 interviews.

The survey questions for this study were developed from the themes derived from the coded MCT app descriptions, information contained in the MCTs, secondary documents and data, news releases, web pages and various public documents. The formal interviews were conducted using a standard interview protocol consisting of a combination of 13 questions, eight of which were multiple choice and scale-based questions and five were open-ended responses The formal survey in available in Appendix K). The interview protocol focused on three primary areas including 1) perspectives about the objectives of the MCT, 2) what kind of interactions happen when they are used, and 3) the technology resources used by the MCT. The survey instrument used in these interviews can be found in Appendix J of this dissertation. Follow-up questions were used to learn more about informants' role in the MCTs, perspectives about their impacts on society and what sector they represented (government, research, non-for-profit, user or other). Informants were encouraged to elaborate and express their personal perspectives about the MCTs.

The formal interviews were transcribed and translated (Available upon request). Thematic analysis approach was used, with both inductive and deductive reasoning on the open, subjective survey responses. The interviews were divided into three topics reflecting the results found in the App descriptions and triangulation of secondary sources: including 1) respondent's

perspectives about the objectives of the MCT, 2) what kind of interactions happen when they are used, and 3) the technology resources used by the MCT. The open question replies were documented in notes that were later combined and coded within the three themes above, then triangulated with the themes found in the analysis of app descriptions and secondary data. The codes were identified to find terms and topics that relate to the emergent concepts, literature, and scope of this research.

A Thematic analysis approach was used, with both inductive and deductive reasoning on the survey responses by coding them into open themes by categories. The interviews were divided into three themes: including 1) respondent's perspectives about the objectives of the MCT, 2) what kind of interactions happen when they are used, and 3) the technology resources used by the MCT. The multiple-choice and scale-based questions were cross-compared and summarized into tables. The open question replies were documented in notes that were later combined and coded within the three themes above. The codes were identified to find terms and topics that relate to the emergent concepts, literature, and scope of this research.

4.4. Data Analysis

Thematic Analysis (TA) methodology was used to analyze the collected MCT data. Searches were performed across the data-corpus to find meaningful patterns that occurred repeatedly (Braun & Clarke, 2006. p.15). These themes were identified through inductive and deductive processes (Braun & Clarke 2006). “Inductive thematic analysis is a method of coding and analyzing the data without trying to appropriate it into a pre-set coding scheme, or even solely to suit the researcher’s analytical presumptions.” (Mukherjee, 2013. p.127. para 01). A theoretical thematic or deductive analysis, on the other hand is primarily ‘analyst driven,’ that is, led by the researcher’s investigative or theoretical interest about the subject (Braun & Clarke, 2006; Mukherjee, 2013).

The deductive themes derived from the Technology Enabled Platforms for Civic Engagement (TEPPCE) framework and inductive themes were later developed. The data being investigated is not self-explanatory and requires a closer look at implicit meanings in the text, such as knowledge flows and government service delivery (Aronson, 1994; Attride-Stirling, 2001; Boyatzis, 1998; Braun & Clarke, 2006; Mukherjee, 2013; Roulston, 2001). It was the chosen method to use for this research because it is regarded as an appropriate method to use when exploring emergent and interdisciplinary topics, such as Mobile Civic Technologies which represents the analyzed data in this research (Guest, MacQueen, & Namey, 2011; Mukherjee, 2013).

This study was designed using, Braun & Clarke (2006) as a guide for conducting the thematic analysis and later adapted into a systematic workflow to illustrate the steps taken in the research design. Braun & Clarke's (2006) approach consists of six steps: 1) Data familiarization; 2) Generating initial categories and codes; 3) Searching for themes; 4) Reviewing themes; 5) defining and naming themes, and 6) producing final description and conclusions. Triangulation of secondary sources was applied to corroborate the findings thus be used to validate the findings. In the next section I describe how the method was applied, adapting a workflow for data science (Guo, 2012).

"One of the purposes of coding is to find patterns in the data" (Saldana (2016), p. 79). Pattern coding refers to a label or category that identifies data that is coded in a similar way in the data-corpus. The patterns help to organize the data into themes which are a consequence of coding (Saldana, 2016. p. 296)

The coding scheme used in my research was done according to the recommendations from Braun and Clark (2006), Miles and Huberman, (2008), Saldana, (2009) and Stuckey,

(2014). The term used in this thesis is coding which is the technique used to find patterns culminating to themes within the data corpus (Braun & Clarke, 2006; Saldana, 2016).

In other words, coding for themes or patterns was the way to condense and arrange the data systematically to provide meaning and attribute codes and themes to answer the exploratory research questions (Saldana, 2009. p.08). It is used in qualitative research during the analysis phase of the research. The coding can be made from a single word to a page of text as well as from moving images. The coding method entails searches for patterns in the data and enables the researcher to organize the coded data into categories and themes (Saldana, 2009. p. 03). The terminology used for this process is as follows:

- **Coding:** The objective of coding is to condense and arrange data systematically to provide meaning and categorize findings towards a system or classification (Saldana, 2009. p.08). It is used in qualitative research during the analysis phase of the research. Stuckey, (2014) suggests three steps to code data: (1) reading through the data; (2) categorizing the data into categories or codes and (3) using analytic memos to interpret and clarify the findings. The coding can be done from a single word to a page of text as well as from moving images. The coding method entails searches for patterns in the data and enables the researcher to organize the coded data into categories (Saldana, 2009. p. 03).
- **Codes:** Refers to a word, acronym or short phrase that captures the essence, attributes and essential elements contained in a section of written or visual data. Codes are applied and reapplied to qualitative data in a process called coding. Coding allows the researcher to group similar data into categories (Saldana, 2009. p.03, 21).
- **Category:** Categories summarize the similarly coded data. They represent the outcome of coding in qualitative research (Saldana, 2009. p.21).

- **Theme:** “A theme captures something important about the data in relation to the research question and represents some level of patterned response or meaning within the data set.” (Braun & Clarke, 2006. P. 10) They are the result of the categories and codes originated during coding of qualitative data (Saldana, 2009. p. 13). Themes can be deductive or inductive. Deductive themes originate from previous theories and inductive themes are strongly linked to the data and is not wed to pre-existing coding frameworks (Braun & Clarke, 2006).

4.5. Coding process and Application of the method

4.5.1. Coding process

To Illustrate how the coding was done, I describe the coding process according to Braun & Clarke’s (2006) approach consisting of six steps:

Step 1) Data familiarization: After collecting the data from the app descriptions, storing them and organizing them into individual files. Step 1 involved reading through all of the 90 app descriptions and begin to take notes of possible patterns found in the descriptions of the apps. Keywords and sections of the app descriptions that could help answer the research questions were noted were highlighted. For example, Colab.re app description explained that: "with Colab, you can participate in building your city and inform about improvements, helping to make decisions and responding to consultations directly with your municipal government". This section indicated that it could help answer research questions 2a and 2b because it spoke about how it allows for civic engagement.

Figure 10: Colab app coding

Steps 2) Generating initial categories and codes; and 3) Searching for themes.

Reading and re-reding the app descriptions and highlighting sections that could help answer the research questions, allowed me to attribute codes (words, and phrases) to sections of written data, separating the data into categories, these categories would later turn into broader themes. The coding happened deductively and inductively. Table 5 illustrates the inductive and deductive themes that emerged from the data:

Table 5: Inductive and Deductive Coding

Research Question	Coding Scheme	Source
1.a. What civic issues do these platforms address?	Inductive	App descriptions and documental sources
RQ1.b. How do they claim to address these issues?	Inductive	App descriptions and documental sources
RQ2.a. Who are the actors (Stakeholders), what are the information and codified knowledge flows that occur when these platforms are used?	Deductive	TEPPCE Framework

RQ2.b. What types of engagement do these MCTs aim to address?	Deductive	TEPPCE Framework
RQ3. What are the technology features of these platforms that enable these information and knowledge flows?	Deductive	App descriptions, and Google Play (Appendix D)

The deductive method consisted of the themes that derived from the TEPPCE framework (Table 4) and the inductive from reading and re-reading the app descriptions and a review of the literature. For example, to answer research question 2b., the app description for the Onde Tem Tiroteio app was coded as a Mode 1 Citizen centric and citizen sourced data of the TEPPCE framework because it explained that the citizens included information about gun shootings, and this helped other citizens to avoid violent areas. The app description was coded inductively for RQ1a. because, there were no lists or categories in the literature for MCTs that addressed security issues. After reading and re-reading the data, it was at first coded with the following codes: Safety (SAF), Gun violence (GV), Security (SEC) hen in the last iteration with the codes, this app was coded in a theme called Security app (SEC)

Step 4) Reviewing themes: The codes and themes created were then triangulated with the secondary data and the interviews to confirm that the descriptions matched the new app codes.

Step 5) Defining and naming themes: In this phase, the literature was re-visited to help define the new categories, codes and themes that emerged.

6) producing final description and conclusions: The final step involved writing the findings, conclusions and producing the resulting taxonomy.

4.5.2. Workflow

The following workflow illustrates the steps taken to perform the TA of the data-corpus for the Brazilian MCTs (Figure 9). This workflow was adapted from Guo (2013) and was

created to illustrate the four main steps commonly involved in data research projects: 1: Preparation of the data; 2: Analysis 3: Reflection and 4: Dissemination. Guo's (2013) workflow was helpful and thus served a basis to illustrate the steps involved in the TA for the Brazilian MCTs. Furthermore, at the time of this study, no investigations were found, that illustrated the steps taken in TA using workflows. This is a contribution to other research that adopt the TA method because previous work had not presented the steps involved in a workflow. Guo, (2013) noted that data research is composed of four main stages: preparation, reflection, analysis, and dissemination. The workflow illustrates the phases during this research, and it is presented in Figure 10 below.

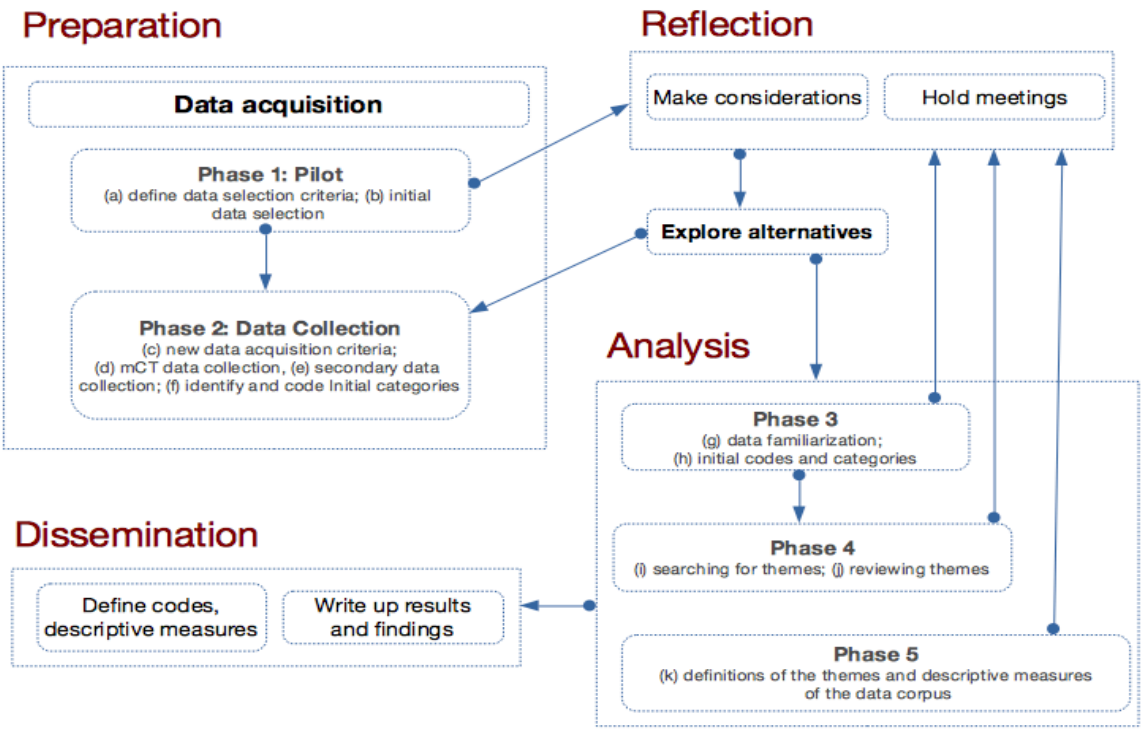


Figure 11: Workflow of thematic analysis of the Brazilian MCTs

Preparation of the data

The preparation represented the data collection and was divided into two phases. Phase 1 consisted of a pilot study to explore data that would later be selected. It included: (a) The definition of data selection criteria; (b) Initial data selection (CTs in the cities that hosted the

FIFA World Cup and the Olympics); reflection (individual and during meetings the supervisory committee) and exploring alternatives. Then, Phase 2 consisted of (c) Creation of a new data acquisition criteria (Brazilian MCTs in the Google Playstore); (d) Collection of the Descriptions of the Brazilian MCTs in Google Play-store and the secondary sources for triangulation and (e) identification initial categories. These preparation steps and data were then revised and reflected upon as follows (Figure 12).

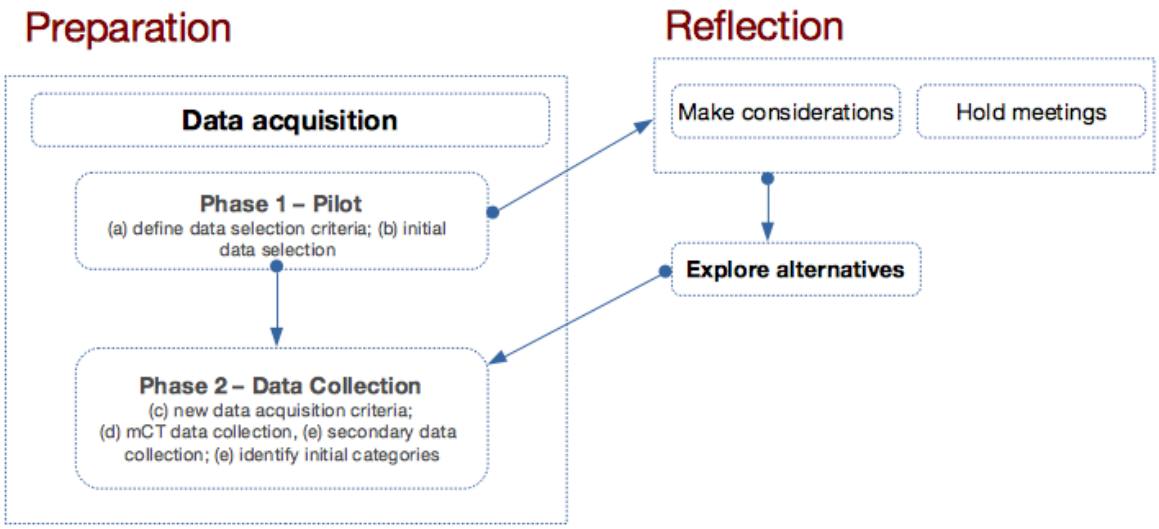


Figure 12: Preparation phase

Phase 1 – Pilot Study

A pilot study was conducted to establish the data selection criteria the following section explains the process taken to conduct the pilot study.

(a) Definition of data selection criteria

Before analyzing the data, one needs to acquire it, and to be able to do that, one must define the parameters or scope for the data to be selected (Guo, 2013). In Phase 1, the pilot study was conducted, and research scope was defined. This helped to define the types of data that would be collected to form the future data corpus. During the pilot study, the data sampling criteria was purposive, as commonly done in qualitative research (Miles, Huberman & Saldana, 2014).

The initial boundaries for the pilot were delimited to the CTs built for the Brazilian cities that hosted the FIFA World cup in 2014 and the 2016 Olympics. After meetings with the committee, it was concluded that this was an appropriate initial scope because large events such as the FIFA World cup and the Olympics often lead to significant changes and expensive upgrades in the cities that host them and consequently citizens would want to voice their opinions and needs to municipal and federal policymakers during these events. Likewise, events such as the FIFA World cup and the Olympics have given reasons for citizens to engage and share their opinion about the budgets, structural, changes, security measures and public transport alterations. These civic engagement activities have often been mediated by ICTs (Butler & Aicher, 2015).

During the years that preceded this study, Brazilian citizens and governments were coming up with interesting innovations in Civic Technologies such as electronic participatory budgeting and collective policy-making tools (Bhatnagar, Rathore & Torres, 2003; Simon, Bass, Boelman, & Mulgan, 2017; Gilman, 2016; Montambeault, 2016). An example of these technologies was the Android App called Participa MA, designed for citizens to vote on the policies they thought as priorities in their cities, as well as to involve citizens in elaborating these local policies (Geromy, 2016). Moreover, there were examples of browser-based Civic Technologies helping shape and contest policies that the citizens did not agree with, such as when the little girl Bia built a nation-wide petition to prevent her school from being demolished and replaced with a parking lot during the preparations to host the world cup (As cited in Chapter 1, McNeil, 2016).

(b) Initial data selection

The initial data-collection criteria and categorization of platforms used for this research was inspired by the Technology-Enabled Participatory Platforms for Citizen Engagement

TEPPCE (Desouza & Bhagwatwar, 2014). To do so, the initial sampled data was tabulated according to their TEPPCE typology (city, name, founders of the platform and goal of the platform – such as: posting projects, voting for ideas, providing information about access to city services and discussing issues in the city). The TEPPCE typology was made in 2014, a time when civic mobile apps were at their very beginnings and the majority of CTs were browser-based. For this reason, the final data-corpus in the TEPPCE, included both browser CTs and Mobile CTs (MCTs) because there were a limited number of MCTs in 2014.

The pilot study was conducted during 2017, when mobile application development had become mainstream, and several MCTs were found for the Brazilian context. In this sense, the pilot study was useful to understand the current context of Civic Tech as it was found that mobile CTs were being developed for civic purposes as well as the previous browser-based versions.

Figure 13: Cities that hosted the FIFA World Cup in 2014 and the Summer Olympics of 2016

This created the need to include adaptations to the TEPPCE according to the Brazilian context, which was widely adapting mobile forms of Civic Tech. This may have happened perhaps due to the convergence of technologies in mobile platforms (As mentioned in Chapter 2). These adaptations to the TEPPCE would later turn out to be contributions to the Civic Tech research area. These will be further noted on Chapters 3 and 4 of this thesis. The data collection

and analysis for the pilot study spanned from April to June 2017 and included the following twelve cities that hosted in the 2014 FIFA World Cup: Belo Horizonte, Brasilia, Cuiaba, Curitiba, Fortaleza, Manaus, Natal, Porto Alegre, Recife, Rio de Janeiro, Salvador and Sao Paulo (Figure 13). It included the CTs, both browser and MCTs, as was done for the TEPPCE for the Brazilian cities that hosted the FIFA World Cup and the Olympics.

During this first phase of exploratory research, both manual search-terms on a browser search engine and automated search using web-scraping scripts to retrieve the data were explored. However, it was found that collecting the qualitative data manually provided important information about the nature of these civic applications and thus would represent the first phase of TA, when the researcher begins to become familiar with the data, while performing the data-collection, Boyatsys, (1998) called this phase, getting to know the data. For this reasons, the final purposeful data collection criteria were defined and consisted of manually inputting the following search terms in the Google search engine:

- Civic application (Aplicativo civico) + name of city.
- Urban civic applications (Aplicativo civico urbano) + name of the city.
- Citizen application (Aplicativo cidadania) + name of city.
- Smart city application (Aplicativo de cidades inteligentes) + name of city.
- Government applications (Aplicativos do governo) + Name of city.

Analytic Memos and Notes

Qualitative researchers are not algorithmic automatons. If we're carefully reading and reviewing the data before and as we're formally coding them, we can't help but notice a theme or two (or a pattern, trend, or concept) here and there. Make a note of it in an analytic memo when it happens, for it can sometimes guide your continued coding processes.

(Saldana, 2009. p. 13)

During the whole process of data collection and subsequent analysis, detailed memos of daily procedures regarding data collection and analysis were produced. These notes were important for reporting the steps taken in the data retrieval and analysis phases as well as discussing with peers to obtain feedback on the how to proceed with coding process and deciding on the themes. The Birks, Chapman & Francis (2008) approach was used as the guide or producing the analytic memos. This consisted of first creating a research activity log which mapped the decision-making process during the data analysis iterations, the second aspect of the memo included extracting the meanings from the analysis of the data during the periods of data collection and analysis. These were interpretations and links to pre-existing concepts and theories. The third aspect of the memos involved keeping track of the thoughts and their evolution throughout the data analysis iterations. Finally, the last aspect recorded in the memo consisted of communications and sharing preliminary data with other researchers to obtain feedback about the coding process, creation of categories and themes created.

Other aspects recorded in the memos referred to ideas on how the data collected informed the research questions, the category choices and the literature that could later inform the emerging themes. In addition, there were operational definitions as well as the emergent patterns, concepts, themes and links, emergent and existing theories, any issues that came up (personal or ethical dilemmas throughout this endeavor), as well as future directions for the study (Saldaña, 2013). This was a research journal of memos that helped keep track of the developments during the study.

The analytical memos were written in Portuguese and English throughout the whole process of applying TA to answer the research questions. “These notes are often informal, kept for insight and information only” (Stuckey, 2014. p. 3). In this research they consisted of: (a)

Information about the resources read at each phase and how they could help in the analysis and writing; (b) Issues encountered during the data collection and (c) Insights about the data. The following are the excerpts taken from the analytic memos, taken during this study:

(a) Information about the resources read at each phase and how they could help in the analysis and writing. For example:

February 21, 2018: "Linders, (2012) presented an interesting framework about the data, information and knowledge flows, Linders stated that citizen to citizen interactions were a form of do-it-yourself civics, because citizens were taking public service-provision into their own hands. I should see if this is the case for the Brazilian MCTs." (Analytic memo, 21st February 2018)

(b) Issues encountered during the data collection: April 08, 2018: "finding information about when the platform was developed is not clear. The main web pages for the CTs often do not mention when they were created and neither do the Appstores. This information could be in secondary sources. The TEPPCE mentions when the platforms were created but does not mention how they found this information".

(Analytic memo, April 08th, 2018)

(c) Insights about the data, for example in the memo written June 15, 2017, about the origin of some e-government mobile apps: "Mobile e-government apps seem to have often originated from pre-existing portals, several were initially e-government portals and then became apps (Caixa Trabalhador and Central 156 apps)" (Analytic memo, June 15, 2017)

(d) Memos related to the process of coding the data such as of March 18, 2018:

"These terms seem to be categories: Social impact app (maybe Caca mosquito), apps for urban infrastructure (Avancar app), apps just for civic information (Direito na Mao) and budgeting apps pondering if I should code these" (Analytic memo, March 18, 2018)

Reflection of phase 1

Sampling is investigative; we are cerebral detectives, ferreting out answers to our research questions. We observe, talk to people, and pick up artifacts and documents. That leads us to new samples of participants and observations, new documents. At each step along the evidential trail, we are making sampling decisions to clarify the main patterns, see contrasts, identify exceptions or discrepant instances, and uncover negative instances where the pattern does not hold.

(Miles, Huberman & Saldana, 2014. p. 48 para. 03).

After the initial data collection, it was concluded that the initial data selection criteria in the pilot study was not helpful to answer the research questions. This was because the platforms built for the events of the FIFA World Cup and the Olympics were generally linked to news, calendar specific to these events and were not created for civic purposes, therefore not be identified as Civic Technologies, for example: the FIFA app, SportTV and Copa do Mundo app (Moura, 2014). These apps were thus removed from the data corpus as they were judged to be too ambiguous and insufficient in helping to address the research questions.

The initial scope was comprised of the cities that hosted the FIFA World Cup and the Olympics. However, some mobile apps could be developed in a specific city but often adopted in several other cities. The analytic memo was useful for this conclusion, for example, the Particity app, was initially developed by the municipal government of Cascavel and later

adopted by other municipalities such as Sao Paulo (Bagatoli, 2017). This was an important finding from this phase regarded the searches performed by city. This is an important characteristic of mobile platforms because they can be developed and later used by several different stakeholders in different cities. Therefore, even if the origin of the applications were identified, knowing where they will be used after its launch in the mobile marketplaces is hard to predict.

Furthermore, when searches were performed for specific cities, the Civic Technologies did not result in significant secondary data that could support the analysis. It was found that most apps were federal or provincial. When looking for platforms initiating the search by city, the data available on the Appstore indicated that the apps had not been installed by many users (information available on the Appstore under approximate number of downloads) for a specific city (therefore difficult to link to the cities for the Olympics.

Exploring Alternatives

The previous pilot study served as a useful step in delimiting the scope of data acquisition. It became clear then, that mobile devices were important for digital civic purposes at the time of the data collection. Thus, the previous phase helped to select clear boundaries for data collection.

The primary scope to explore the Brazilian Civic Tech landscape remained the same, but the new scope was delimited to mobile CTs (MCTs). The initial data collection resulted in apps aimed to inform and deliver government services as well as enabling real-time citizen engagement. The focus were the mobile platforms due to their ubiquitous nature. In addition, when mediated by mobile devices, codified knowledge can occur in real time which, allow for interesting reporting and participation between stakeholders. Furthermore, the data available

for the mobile marketplaces such as in the Android Play Store (Appendix D) offered a wealth of data that could be analyzed qualitatively as well as quantitatively (Harman, 2012).

Phase 2 – Data Collection

Due to the unique context of mobile technology enabled civic engagement, data had to be collected in a purposive manner (Desouza and Bhagwatwar, 2014; Miles, Huberman & Saldana, 2014). The underlying criteria for collecting the data corpus of MCTs was to look for Brazilian mobile apps that addressed the objectives of Civic Technologies to address urban issues (politics, culture, society.). This was based on a selective sampling procedure similar to that carried out by Desouza and Bhagwatwar, 2014). The first part of the data collection phase involved sampling the Brazilian MCTs that matched the previously data selection criteria.

(c) New data acquisition criteria

Google Play Store was chosen for analysis due to its fast-growing user-base and popularity in Brazil. 94.2% of mobile devices run in Android operating system (Kanter, 2018). Because the scope of Civic Technologies ranged widely in definition, roles and characteristics, it seemed appropriate to collect the data based on conceptual and explorative questions, rather than representativeness (Miles, Huberman & Saldana, 2014).

There were no lists of the MCTs in Brazil available and for this reason an online search was conducted to locate these platforms. Furthermore, there are no Digital Civics, Technology Meditated Civics or Civic Tech categories in the Google Play Store, so to proceed with the data collection it was necessary to identify the Brazilian Civic Mobile applications according to a specific criterion. For this, a framework for identifying these apps based on that criterion was developed. To do this, the conceptual framework was revisited to create a selection criterion based on conceptual definitions in the literature. This is explained in the following section.

(d) MCTs Data Collection

The primary MCTs data collected originated from the Google Android Play Store (Appendix, D) data and was collected based on the following inclusion criteria:

- The app is available for download on Android devices.
- The app was created in Brazil or made for the Brazilian context.
- App language was Portuguese. This criterion was selected because these were Brazilian apps and the language spoken in Brazil is Portuguese.
- The app description included information about civics and citizen participation.
- The app description offered information about improving local civic issues (Accessibility; Budgeting; Culture; E-documents; Education; Elections; Energy; Environment; Fiscal; Health; Infrastructure; Policies; Security; Transport; Mobility).

Explicit or implicit presence of the words in the Play Store description section of Plays Store about the mobile platforms:

- Cidadania (civics),
- Cidadao (citizen),
- Aplicativo para cidadania (Civics app),
- Aplicativo de participacao (participatory application)

(d.1.) Exclusion Criteria:

An app was excluded if it did not meet any of these criteria:

- Apps that did not have any secondary sources were excluded.
- No data regarding features used in the app.

In the second phase of data collection apps that were no longer available in the Play Store were removed. This was because the permissions were no longer available for retrieval and therefore research question number three could not be answered.

(d.2.) Checking, storing, and cleaning the data:

After the data was acquired from the Google Android Play Store online software repository, it was added to a Libre office software suite spreadsheet. Data was then cleaned and checked for inconsistent formatting. The semantic errors, double or missing entries were then removed and corrected in the data-corpus, aligned with Braun & Clarke's (2006) data familiarization phase. The following excerpt is from the analytic memo and illustrates an issue regarding information from the app permissions which would be a problem during the analysis of the data: "Found some apps that are no longer available, I can't retrieve their permissions. They should be organized into a dump file" (Analytical memo, 12th June 2018).

(e) Secondary Data Collection: to triangulate the findings, secondary data was included to inform about the nature of these applications. This was helpful because it allowed to begin understanding the data corpus in the initial steps of the research (important characteristic of thematic analysis phases of getting to know the data). Figure 14. illustrates the results page of Google News (taken on October 17, 2018) when searching for the secondary data about the application called Cidadera.

Figure 14: Selection of secondary data

The secondary data consisted of news reports, blogs, government websites, scientific papers, business reports, Governmental and Non-governmental organization reports. The selection of the secondary data for triangulation was done in four steps:

1. Searched for the names of the apps in the news section of Google search engine
2. Screened for relevance based on the information provided in the title and then
3. Evaluated it for inclusion based on the full text
4. Then subsequently named, stored as a PDF file, and tagged with the name of the app it represented.

The following mandatory selection criteria were used to obtain the secondary data on the sample of mobile apps used in this study:

- Explicit or implicit presence of the words: Civics *(cidadania),* Citizen *(cidadao)* + name of the application
- Keywords within the secondary data source which yielded at least one entire news mention for the name of the mobile application
- Open or publicly accessible blogs, blog posts or video content provided information about the nature, objectives and uses of the platform at least three different secondary sources (research articles, mentions in the media and magazine articles) to be able to triangulate with the findings.

Screenshots of the main screens of the applications were included as they provided rich information for the future analysis. Miles, Huberman & Saldana, (2014) suggested that the ease of access and ubiquity of digital tools allowed for an increase in qualitative research analyzing visual data. Analyzing visual data can allow for several interpretations which can be more systematic and closer to content analysis by allowing for counts and categories while at the same time allowing holistic interpretations. Saldaña, (2015) advocated coding visual data. By

visual data, he referred to pictures, screen captures or Internet websites which can be analyzed in a holistic manner to answer research questions. In this context, analytic memos were useful because they helped keep track of the evolution in coding each MCTS. During the analysis phase of the visual data, analytic memos were kept helping in the subsequent coding. The codes for the visual data also emerged progressively with the iterations (Miles, Huberman & Saldana, 2014).

A thorough selective sampling process was followed until saturation to find the remaining Brazilian MCTs. Complete data collection (primary and secondary data) ended on July 30, 2018. Of the 162 Apps sampled, 72 were excluded because it was not possible to retrieve enough secondary data for triangulation and therefore unable to retrieve data. Figure 15. illustrates the data-collection process and Table 6. MCTs Selected for this study. lists the apps that were included in final data-corpus.

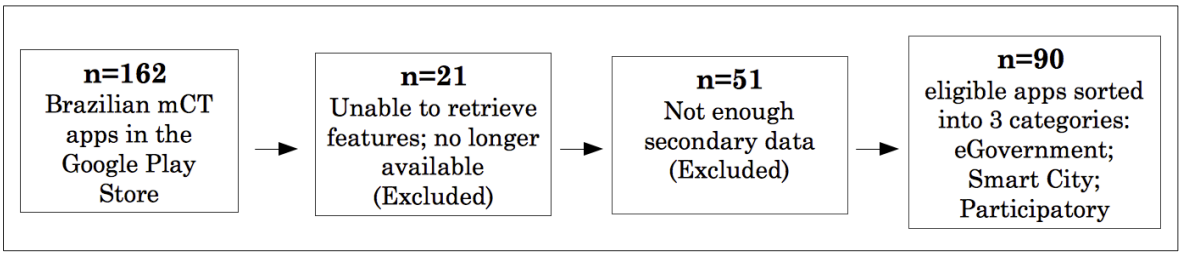


Figure 15: Selection of the study sample

Table 6. MCTs Selected for this study

#	Name	#	Name	#	Name
1	#3ConfJuv	31	Direito Na Mao	61	Particity
2	App Barueri	32	e-Titulo	62	Patrimonio PE
3	App do Cidadao	33	Eleicoes 2016	63	Poa Transito
4	As diferentonas	34	Eu Cidadao	64	Portal do patrimonio
5	Avancar	35	Fala Cidadao	65	Porto Alegre #EuFaçoPOA
6	Bairro Seguro	36	Fala limoeiro	66	Pra Cima
7	BH Resolve	37	Falando com o prefeito digital	67	Prefeitura de Porto Alegre
8	Bombeiros Parana	38	Falaparnamirim	68	Proximo Onibus Curitiba
9	BusCode POA	39	Fiscalizatu	69	Radar Cidadao
10	Caca Mosquito	40	Fogo Cruzado	70	Recicla Retro Recife
11	Cade o Meu Onibus	41	Goiania Contra Aedes	71	Reclame Aqui
12	Cade O onibus	42	Hemogram	72	Reli
13	Caixa Trabalhador	43	inforMe Denuncias	73	Resultados
14	Calculadora Cidadao	44	Limpa Rapido	74	Rota Da Reciclagem
15	Carteirada do bem	45	Malalai	75	Rua BH
16	Cataki	46	Menor Preco Nota Parana	76	Sempre Alerta
17	Central 156	47	Meu Ambiente	77	SIC.SP
18	Cidadao Online 4r	48	Meu Digisus	78	Sigep
19	CittaMobi	49	Meu onibus	79	Sincov Cidadao
20	Colab.re	50	Moda Livre	80	Sinesp Cidadao
21	Coleta seletiva Salvador	51	Monitora Brasil	81	SIU Salvador
22	Comida Invisivel	52	MPRJ	82	SOS Infancia
23	comuniQ	53	MT Cidadao	83	SP Servicos
24	Copel Mobile	54	Mudamos+	84	sp156
25	Delegacia online RJ	55	Nota Parana	85	Sr. cidadao

#	Name	#	Name	#	Name
26	Denuncia Ambiente	56	Onde fui Roubado	86	Tarifa taxi POA
27	Desenvolve Brasil	57	Onde Votar	87	TCMRJVisitas as escolas
28	Detran RN	58	Onibus ao vivo	88	Transalvador_Noa Cidadao
29	Detran SP	59	OTT (Onde Tem Tiroteio)	89	Visit Natal
30	Df Aguas Claras	60	Participa BR	90	Zona Azul Facil

(e) Identify the initial categories

During this data collection phase, the data pre-coded with what Saldana, (2013. pg. 41) identified as categories that were attributed to the data. This happened because, when the data was collected, interesting characteristics of the material were noted. Thus, these sections were recorded because they could be coded in the future. The following passage is an analytic memo that illustrates the thought process for creating the category which would later be named Informational Apps (Chapter 3):

> I'm pondering if some apps that are not participatory are still relevant here, they inform citizens about their civic rights, government spending and responsibilities (MPRJ app), civic education is an important aspect of DC, also the apps that just offer a government service are also in the scope of DC research (BH Resolve app).
>
> (Analytical memo, June 06th, 2018)

Notes such as these analytical memos and highlighted, explaining why certain characteristics of the data-corpus were important and relevant for the study, as recommended by Boyatsis (1998) and Layder (1998). This also helped to detect recurring patterns in the data. During the exhaustive reading and re-reading of the data, which is typical of the data familiarization phase, the data was read and re-read in an active way, to search and record meanings in data segments, as suggested by Braun & Clarke, (2006).

Analysis

The analysis incorporated: Phase 3: (g) Data familiarization, (h) Initial codes and categories (coding for categories); Phase 4: Searching for themes, (j) Reviewing themes and descriptive measures of the data corpus; Phase 5: Definitions of themes and descriptive measures of the data corpus (Figure 16).

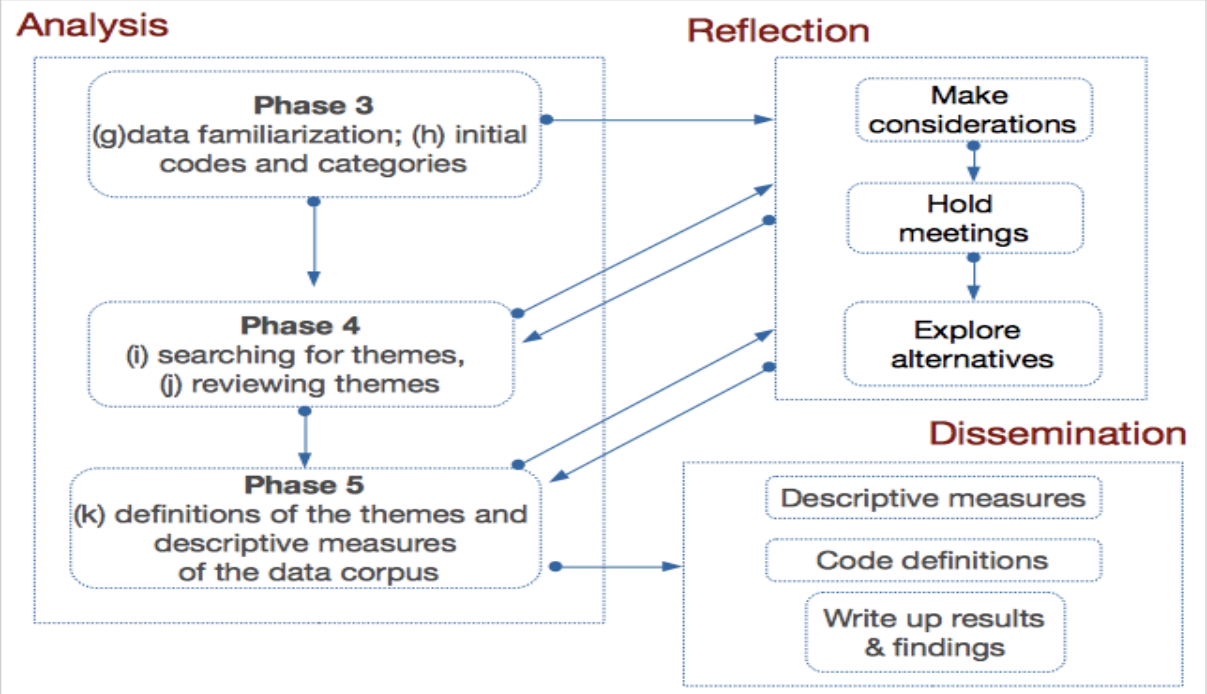


Figure 16: Workflow representing the phases of data analysis

Phase 3

(g) Data familiarization

Following the data collection, the apps were read and re-read. During this phase of analysis, the characteristics of the data were investigated, to see if the themes and categories from the TEPPCE framework could reflect the Brazilian MCTs data corpus and inform the research questions (Table 4). Skucky, (2014) argued that this an important task to do before coding is to revisit the research questions because the final account of the research is to direct the analysis of the data to the research questions. 90 Brazilian mobile civic platforms available

on Google Play Store were analyzed. These were apps designed to mediate interaction among agents (citizens, governments, private sector, and non-for-profit organizations) who live in cities and interact with each other by exchanging data, information, knowledge, and expertise to address urban issues.

(h) Initial codes and categories

Categorizing and thematic analysis of the data was done deductively and inductively. The deductive analysis was performed in a 'top down' way, which required prior engagement with the literature to build upon and refute existing studies (Boyatzis, 1998; Hayes, 1997; Braun & Clarke, 2006; Mukherjee, 2013).

This is a common characteristic of thematic analysis because it allows for the discovery of new themes within each dataset (Mukherjee,2013). The TEPPCE (Table 4) framework was helpful for the initial analysis but was later adapted due to the nature of the platforms studied. For example, the TEPPCE included the theme "medium" which referred to offline and online civic engagement mediated by ICTs. Online were the browser portals and MCTs and offline were hackathons that resulted in apps (Table 3). As this research was focused on MCTs, therefore, all were online forms of civic engagement.

This was when the analysis became inductive. Inductive TA was coded in a 'bottom up' way, where the data was coded and analyzed without placing it into a pre-set coding schemes based on its characteristics (Frith & Gleeson, 2004 as cited in Braun & Clarke, 2006). This allowed for new categories to emerge from the analysis and coding.

Miles, Huberman & Saldana, (2014) refer to coding categories as means of capturing attributes about text and visual data. Categories are generated to give meaning to the data. Chamaz (2001) acknowledged that coding is an important activity in qualitative inquiry because it aids in putting together the data collection and explaining the meanings within the

data. Codifying consists of systematically arranging the data to place it within a classification system or categories. It is different than semiotics in the sense that it is not meant to interpret symbols or the social context. The categories (codes) were used to categorize similar groups of data to cluster the information for further analysis leading up to the themes.

The approach to coding was also inspired by the Miles, Huberman & Saldana (2014) paradigm which states that coding is a process of deep reflection, analysis, and interpretation about the data corpus. The coding process was initiated by assigning descriptive codes to the app descriptions shown on the Android Play Store. For example, the AppBarueri's description: "the prefecture of Barueri city provides the AppBarueri so that citizens can report problems to solve local issues" (AppBarueri app description, 2018. Para.1) was coded as Civic Reporting of Problems (CRP) and to enable a citizen to government flow of data, information, and codified knowledge (Appendix B). Descriptive codes refer to short words or phrases that summarize a passage of textual data derived from the descriptions and categories from Google Play and from the secondary data (Appendix D and https://bit.ly/3FQ3dL4).

Deductive coding began with the TEPPCE framework to help answer the research questions. Each code was assigned to the data "chunks' and then a label was assigned to denote what the text segment represented. This was done in a heuristic manner the data was read and re-read while carefully reflecting on its core meaning. This approach provided an intimate familiarity with every element of the data corpus. Planning a systematic first cycle of coding was crucial to facilitate the following iterations of the research. Braun & Clarke (2006) advise that this initial acquaintance with the data is important as it will likely turn into themes that will be relevant as the research developed.

The coding process naturally goes through several changes and adjustments with each iteration with the data as confirmed by Miles, Huberman and Saldana (2014). This also

happened in this research. For example, some deductive codes did not describe the characteristics of the data when the TEPPCE by Desouza and Bagwhatwar (2015) was used. This is because they were analyzing web content and apps and this study focused solely on apps.

Each of the Play Store data points (Appendix D) and app descriptions (https://bit.ly/3FQ3dL4) were read in their entirety to make sense of the objectives of each app. Following that, each secondary data source was also carefully read to confirm the findings for the app descriptions. The initial codes were the same as the TEPPCE and included the following categories: city, name, attractors, medium, information and knowledge flows, founders, year, goal of the platform, mode of participation. Their framework consisted of the categories listed on Table 4.

During analysis, the app descriptions and app information were the app page of Google Play and from secondary data sources (Desouza & Bhagwatwar, 2014). Then, each MCTS was inspected and initially coded to ensure consistency in the data collection, which averaged between 45-60 minutes for each MCTs depending on the amount of secondary data.

Reflection

The TEPPCE was an interesting framework because it classified technology-enabled civic engagement by updating Arnstein's well-known ladder of citizen participation. The research questions were first addressed deductively using a qualitative analysis approach. However, the TEPPCE framework was only used for platforms in the USA. In Brazil, new categories emerged because it is a different country, with different issues. The new categories and themes that emerged from this research are presented in Chapter 3, which may be viewed as a contribution to Desouza & Bhagwatwar's (2014) framework and serves to extend its scope.

Some of the TEPPCE categories were useful for describing the data collected but they were not sufficient to address the research questions. This is common when analyzing data deductively with TA as each qualitative inquiry has its own characteristic. The objective was to derive a portrait of Brazilian MCTs. For example, what specific kinds of local issues were these platforms addressing? TEPPCE only mentioned them as local issues. They did not specify which issue, nor how these platforms addressed them. Furthermore, inductive categories were also found in the data available for the mobile platforms were also noted as they came in categories pre-defined in the Google Play Store (Appendix D: Play Store Data). In Table 7, the TEPPCE framework categories are listed as well as whether they helped to address the research questions.

Table 7. TEPPCE framework and applicability to answer the research questions

#	TEPPCE Themes	Definition	Example	Categories	Source		Address RQs?	Comments
					Playstore	Secondary Data		
1	City	The city that the platform was developed and used	Houston, Denver	Various cities	No	Yes	No	We did not use this information in our analysis because, Mobile applications even if created in one city are often used in other cities because they are available in Google Play for anyone to install independent on the location This does not inform our research questions.
2	Platform name	Platform name	MyCityHouston, Jax Ready	Various Names	Yes	Yes	Yes	Important to distinguish the mCTs.
3	Founders	Organization or person that created the application	My City Houston, Citizens group Denver	Various Organizations	Yes	Yes	Yes	Informs on the type of agents involved Research question 2. a.
4	Year	Year the application was created	From 1975 to 2012	Various years	No	In some cases,	No	It would not help us to answer the research questions.
5	Goal	Is a description of what the aim of using the CT.	ParkMe Austin TX, allows citizens to view real time parking information	information, collaborate, engage, citizen input, vote for ideas.	Yes	Yes	Yes	Helps to answer research question 1. b.
6	Attractors	Problems and opportunities that stimulate citizens to participate, for example: Local Issues, Information Access and Sharing.	SmartGov, San Jose Citizen Space, Citizens for a safer Denver	Local issues; Information access and sharing; monetary incentives.	Yes	Yes	Yes	TEPPCE did not specify how they collected the data for the attractors, nor did they inform which local issues were being addressed.
7	Medium	Tool and way in which these technologies enabled civic engagement.	San Jose citizen Space was used online and offline	Online only, Online & Offline	No	No	No	Our focus was to explore mobile CTs, therefore all the interactions are done online.
8	Information and Knowledge Flows	Information and knowledge flows support civic engagement activity.	SeeClickFix had a G2C flow; ParkMeAustin had a C2C flow	Citizen to citizen (C2C); Government to Citizen (G2C)	Yes	Yes	Yes	Yes, and we soon noticed we could expand on this notion because we found that some mCTs also incorporated the participation businesses, who are agents that have also been contributing to addressing local issues.
9	Technological Features	The technological features enable the flow of information and knowledge between the agents	ParkMeAustin provided real-time information feeds	Maps, Real-time feeds; Discussion boards; voting informational website	Yes	Yes	Yes	Yes, we found that Mobile CTs offer interesting opportunities for civic engagement because mobile devices enable technologies such as messaging, phone, camera, that can support rich engagement

#	TEPPCE Themes	Definition	Example	Categories	Source		Address RQs?	Comments
					Playstore	Secondary Data		
								and flows of information and knowledge.
10	Modes of Participation	Final TEPPCE taxonomy	M1: Localocracy app, citizens communicate and think of solutions for local issues; M2: Oakland Crimespotting app where citizens provide information about crimes locally; M3: www.austintexas.icanmakeitbetter.com; Mode 4: Hackethons such as the new york city apps.	Mode 1 (M1): Citizen Centric and Citizen Sourced data; Mode 2 (M2): Citizen Centric government Open data; Mode 3 (M3): Government-centric citizen-sourced data; Mode 04 (M4): Government-centric Citizen-developed solutions	Yes	Yes	Partially	We soon noticed that non-participatory applications also supported the notion of Civic Technologies and Digital Civics. For example, informational apps supported the definition of Digital civics. Therefore, added a category which is M0 or non-participatory which can include for example government services (e-government services). This will be further explored in the following chapters.
11	Agents	Stakeholders that participate on the platform.	Citizens, Governments and Businesses	Citizens and Government	Yes	Yes	Yes	We added businesses (B)

4.5.2. Limitations of deductive analysis TEPPCE Framework

The TEPPCE did not specific problems each Civic Technology aimed to address in the Theme Local Issues (Table 7) Furthermore, it only considered what the authors regarded as participatory (the four modes of participation mediated by technology). During the initial phases of analysis, it was soon realized that non-participatory apps (according to the TEPPCE) were also important to be considered as they were contributing to the goals of improving urban life and service delivery, characteristics of digital civics objectives. Therefore, even though they would be considered non- participatory apps according to TEPPCE framework, these seemed to have been important in the realm of Digital Civics due to their utility for citizens. For these reasons another iteration was performed where Google Play and secondary data was then analyzed to find patterns and categories that were not in the TEPPCE but emerged in the Brazilian data. These new findings will be illustrated later in this dissertation on Chapter 3, Findings in the context of the TEPPCE framework.

The TEPPCE analyzed information available on websites, portals and applications. When Desouza and Bhagwatwar, (2014) published their research, mobile civic apps were not mainstream yet, thus their typology and analysis were not sufficient to draw conclusions about the data corpus collected regarding the Mobile Civic apps in Brazil. In this research, the analysis focused on mobile apps, because they offer important opportunities in the context of citizen engagement due to the technological convergence of digital devices and such as camera, sensors, LTE network, GPS and software related to them. These enable citizens to record issues and events and report them in real time. The Civic Tech that was gathered during the TEPPCE did not offer real-time civic abilities. The TEPPCE was thus a guide to analyze the Brazilian MCTs.

Item 10 in Table 7 reflects an important reason why the TEPPCE could be extended for the Civic Technologies in Brazil. The TEPPCE only analyzed apps that were considered

participatory. However, it was noted from the Brazilian data corpus, that non-participatory applications also supported the notion of Civic Technologies and Digital Civics. For example, informational apps supported the definition of Digital Civics. Therefore, a theme was added here during the analysis phase of the research (Mode 0) or non-participatory which can include for example government services (e-government services). For this research, Thematic Analysis was used to build a classification to represent these interactions between agents, (governments, private sector and citizens) by means of mobile technologies which will be further explored in the following chapters.

Phase 4 – Data Analysis

This phase included analysis with the primary and secondary data. After coding the Brazilian MCTS data based on the TEPPCE and concluding that new categories, were emerging, for example, mobile-government apps that informed citizens about government services or provided forms of civic education such as Meu digiSUS app "Meu digisus is a mobile platform that offers information regarding the services offered by the ministry of health, where citizens can have access to important information about health" (Meu digiSUS app description, 2018. Para 1). For this more iterations were done by reading the Google Play data and secondary data. Braun & Clarke (2006) referred to as the code generation and reorganization of the data-corpus into significant categories that would inform our research questions.

To code and analyze the data, several methods (manual coding) and software were explored. Such as the Qualitative Data Analysis (QDA) software RQDA (Ronggui, 2016), IramuteQ (Ratinaud, 2018) and PyQDA (Python Software Foundation, 2018; PyQDA, 2013).

They were installed and tested; however, it was concluded that coding process would remain the same, regardless of using the software or not. Stukey, (2014) acknowledged this:

> "One common myth that I frequently hear is that 'the qualitative software program will code the data for me.' This is not true. The software program helps to organize your data, but it does not code it. Software is a data management system, which is extremely helpful for large projects, or projects that require cross-analysis of variables such as demographics to specific codes (for example, running a report with "women" and "feeling worried about complications"). It is important that using software cannot be a substitute for learning data analysis methods because the researcher must know how to create codes and analyze the data. However, regardless of whether you choose to use data management software or code the data manually, you will follow the same process." (Stuckey, 2014. p. 08. para. 5)

In the first round of coding all the data collected was read, re-read and coded. 484 codes emerged from this reading and re-reading of the data. To better analyze and visualize these codes, they were then included in a mind-map to better view of the codes.

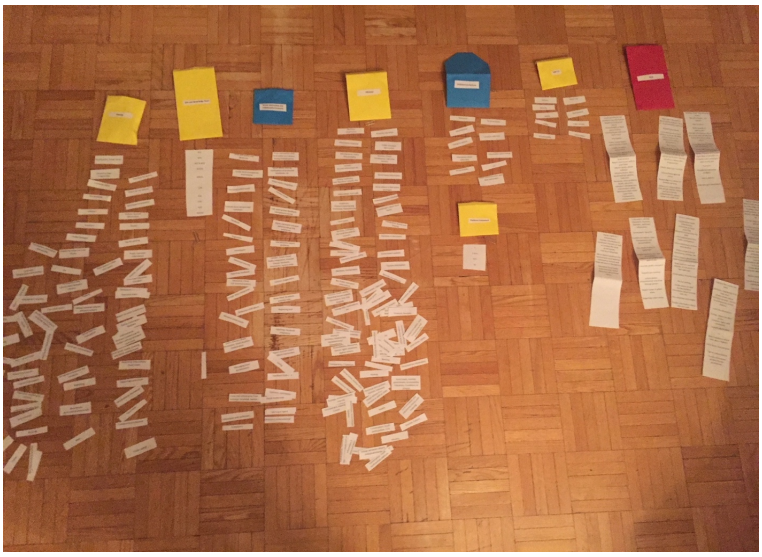


Figure 17: Coding on the floor of my apartment

In the second round of coding, the app descriptions and secondary data were read the segments of texts were highlighted and coded into the deductive and inductive codes. These codes were then printed on paper to have a birds-eye view of all the codes and try to find

patterns and similarities to reduce the number of categories (Figure 17). Then these were again input and viewed on a mind-map until the categories had been reduced and the thematic patterns emerged.

(I) Searching for themes

Shortly after the initial coding, new categories emerged from the previous analysis. For each app, the data item was coded into single or multiple thematic categories and again a data excerpt was created. To do so, the Google Play and secondary data were re-read entirely, and the secondary data was triangulated with the app descriptions. Then, excerpts that would illustrate the themes were identified and recorded in analytic memos. For example, an app that would allow users to use and transmit e-documents to governmental agencies was coded as EDO, which stands for e-documents (Appendix B and Chapter 4)

Each data item was then qualified by implicit or explicit presence of descriptors that would help to answer each research question. For example, question 1, aimed to understand the local issues that were being addressed. In this case, an excerpt of the app description was noted and categorized regarding the type of local issue it aimed to address according to the app developers. For example, the app BusCode POA app included in its description: “The BusCode POA is an application developed to help users of public transportation in Porto Alegre, Brazil created by a citizen with open government data. Allows for offline access.” so it was coded (T&M) in a theme named Transport & Mobility.

Reflection and Meetings

After data collection and the first coding cycle, the categories were clustered. The relationships between the categories were investigated as well as the memos that helped to develop a higher-level analysis of the data corpus. This was done with a method called pattern coding, which helped us to reduce the number of labels, categories, and codes by grouping

similar ones into broader, higher-level codes and categories. Miles, Huberman, & Saldana, (2014) claim that this is analogous to cluster analysis used in quantitative research. By pulling together the relevant material from the first cycle, pattern coding helped to create meaning by categorizing and grouping the large data corpus into smaller analytic units.

During this phase, the help of one Ph.D. candidate and one post-Doctoral fellow in the field of Information Studies were recruited, both experienced with qualitative data analysis and thematic analysis, to examine the code creation process and advise on strategies that could aid in finding patterns for the future themes. As they were familiar with this method, helped to check at the data and suggested ways in which to group them into categories. Then helped to review the mind map of initial codes and categories and discussed a schema for understanding the interactions and convergences between the categories and initial themes that had been created. This data corroboration by qualified qualitative researchers, helped increase the validity of the thematic analysis process.

Then a second cycle of inductive coding starting from the codes resulting from the first cycle. According to Miles, Huberman & Saldana, (2014) coding is rarely done correctly in the first attempt and multiple iterations are a common practice. In this cycle, the objective was to start the systematic process of analysis of the data corpus. It was similar to the first cycle, but the aim was to reduce the number of codes and explore whether the data was informing the research questions.

The themes were coded until saturation and until the commonly found themes and larger meanings across the data could be grouped into categories. This coding cycle was done to select the themes. The definitions of each theme are described in the following chapter. Qualitative coding is a repetitive process that allows for adjustments during each iteration, for example, new categories were identified with each iteration, adjusted the labeled as the understanding of the data corpus matured (Powel & Renner,2003; Mukherjee, 2013).

Phase 5

(k) Definitions of themes and categories and descriptive measure of the data corpus

Defining and naming themes corresponds to Braun & Clarke's 5th step in conducting thematic analysis. It typically begins when the different themes are well understood after several iterations with the data. This means that to begin step 5, the different categories, the themes, their connections, patterns, and how the data can inform the research questions have become clear.

The last step in this phase consisted of re-analyzing the entire data set to confirm if the codes and themes represented and informed the research questions. By doing this, data that might have been missed in earlier coding stages can be included. This is why thematic analysis is essentially an "ongoing organic process" (Braun & Clarke, 2006, p. 92-93). Desouza & Bhagwatwar's (2014) work served as a guide to this investigation, but as mentioned earlier, the Brazilian context differs from that of the USA. As a result, new themes and observations emerged in this step.

Dissemination

This last phase represented the discussion of the Findings (Chapter 03). For this, magnitude coding was used to illustrate issues such as intensity or frequency of certain attributes of the MCTs which provided descriptive frequencies to further inform the data corpus (Saldana, 2013). The outcome of this phase is discussed in the Findings, Chapter 3.

4.6. Limitations of the method

Thematic analysis is a flexible and accessible qualitative research method that helps to develop a deeper understanding of social phenomena and their dynamics and can be applied to various theoretical and analytical frameworks. It can be used to explore themes and inform

about the key features of a large body of data and has been useful in research exploring data in blogs, social networks and data derived from case studies (Attride-Stirling, 2001; Nosko, Wood & Molema, 2010; Mukherjee, 2013). However, it is considered a time-consuming method and if the process of coding themes is done without any theoretical background to support the analysis, then the results of a thematic analysis may yield only shallow explanations of the data (Mukherjee, 2013). To mitigate this, literature about Civic Technologies was researched and cited to support coding of the categories and themes during application of the TA.

Furthermore, Braun & Clarke (2006. P. 16) argue that its flexibility can also be a disadvantage. This is because there is no consensus on how to conduct this analysis. Only guidelines exist and these are, according to the authors, not clearly demarcated. Another limitation is subjectivity, as different researchers may produce different analytical results due to their research trajectories and prior knowledge of the content. To mitigate this, Guo's (2012) workflow for data research was adapted to illustrate the phases for conducting the TA to define boundaries and illustrate how the analysis was conducted as well as to reduce subjectivity.

Phase 1 and 2 consisted of data collection and cleaning the data. Phase 3 proceeded with coding of the data and identified the elements that were present in the MCTs. This was an important step because it allowed to determine how and if the information identified in the TEPPCE was available in the data-corpus about the Brazilian MCTs. The TEPPCE framework helped to classify the Brazilian MCTs data, but due to the nature of the apps and the different country, the framework was adapted for this data analysis. In phases 4 and 5 concluded the analysis and proceeded to describing the findings.

4.7. Research Rigor

Rigor is fundamental in research, but it typically has a quantitative bias (Morse et al, 2002). For example, reliability and validity are terms commonly used in quantitative research.

They are rooted in a positivist perspective, employing experimental methods and measures to test hypothesis (McDonald, 2013). Kvale (1996) suggests that the parameters used to judge quantitative studies are inappropriate for judging the qualitative research. Kvale (1996) argued the following:

> In modern social science, the concepts of generalizability, reliability and validity have reached the status of a scientific holy trinity. They appear to belong to some abstract realm in the sanctuary of science far removed from the interactions of the everyday and to be worshipped with respect by all true believers in science.
>
> (p. 229)

Qualitative research is naturalistic, and examines data from natural settings such as interviews, questionnaires, documents, and artifacts (Golafshani, 2003). Therefore, to ensure rigor of qualitative research, it should provide reliability and validity adapted to qualitative paradigms which should be adjusted to reflect a naturalistic approach (Davies and Dodd, 2002; McDonald, 2013).

4.7.1. Reliability

Reliability aims to provide replicability or repeatability of results or observations (Golafshani, 2003; Joppe, 2000). It is most present in quantitative research (Eisner, 1991; McDonald, 2013). Stenbacka (2001) finds that using reliability in qualitative research is misleading and if a qualitative study is discussed in terms of reliability, it becomes inadequate and unsatisfactory. For Corbin & Strauss (1990, p. 419) qualitative research needs to respect the "usual canons of good science", but these characteristics should be adapted to adjust to the realities of this type of research.

Positivist views of reality, assume that the conditions which enable replication of the study do not change, this is not the case for qualitative research. Instead, qualitative researchers should aim to achieve dependability because situations change for each study (Henning, 2004;

McDonald, 2013). This is true for the MCTs in this research. MCTs go through several updates and changes, sometimes several times a year. In these updates, important app feature changes happen, such as the addition of voting sections, or allowing access to the camera on the mobile device, to for example facilitate reporting local issues.

To achieve dependability (reliability) in qualitative research, Babbie and Mouton (2001) recommend using an audit trail in case doubts arise about the research data. This audit trail can be achieved by keeping the evidence in a format that is easy to retrieve and access to enable others to investigate it. Another way to provide an audit trail is to keep a log that catalogues how the research was conducted (Analytic Memos), providing a level of transparency that makes the findings dependable (Pather, 2006; McDonald, 2013).

Neuman (2006) considered stability reliability because it also aims to safeguard that the data does not vary across time. Stability reliability aims to safeguard that the data does not vary across time. To ensure that the data was stable, archives of images of the data recorded at the time of data collection were recorded. Future studies could use several time-lapse captures of the MCTs and analyze them in a longitudinal fashion (such as capturing various moments within a period of one year). Representative reliability refers to reliability across groups. The first phase of coding was adapted and inspired by previous studies Desouza& Bhagwhatwar, (2014). Therefore, this approach extends these frameworks to a Brazilian and MCTs context.

When aiming to improve research rigor, Inter-Coder Reliability (ICR) is a common and has become a frequently expected practice in qualitative analysis (Keene, 2022). In ICR, the principal researcher assigns and reports numerical measures to degrees of agreement between multiple coders (O'Connor and Joffe, 2020). There are, however, controversies regarding ICR. For example, an argument in favor of using this tool is that it helps to convince the researchers and audiences that the analysis can be understood and communicated between people. This can facilitate future comparisons between different settings, locations, and datasets (Joffe &

Yardley, 2003 as cited in O'Connor & Joffe, 2020. p. 03; Yardley, 2008;). However, Keene, (2022) argues that using multiple coders and assigning measures to them is a practice that comes from the quantitative research domains, and it is not necessarily appropriate but has been widely adopted in qualitative information science and health research for example. On the other hand, in research areas such as sociology and anthropology, this practice is not as commonly employed (Small, 2008; Dorey, 2018). Qualitative researchers have argued that relying on multiple coders to ensure research rigor reduces the importance of important qualitative research practices such as the use of analytical memos and triangulating (Morse, 2015; Keene, 2022). Here, the analytical memos were a crucial part of the analysis of and reflection of the coding process for the MCT data-corpus.

Furthermore, when a qualitative study includes several iterations with the data, the researchers can revise the codes they assigned to the data, this improves the quality of analysis. Finally, a drawback for employing additional coders is that it requires resources such as time and monetary funds to hire additional coders that can pose as an additional obstacle for some researchers. In other words, there are benefits and reservations for using ICR in qualitative studies and Keene, (2022) defends that the strength of a study is not dependent on this decision alone.

To ensure dependability (reliability) of this research, all the data-corpus (app descriptions, secondary data and logs of the data-collection and analysis were kept throughout the entire research. These were the analytic memos and notes which are also presented throughout the dissertation.

4.7.2. Validity

Validity is traditionally associated with quantitative research and is rooted in a positivist tradition (McMillan and Schumacher, 2010; Golafshani, 2003). "Validity determines whether the research truly measures that which it was intended to measure or how truthful the research results are. In other words, does the research instrument allow you to hit "the bull's eye" of your research object?" (Joppe, 2000. p.1). For, Winter (2000) it is possible to address validity in qualitative research, but it should not be viewed as a single, fixed, or universal concept, but a contingent construct, grounded in the processes and intentions of research methodologies and projects. Davies and Dodd (2002) argue that considering validity in qualitative research is futile unless it is considered in conjunction with reliability. Lincoln and Guba (1985) defend that triangulation is a suitable strategy for ensuring the validity and improving the reliability of research. Patton (2002) points out that the use of triangulation strengthens a study by combining methods. For Henning (2004) internal validity in qualitative research is accessed through credibility and external validity through transferability.

Ritchie and Lewis (2003) defend that triangulation is an appropriate way to ensure credibility (internal validity) of qualitative research, because it involves multiple methods and sources to ensure the integrity of the data and its analysis. In this research, the app description data is triangulated with news sources and interviews to ensure credibility of the findings. "The adoption of triangulation adds expansiveness to the research and provides a more comprehensive understanding of the phenomena under investigation. " (McDonald, 2013).

Credibility (internal validity) will be ensured in this research by triangulating various sources (app descriptions, news articles, research papers and interviews, providing referential adequacy by recording the evidence and making it available to other researchers and by selecting interviewees in a purposive manner (McDonald, 2013).

Transferability (external validity) refers to how the research findings can be applied in other contexts with other participants (Babbie & Mouton, 2001; Henning, 2004). For Richie and Lewis (2003) it should be used in qualitative research in place of generalizability. Transferability can be improved if the evidence and reports are collected detail, so that the reader can interpret the level of transferability. Another way to ensure transferability is to select data and interviewees in a purposive manner and maximize the diversity of data. This adds richness to it, making the findings more transferable (McDonald, 2013). Transferability of the findings in this research will be ensured by providing detailed descriptions of the findings with quotes taken from the MCT app descriptions, secondary data, and interviews. The interviewees will be selected purposive manner, representing the app developers, users, and designers. This will add richness to the data for more transferable findings.

4.7.3. Ensuring rigor in qualitative research

Golafshani (2003. p. 597) argues that "triangulation as used in quantitative research to test the reliability and validity can also illuminate some ways to test or maximize the validity and reliability of a qualitative study". For, Lincoln and Guba (1985) triangulation is a suitable strategy to ensure the validity and improve the reliability of research. Triangulation uses distinct data sources of data and information to build a comprehensible set of themes by adopting multiple sources such as written text, observations, and interviews. The goal is to lead research to a more valid and reliable construction of reality (McDonald, 2013; Johnson,1997; Creswell, 2008).

Triangulation of different data sources was used as a method to help to confirm the findings. This method supported the findings by showing independent information that agree with or contradict the propositions made by the app developers. Secondary data was collected such as YouTube videos, news reports as well as scientific papers. This depended on what was available for each MCTS. Then interviews were made with stakeholders to confirm what was

found in the other data-sources. Data sources were collected from different foci and strengths so that they could complement each other (even though this was sometimes not possible). According to Miles, Huberman & Saldana (2014), corroborating different sources increases the trustworthiness of the data analysis. In this research, three secondary sources were selected for each app. To increase trustworthiness, one Ph.D. candidate and one post-Doctoral fellow in the field of Information Studies, both experienced with qualitative data analysis and thematic analysis, were recruited to examine the code creation process and advise on strategies that could aid in finding patterns for the future themes.

Denzin, (2006) suggests that triangulating theories by using more than one theoretical framework for explaining an issue helps to improve validity in qualitative research. This was done in chapter xx and phase 5 of the analysis, where other theories that would help answer the research questions were incorporated.

Triangulating independent sources also helps with dependability as well as validity because data was confirmed by using different sources to arrive at the same conclusions (Miles, Huberman & Saldana, 2014). Validity has been contested among qualitative researchers. For example, Wolcott (1990) advocated that quantitative measures are not appropriate for qualitative inquiry. Miles, Huberman & Saldana, (2014) state that qualitative research chooses to use these terms to suggest rigor. In this research, the efforts to improve the validity were also based on Miles, Huberman & Saldana, (2014) as followed according to their recommendations for improving validity in qualitative research:

- Aimed to provide a rich description of the coding process as well as the codes resulted from the iterations.
- Triangulation with secondary data sources helped to produce somewhat similar conclusions. When this did not occur, the aim was to explain the reasons why.

- The data corpus was linked to the categories created to reflect the phases of the data analysis.
- Produce clear and concise findings that were systematically related to one another (Charmaz, 2006; Eisner, 1991).

Another way to increase the validity of qualitative research is to provide numerical values about the frequencies and prevalence of the codes and themes present in the data-corpus such as the percentage and number of analytic units that help to explain the themes and categories that emerged from the data (Howitt & Cramer, 2007).

To ensure that the data was stable, archives of images of the data recorded at the time of data collection were recorded. Future studies could use several time-lapse captures of the MCTs and analyze them in a longitudinal fashion.

Braun & Clarke (2006) advise that to validate qualitative research, it is important for the researcher to subjectively focus on the social context of the issue of analysis. Using thematic analysis for this research has enabled to read and re-read, understand, and identify the common issues that were being addressed by MCTs in Brazilian cities. For example, some apps used in Rio the apps that came from Rio, which were popular for users and appeared frequently in media mentions were often related to the relevant issue of gun violence and public safety (such as the apps OTT and Malalai), whereas in safer cities addressed issues such as public transport. Analytic iterations provided the means to methodically read, understand and identify topics within the data which helped to understand these applications.

4.7.3. Representativeness

Multiple theories and epistemologies can be applied to thematic analysis (Braun & Clarke 2006), and it is also well suited to large sets of data (Guest, 2012). This research is limited because it was not representative of the entire population of MCTs. As the choice of the sample

was based on conceptual grounds (MCTs) the objective was not to attempt to find a representative sample as grounded theory was used to conduct an exploratory study (Miles, Huberman & Saldana, 2014).

4.8. Ethical Concerns

In this doctoral research, two types of data were collected. 1) publicly available online content and 2) Formal interviews. The formal Interviews required McGill Ethics Board clearance before conducting the surveys because humans were involved. The ethics application form and all the ethics certificates can be found in Appendices I.

The data collected for the MCTs were all publicly available on the Google Playstore, Websites, and social media. However, this raises questions and concerns such as to what private and public information is online, how to use digital content, protect privacy and copyright issues (Mukherjee, 2013).

Scholars have contrasting views on this subject. On one hand, some argue that because archives are publicly available online, this means that there is no need to request consent from the participants (Sudweeks & Rafaeli, 1995; Walther, 2002; Mukherjee, 2013). Others however note that even though online comments or posts are publicly available, the participants that made them usually have certain expectations regarding their privacy and therefore researchers should honor these expectations (Elgesem, 2002; Scharf, 1999; Mukherjee, 2013). And finally, there are researchers such as Mukherjee, (2013) and Hookway (2008) who embrace a middle ground and propose that online archives should be researched using a fair use of content in a public domain (Mukherjee, 2013, p. 139). Which means that the content being researched should be located within the public domain.

In this research, the MCTs were chosen as they were publicly available and did not violate any privacy of information policies. They were all available at no cost to use in the

public domain. Also in this study, when observing levels of citizen participation within the chosen CTs, we were not direct participant observers which ensures further privacy as the objective here is to explore the CTs and not the people who use them.

4.8.1. Management of the Data

An archive file of the data was created to ensure that it was accessible and to document the analysis that had been carried out. For each platform, we took a screen capture and downloaded the Play Store data to reflect the status of the platform at the time of analysis available in the following link: https://bit.ly/3FQ3dL4.

4.8.2. Emulating the Applications

Each app was emulated each from the data-corpus on Android Studio which is the official integrated software development environment for Android Apps. It provides an emulator to test applications on a variety of virtual devices without needing a physical device. (Android, 2018). This was an interesting tool for this research because there were no sufficient resources to buy several devices, install several versions of the Android operating systems and run the apps from the data-corpus, individually on each device. Furthermore, the Android Studio emulator provided most of the capabilities of the mobile devices that are able to run the Android OS. Figure 18. Illustrates the app Colab.re emulated on Android Studio.

Installing and running each app was time consuming and soon found out that this was an interesting exercise to better understand how these apps work, but it did not further inform the research questions. The data was available on the Play Store and secondary sources were closely related to the objectives of this research

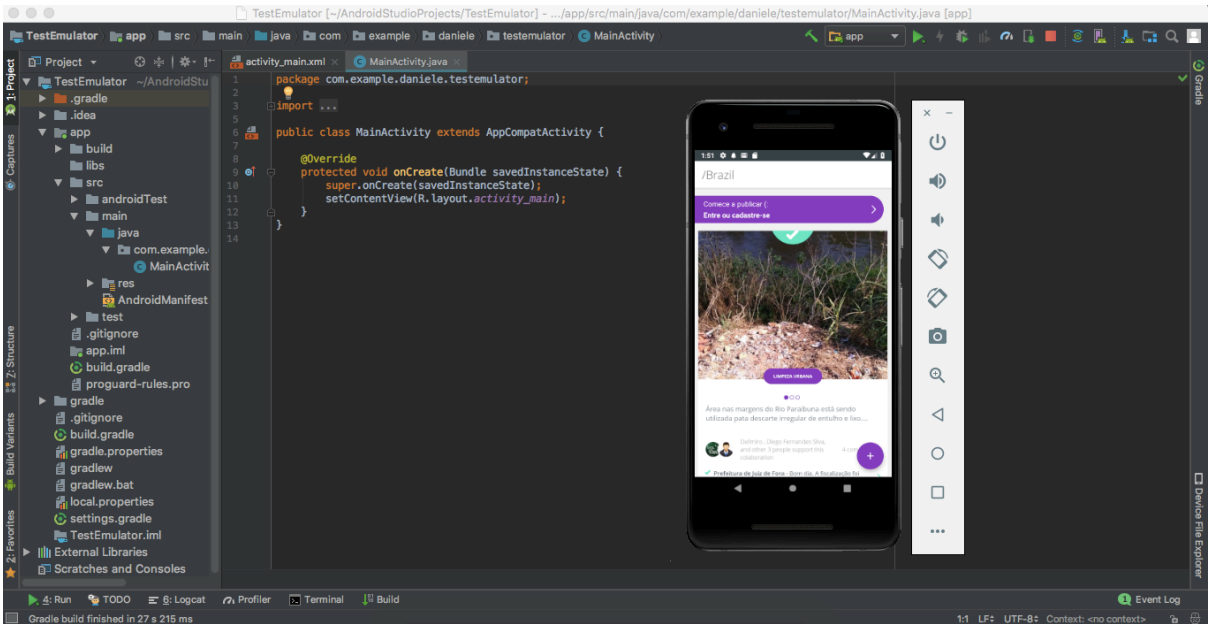


Figure 18: Android Studio Emulating the Colab App

3.9.2. Anonymizing

The Playstore shows user reviews on the main page that informs about the app. This data includes the users' identity and picture. Therefore, to ensure user privacy, we had to anonymize each file that showed user reviews for the apps.

Chapter 5: Results

5.1. Chapter Overview

In this chapter, the themes and categories derived from coding the data are described. The aim in thematic analysis is to find themes in the data that help to answer the research questions (Braun & Clarke, 2006. p. 10). These findings are presented as a description of the categories and themes discovered after data analysis and that helped to answer the research questions. The description of the codes, categories and themes has been a common way of presenting the findings from thematic analysis (Mukhegee, 2013; Motai, 2011; Guest, Greg; MacQueen, Kathleen; Namey, Emily 2012. p. 262).

Chapter 5 is divided into three parts to reflect the three research objectives and research questions. The first part shows the findings pertaining to research question 1 that explored the objectives of the apps and is subdivided into two research questions (1.a. and 1.b.). The second part presents the findings from research question 2, exploring the themes related to the interactions that occur when these apps are used, also divided into two sub-questions (2.a. and 2.b.) and the last Research Question 3 discusses the findings regarding the technology features that these apps enable to be used.

The description of the findings is presented with a table describing the themes that derived from the analysis of the data. This table includes the codebooks that were created for each theme, the name of the theme, the definition, and an example of these themes. Then each theme is explained, together with apps that represent them and excerpts that show how these themes combine with the description of the apps (Table 8). These were translated from the Portuguese language and the original versions are available on Appendix (F).

5.2. Research Question 1.

What civic issues do these platforms to address?

Research question one explored how the app descriptions publicly available on the Google Play Store stated how they aimed to address civic issues in Brazilian cities. These app descriptions are often written by the app developers as well as people within the organization that designed the app. The app descriptions were triangulated with publicly available secondary sources such as mentions in the news and blog posts available during the time the data was collected.

5.2.1. RQ1a.

What Civic Issues do these platforms aim to address?

To answer the first research question, the data corpus was coded into the themes presented in this section. To retrieve this information, the app descriptions were analyzed and triangulated with the data from secondary sources. This analysis extended the TEPPCE framework, because that framework did not specify the specific issues that their data corpus addressed. All the themes found in RQ1a. were inductive (they did not derive from the TEPPCE framework)

Table 8. RQ1a. Codebook

#	Code	Theme Name	Definition	Example
1	BUD	Budgeting	Citizens and the public sector deliberate on where to allocate local budgets.	• Information about where budgets are allocated • Participatory budgeting
2	CUL	Culture	Apps that address local cultural topics such as history, tourism, and local events.	• Maps with tourist locations • Cultural heritage information
3	EDO	E-documents	Mobile government (mGov) apps that enable citizens to view and apply for electronic documents.	• Government service provision such as documents, tax returns, labor benefits, and public retirement pensions
4	EDU	Civic Education	These apps address issues related to information and education matters	• Informing citizens of their civic rights • Information about general conditions of schools
5	ENV	Environment	Inform and invite citizens to engage regarding environmental and urban sustainability issues	• Waste management information • Maps of recycling centers
6	HEA	Health	These apps aim to inform, locate, and help with health issues.	• Locate hospitals • Encourage blood donations

#	Code	Theme Name	Definition	Example
				• Information about infectious diseases
7	I&A	Infrastructure & Accessibility	These apps refer to the physical infrastructure and aim to address urban facilities and systems necessary for the economy to function	• Information about urban construction projects • Construction status and budget allocated • Citizens communicating with government to report on public construction issues
8	POL	Policies	These are apps intended for citizens to vote, monitor, and deliberate on policies.	• Collaborative policy design • Citizens vote for policies
9	SEC	Security	Real time information about security issues	• Gun violence • Stolen cars • Collaborative information about dangerous locations
10	TRA	Transport, Mobility	These are apps that address public transport issues and road safety concerns.	• Bus routes • Real-time information about bus delays • Real time information about road accidents • Information about public transport

*Apps could be coded in multiple categories

After multiple iterations of reading and re-reading the data, the following 10 themes were found that described the specific issues these MCTs aimed to explore: (1) Budgeting, (2) Culture, (3) e-Documents, (4) Education, (5) Environment, (6) Health, (7) Infrastructure, (8) Policies, (9) Security, (10) Transport and Mobility. The full list of categories is provided in Appendix B. Some applications addressed more than one issue, for example the Colab.re app aimed to address the following issues: The following table 9 lists the number of apps that were identified in each theme:

Table 9. Number of apps in each theme

#	Code	Theme	Number of apps* (%)
1	BUD	Budgeting	12 (13.13)
2	CUL	Culture	22 (24.44)
3	EDO	E-documents	12 (13.33)
4	EDU	Education	35 (38.89)
5	ENV	Environment	28 (31.11)

6	HEA	Health	28 (31.11)
7	INF	Infrastructure	31 (34.44)
8	POL	Policies	15 (16.67)
9	SEC	Security	31 (34.44)
10	TRA	Transport, Mobility	42 (46.67)

*Apps could be coded in multiple themes

Each app could be classified in more than one theme. For example, the app "Caca Mosquito", a government-built app (Government to citizen and citizen to government) to detect location where the Aedis Aegipti mosquito could be present, was classified as an app that would allow information dissemination (Code: INF), Public health and sanitation (Code: HEA). The following table show all the themes that each app addressed.

Table 10. Number of themes per app: RQ1

	RQ1a. What issues do theses platforms claim to address (Number of themes in each platform)											
#		**BUD**	**CUL**	**EDO**	**EDU**	**ENV**	**HEA**	**INF**	**POL**	**SEC**	**TRA**	**Count**
1	#3ConfJuv				x	x	x		x	x	x	6
2	App Barueri				x	x	x		x	x	x	6
3	App do Cidadao			x								1
4	As diferentonas											0
5	Avancar	x						x			x	3
6	Bairro Seguro									x		1
7	BH Resolve					x		x			x	3
8	Bombeiros Parana									x		1
9	BusCode POA										x	1
10	Caca Mosquito						x	x		x		2
11	Cade o Meu Onibus										x	1
12	Cade O onibus										x	1
13	Caixa Trabalhador			x								1

	RQ1a. What issues do theses platforms claim to address (Number of themes in each platform)											
#		BUD	CUL	EDO	EDU	ENV	HEA	INF	POL	SEC	TRA	Count
14	Calculadora Cidadao				x			x				2
15	Carteirada do bem	x			x		x					3
16	Cataki					x		x				2
17	Central 156		x			x		x			x	4
18	Cidadao Online 4r					x	x	x				3
19	CittaMobi										x	1
20	Colab.re	x	x	x	x	x	x	x	x	x	x	10
21	Coleta seletiva Salvador					x		x				2
22	Comida Invisivel						x					1
23	comuniQ				x		x	x			x	4
24	Copel Mobile							x				1
25	Delegacia online RJ			x						x		2
26	Denuncia Ambiente		x			x						2
27	Desenvolve Brasil		x					x				1
28	Detector								x	x		2
29	Detran RN			x							x	2
30	Detran SP			x							x	2
31	Df Aguas Claras				x			x			x	3
32	Direito Na Mao				x				x			2
33	e-Titulo											0
34	Eleicoes 2016											0
35	Eu Cidadao				x		x	x		x	x	5
36	Fala Cidadao					x	x	x		x	x	5
37	Fala limoeiro				x	x	x	x		x	x	6
38	Falando com o prefeito digital				x	x	x	x		x	x	6
39	Falaparnamirim		x		x	x	x	x		x	x	7
40	Fiscalizatu										x	1
41	Fogo Cruzado									x	x	2
42	Goiania Contra Aedes				x		x					2
43	Hemogram						x					1

	RQ1a. What issues do theses platforms claim to address (Number of themes in each platform)											
#		BUD	CUL	EDO	EDU	ENV	HEA	INF	POL	SEC	TRA	Count
44	inforMe Denuncias									x		1
45	Limpa Rapido					x		x				2
46	Malalai		x							x	x	3
47	Menor Preco Nota Parana											0
48	Meu Ambiente					x						1
49	Meu Digisus						x					1
50	Meu onibus										x	1
51	Moda Livre		x		x	x						3
52	Monitora Brasil	x	x		x				x			4
53	MPRJ	x			x	x	x		x	x		6
54	MT Cidadao		x					x			x	3
55	Mudamos+	x	x	x	x	x	x	x	x	x	x	10
56	Nota Parana				x	x						2
57	Onde fui Roubado									x		1
58	Onde Votar				x							1
59	Onibus ao vivo										x	1
60	OTT (Onde Tem Tiroteio)									x		1
61	Participa BR		x						x			2
62	Particity	x		x	x	x	x	x	x	x	x	9
63	Patrimonio PE		x		x							2
64	Poa Transito										x	1
65	Portal do patrimonio				x							1
66	Porto Alegre #EuFaçoPOA				x	x	x	x	x	x	x	7
67	Pra Cima		x		x	x	x	x	x	x	x	8
68	Proximo Onibus Curitiba										x	1
69	Radar Cidadao		x			x	x	x		x	x	6
70	Recicla Retro Recife		x		x	x						3

	RQ1a. What issues do theses platforms claim to address (Number of themes in each platform)											
#		BUD	CUL	EDO	EDU	ENV	HEA	INF	POL	SEC	TRA	Count
71	Reclame Aqui	x		x	x	x	x	x	x	x	x	9
72	Relix				x	x						2
73	Resultados							x				1
74	Rota Da Reciclagem		x		x	x						3
75	Rua BH		x		x						x	3
76	Sempre Alerta							x		x		2
77	SIC.SP									x		1
78	Sigep			x								1
79	Sincov Cidadao	x							x			2
80	Sinesp Cidadao		x	x						x		3
81	SIU Salvador										x	1
82	SOS Infancia						x			x		2
83	SP Servicos	x	x		x	x	x	x		x	x	8
84	sp156	x			x	x	x	x		x	x	7
85	Sr.cidadao		x		x				x			3
86	Tarifa taxi POA										x	1
87	TCMRJ - Visitas as escolas		x		x		x	x	x			5
88	Transalvador Noa Cidadao			x	x			x			x	4
89	Visit Natal		x		x						x	3
90	Zona Azul Facil							x			x	2

The different themes found to classify the Brazilian MCTs are explained and discussed in the following section (T1 refers to Theme 1 of RQ1a.).

T.1. Budgeting: Twelve apps (13.13%) offered citizens and the public sector mechanisms to discuss on where to allocate local budgets. For example, the “As Diferentonas” app informs citizens about the budgets allocated to their cities (Figure 19). The app calculated how much was allocated in certain sectors such as health and infrastructure. It also informs citizens about the progress and expected completion date of construction projects (such as parks and schools).

It is an informative app that aims to help improve transparency as it contributes to an open government agenda. The app As Diferentonas (Figure 19), illustrates efforts to inform citizens about where budgets have been allocated to promote transparency regarding public resources. Colabore app for example, has enabled the possibility for citizens to collaborate in the decision-making of where local budgets should be allocated.

This is a form of Participatory Budgeting (PB). PB in MCTs apps were at their infancy at the time of this research, however, PB efforts have been around since the early 1980's with its origin in Porto Alegre, Brazil (Sintomer, Herzberg, & Röcke, 2008). In PB, citizens participate in deciding on how to allocate municipal or public budgets. In this form of decision-making, citizens are invited to identify, discuss, and prioritize public spending projects, thus giving them power to make real decisions about how money is spent in their communities (Montambeault, 2016). Participatory Budgeting in Brazil has varied significantly in practice depending on the time and region. The municipalities that adopted this form of citizen engagement increased the allocation of funding to sanitation and health services, which in turn, reduced infant mortality rates while maintaining capital budgets constant. McNeil, (2016) defends that the participatory budgeting is positive because authorities are encouraged to provide services that meet the needs of underrepresented citizens as well as creating frequent citizen checks on promised governmental actions.

Theme 2: Culture

This includes apps that address local cultural topics such as history, tourism and local events. Visit Natal is an app that informs tourists and citizens about local cultural sites.

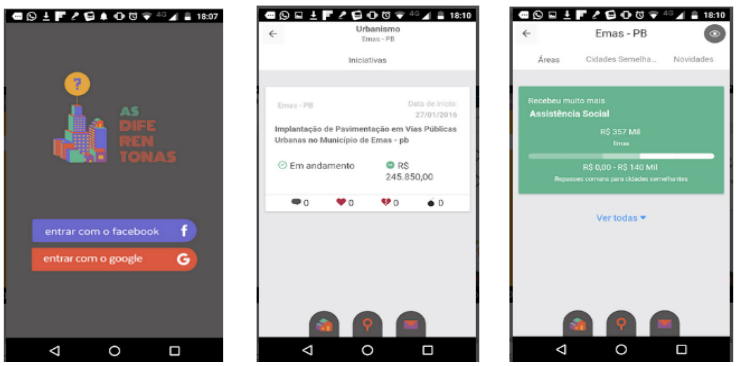


Figure 19: As Diferentonas App

> O Visit Natal é o aplicativo de turismo oficial da Prefeitura Municipal do Natal, desenvolvido em parceria com a Universidade Federal do Rio Grande do Norte (UFRN), possuindo como objetivo principal auxiliar o turista em visita à cidade a melhor aproveitar sua viagem. O guia turístico inclui informações sobre os principais atrativos histórico-culturais e naturais, eventos, compras, além de informações sobre os serviços turísticos e não turísticos disponíveis na cidade.
>
> [Visit Natal is an official tourism application from Natal municipal government, developed with the Federal University of Rio Grande do Norte (UFRN). Its main goal is to help tourists to enjoy their trip to Natal. The tour guide includes information about the main natural, cultural-historic attractions, as well as events, places to shop and information about several tourist services available in Natal.]
>
> (Visit Natal App description, 2018)

T3: E-documents: Were MCTs enable citizens to view and apply for electronic documents. These are digital data used for digital government administration through provision of electronic and non-electronic government services. Some were developed by governments. For

example, Sinesp Cidadao, which was downloaded over 10 million times, is a government-developed app that provides services regarding public and transport safety. This app provides information on vehicle theft, missing people and integrates information from police departments in participating states (such as Sao Paulo, Brazil): "O SINESP Cidadão é um módulo do Sistema Nacional de Informações de Segurança Pública que permite ao cidadão brasileiro acesso direto a serviços da Secretaria Nacional de Segurança Pública do Ministério Extraordinário da Segurança Pública" [SINESP Cidadao is a module from the Public Safety National System that allows citizens to have direct access to services from the Ministry of Public Safety of the Extraordinary Ministery of Public Safety] (Sinesp Cidadao app description, 2018).

Cidadao app, was developed privately and downloaded over 500.000 times, the goal is to unify several government services such as tax returns and vehicle taxes." O aplicativo do cidadão foi desenvolvido com o intuito de unificar os serviços mais importantes para o povo brasileiro." [The app, aplicativo do cidadao was developed to unify the most important services for the Brazilian people] (Aplicativo do cidadao app description, 2018).

Another example are e-documents relating to civic benefits (such as pensions), aid in paying taxes and provide information about labor rights. For example, the government-developed app, Caixa trabalhador, provides e-documents and services regarding pensions, unemployment benefits and allows users to view their documents on mobile devices:

> "Ficou mais fácil saber sobre os seus diretos de trabalhador. As informações que você precisa sobre Seguro-Desemprego, PIS e Abono Salarial estão nesse aplicativo desenvolvido pela Caixa. Com alguns toques você acessa o calendário de pagamentos e ainda visualiza a situação dos benefícios. O aplicativo também reúne as perguntas mais frequentes sobre cada benefício para que você não tenha dúvidas. Se precisar, use

também o mapa e encontre a Caixa mais próxima de você. Com tudo à mão, você fica mais seguro e informado."

[It is now easier to know about labor rights. The information that you need about unemployment benefits, social integration program (Programa de Integracao Social – PIS) and salary bonuses are available in this application that was developed by Caixa. With a few clicks, you can access the payment calendar and you can view the situation of your benefits. The app also provides an FAQ section about each benefit. If you need, you can also use the map that shows you the closest Caixa to you. With everything in your hands, you are safer and more informed.]

(Caixa Trabalhador app description, 2018).

T4 Education: These apps address issues related to information and education matters. For example, the TCMRJ visitas as escolas (Tribunal de Contas do Municipio do Rio de Janeiro) app was developed by the government to help inform citizens about the general conditions of public schools such as infrastructures (images of the buildings and the sports facilities). The App informed citizens about these government Project and invited citizens to participate by rating their local schools, and providing their inputs ideas and suggestions: "Aplicativo sobre as condições das escolas públicas municipais da cidade do Rio de Janeiro...Participe, enviando uma solicitação a respeito de quaisquer problemas acerca da educação pública municipal, da Educação Infantil ao 9o ano do Ensino Fundamental." [Application that is concerned about the conditions of public schools in Rio de Janeiro... Participate by sending a request about any concerns regarding municipal education, from kindergarten to the 9th year of primary school.] (TCMRJ app description, 2018)

T5: Environment

These apps designed to inform and invite citizens to engage regarding environmental and urban sustainability issues such as correct garbage disposal and recycling and waste management. The Coleta Seletiva Salvador app, for example is a government-developed app that informs citizens about the correct places to dispose of waste.

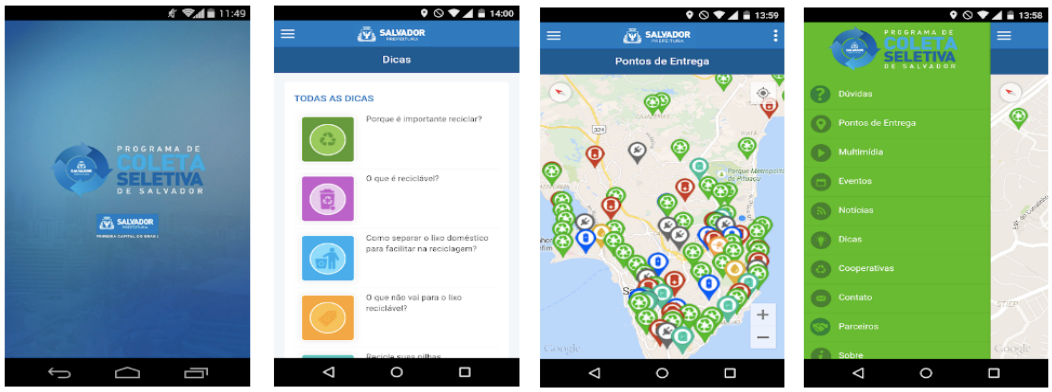


Figure 20: Coleta Seletiva de Salvador app

"[A Prefeitura Municipal de Salvador reconhece a importância da coleta seletiva como instrumento político, social e econômico de estruturação do planejamento urbano e da gestão dos Resíduos Sólidos na cidade. Para isso, definiu-se pela implantação de um programa de coleta seletiva, inicialmente disponibilizando ao cidadão Pontos de Entrega Voluntária - PEV, distribuídos por diversos locais da cidade com o objetivo de destinar os materiais recicláveis gerados em suas residência e local de trabalho." [The municipal government of Salvador recognizes the importance of garbage and waste selection as a political, social, and economic instrument for urban planning and waste management in the city. In this context, the program for selective waste management was created, the first step was to provide locations for volunteered garbage disposal (Pontos de Entrega Voluntaria – PEV) that were distributed in several places in the city. The goal is to send the recyclable material that are found at home and in offices to locations where these materials can be recycled.] (Coleta Seletiva Salvador App description, 2018).

Health (T6): These apps aim to inform, locate and help with health issues. For example, they can help locate nearby hospitals, find out where they can donate blood, and report health issues such as combating areas infested with the Aedis Aegipti mosquito, combating yellow fever or help find information on prenatal health. Hemogram for example, is an app to motivate citizens to donate blood: "O Hemogram, desenvolvido pelo Instituto das Cidades Inteligentes, é um aplicativo colaborativo cuja intenção é promover e incentivar a doação de sangue envolvendo a população e as organizações de saúde que mantém os bancos de sangue e os postos de coleta e distribuição." [Hemogram was developed by the Smart Cities Institute. It is a collaborative app that aims to promote and encourage blood donations from the population and health organizations that manage the blood banks, collection, and distribution.] (Hemogram app description, 2018)

Goiania contra Aedes is an app that allows citizens to report locations that may be infested with Aedes Aegypt mosquito. It allows citizens to post pictures taken with their mobile devices so that local authorities can address these cases and combat further proliferation of yellow fever and the Zika virus: "Aplicativo utilizado para que o cidadão de Goiânia possa fazer denúncia sobre focos do Aedes Aegypti, com opção de anexar fotos." [App that enables citizens from Goiania to report areas that are a focus for the Aedes Aegypti, with an option to send pictures.] (Goiania contra o Aedes app description, 2018)

Infrastructure and Accessibility (T7): These apps refer to the physical infrastructure and aim to address urban facilities and systems necessary for the economy to function. For example, roads, bridges, telecommunications, and water supply. (O'Sullivan & Sheffrin, 2003). The Avancar app, was developed by the federal government to inform citizens about construction

projects around the country as well as how much of the federal budget was allocated towards each project.

> "Rodovias, creches, aeroportos e muito mais. Mais de 7 mil obras estavam atrasadas, atrasando também a vida dos brasileiros. Com o programa Avançar, serão mais de R$ 130,97 bi em investimentos para a execução de rodovias, creches, aeroportos, habitações e muito mais. Agora que você já conhece o Avançar, o programa que avança o Brasil, conheça também o aplicativo oficial. Use o aplicativo para: Pesquisar obras por geolocalização; acompanhar de perto qualquer os empreendimentos; Ver fotos e informações sobre as obras." [Roads, nurseries, airports and much more. More than 7 thousand infrastructures and construction projects were late, delaying the lives of Brazilian citizens. With the program Avancar, more than R$ 130,97 billion in investments on road construction, nurseries, airports, housing and much more. Now that you know about Avancar, the Program that advances Brazil, explore, the official app. You can use this app to: Search for projects based on geolocation; check on any project; and see information and pictures of the status of the infrastructure projects.] (Avancar app description, 2018)

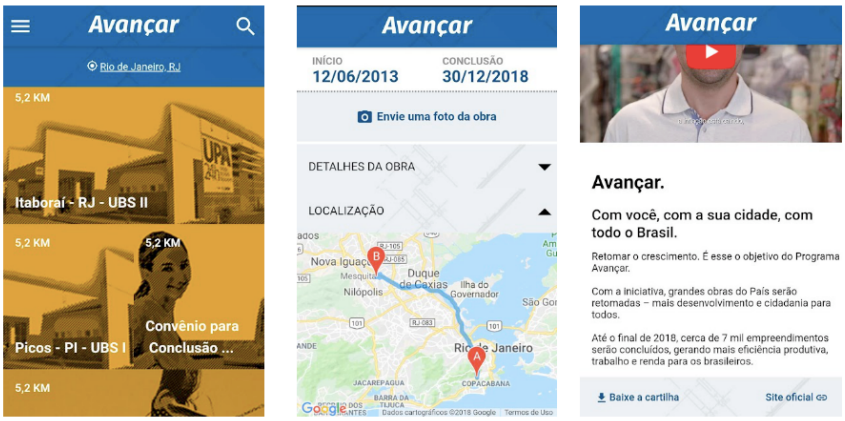


Figure 21: Infrastructure app Avancar

This theme also aggregated the apps that are intended to help people with disabilities and apps that enable ease of access to places as well as apps that can receive citizen input regarding

access design (Henry, Abou-Zahra & Brewer, 2014). For example, the Cidadao 4R app is an e-Government app that allow citizens to report on issues regarding accessibility barriers such as fallen trees, and potholes (Figure 20, Cidadao 4R).

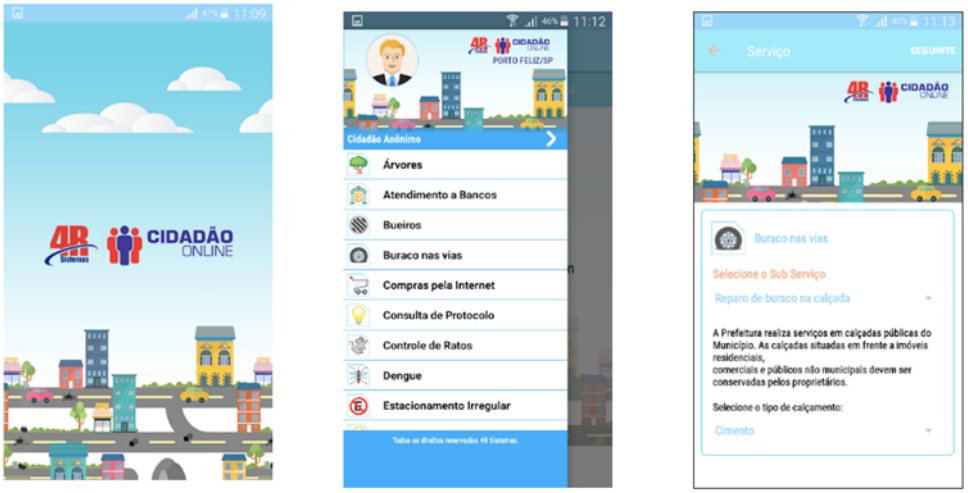


Figure 22: Accessibility app "Cidadao 4R"

" Um problema qualquer, como um buraco, um semáforo com defeito ou vazamento de uma boca de lobo, pode ser facilmente resolvido se a Prefeitura estiver conectada com sua população." [Any problem such as a tree that has fallen, a broken traffic light or a leaking pipe, can be easily fixed if the local government is connected to the population.] (Cidadao 4R app description, 2018)

Policies (T8): These are apps intended for citizens to vote, monitor and deliberate on policies. Colab.re is an app that offers an option for citizens to give their input on public consultations through their mobile devices:

> " Caso a sua prefeitura esteja conectada à plataforma, você ainda pode participar de consultas para tomadas de decisão de uma maneira fácil e dinâmica. Imagine a Prefeitura da sua cidade querendo decidir onde abrir novas ciclofaixas e você podendo dar sua opinião diretamente pelo aplicativo! No Colab, tudo isso é possível!

Acreditamos na gestão colaborativa das cidades, com cidadãos mais engajados e governos mais participativos." [If your municipal government is connected to the platform, you can participate in public consultations for public decision-making in an easy and dynamic way. Imagine a municipal government that is building new bike lanes and you can give your opinion directly in the application! Colab, all of this is possible! We believe in collaborative city management with engaged citizens and participatory governments.]

(Colab.re app description, 2018)

The secondary data confirmed this finding for example, Figure 24 shows the voting function in the Colab.re app. Colab.re's main function is for civic reporting of local issues (Soprana, 2016). But it includes policy voting as well. The Niteroi prefecture, a municipality of the state of Rio de Janeiro, launched a public consultation, in the Colab.re app to ask the citizens if they agreed to change the name of the Rua de Icarai Street to Paulo Gustavo, a famous comedian who had passed from COVID 19 (Prefeitura, nd. 2021). The voting functionon figure 24 was used to for this public consultation. Mudamos+ app allows citizens to vote on and create policies collaboratively: " Com o aplicativo Mudamos você pode assinar projetos de lei de iniciativa popular de forma eletrônica, tendo sua privacidade, autenticidade e transparência garantidas com a segurança da tecnologia blockchain." [With the app Mudamos, you can sign public policy projects electronically and be assured your privacy, authenticity and transparency guaranteed, with blockchain technology.] (Mudamos+ app description, 2018)

Security (T9): These apps aim to locate security issues and inform citizens in real-time with the aid of features on smartphones such as GPS and messaging. Security is a pressing issue in Brazil, with over 70 thousand violent deaths in 2016 (Chade, 2017). To address these concerns, several apps have been developed to enable people to inform each other in real time about

safety concerns such as gun violence (OTT and Fogo Cruzado), and stolen cars (Sinesp Cidadao). Malalai, for example is a virtual security companion. The user assigns a friend to be notified of their location when going to dangerous places.

Figure 23: Policy votin function Mudamos+ app

Figure 24: Policy voting function on the COLAB.re app

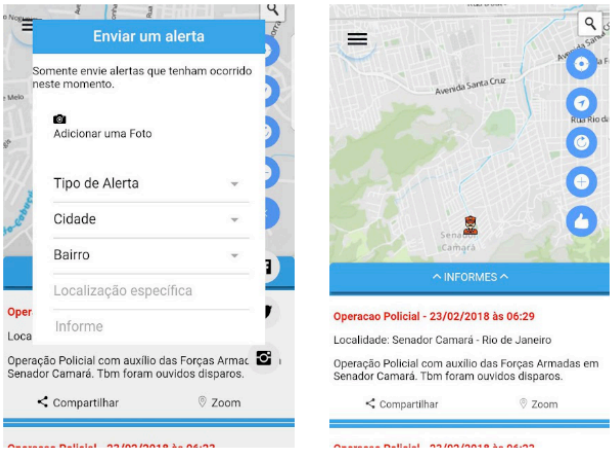


Figure 25: Security app Onde Tem Tiroteio (OTT)

" Seja qual for o meio de transporte e rota, escolha alguém da sua confiança para acompanhar seu deslocamento e ser notificado automaticamente por mensagens sobre sua localização. Ah, o MalalaiApp avisará quando você chegar! ;)" [Whatever your means of transport and route, choose someone you trust to accompany you from one

place to your destination. This person of trust will be automatically notified with message, oh the MalalaiApp, will notify them when you arrive too! ;)]

(Malalai app description, 2018)

Secondary data confirmed that Malalai provided features to help women to commute alone in safety and without fear. For example, it provided an emergency button that communicated directly with trusty contacts, sharing the location of the device in real time (Marfim, 2017). Another feature of the app was to analyze typically dangerous routes, based on crowd-sourced data from other female users. This helps users find safer routes to commute. (Melero, 2017). The GPS and SMS are important features used by this app However, when Marfim (2017) tested the app, it was not stable and would close without notice. This was addressed in the subsequent app updates.

Onde Tem Tiroteio (OTT), was an app developed by citizens in Rio de Janeiro who were concerned about the growing gun violence in their city. It aims to inform citizens of shootings in real time and hopes to remove people from dangerous zones where they might be at risk or even within range of the firearms. (Figure 25).

"Fundada em Janeiro de 2016 por quatro amigos preocupados com o crescimento descontrolado da violência no estado do Rio de Janeiro, a OTT-Brasil tem como principal missão retirar todos os cidadãos das rotas dos arrastões, das falsas blitzen e das balas perdidas, com informações que são colhidas, analisadas e divulgadas num curtíssimo espaço de tempo."

[Founded in January 2016 by four friends that were worried about the uncontrolled growth of violence in Rio de Janeiro, OTT-Brazil's main mission is to remove Brazilian citizens from gun violence, fake police and stray bullets with information that is collected and analyzed very quickly.] (OTT app description, 2018).

The Fogo Cruzado app offers a similar service, allowing citizens to report on gun violence and to view recent shootings (Figure 26).

> " O aplicativo vai ajudar a aprofundar o debate sobre segurança pública, permitindo que a população dos bairros mais afetados pela lógica da Guerra se manifeste de forma concreta e segura. É uma ferramenta para que a população mostre, através do aplicativo, todas as vezes em que é colocada no meio do "Fogo Cruzado". O app permite que qualquer cidadão compartilhe dados toda vez que presenciar ou ouvir um tiroteio. Ao preencher um formulário simples e seguro, a informação é transformada pelo app em uma notificação em um mapa. Assim, de forma interativa com a população, os mapas gerados pelo aplicativo podem ser agregados e combinados a informações de outras áreas, tais como a saúde e educação. Nesse processo, vamos obter aos poucos um retrato mais real da violência armada na cidade o que será útil para delinear políticas públicas mais abrangentes e eficazes de enfrentamento ao problema."
>
> The app will help deepen the debate about public safety. It allows the population of the most affected areas to manifest themselves in a concrete and secure way. It is a tool that enables citizens to report all the times that they are in the crossfire of Gun Violence - "Fogo Cruzado". The app allows any citizen to share data every time he/she witnesses or is exposed to a crossfire or gun shots. After filling in the safe form, the information is transmitted to other users as a notification on a map. This way, the interactive and collaborative information and mapping data can be combined with information from other areas, such as health and education. In this process, we will slowly obtain a more real portrait of armed violence in the city that will be useful for public safety policies. (Fogo Cruzado App description, 2018)

Transport and mobility (T8): These are apps that address public transport issues and road safety concerns. They often use the GPS and network location services available on

smartphones to help users to find their location and navigate towards their desired location. For example, SIU Salvador, Cade o Onibus and Proximo Onibus Curitiba apps help users know when their bus will arrive (Figure 27).

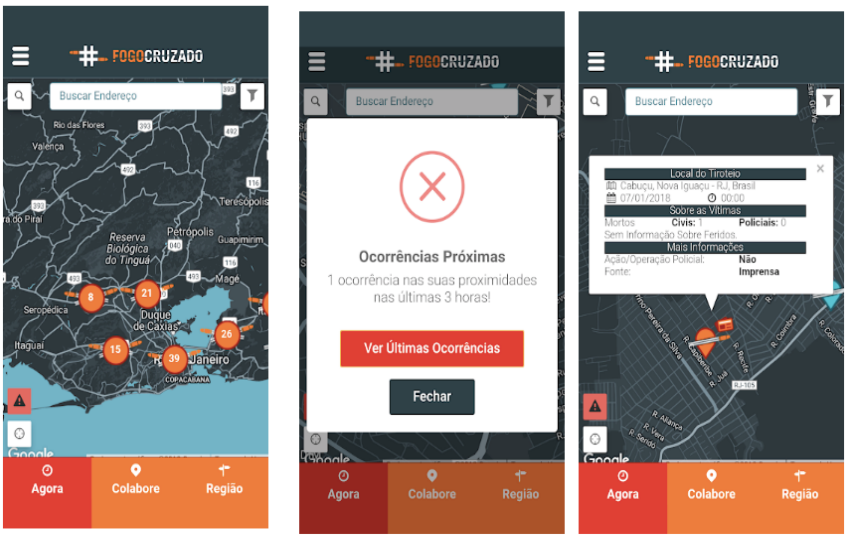


Figure 26: App Fogo Cruzado

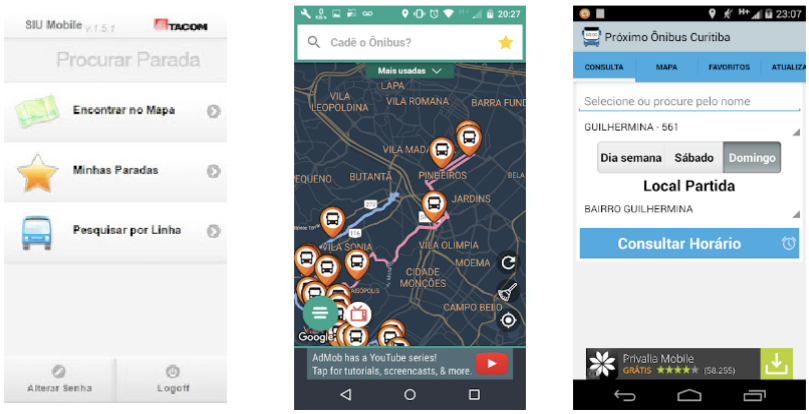


Figure 27: SIU Salvador, Cade o Onibus and Proximo Onibus Curitiba Apps

5.1.2. RQ1b.

How do these apps claim to address these issues?

After the analysis, and subsequent iterations, the following themes reflected how these apps claimed to address the issues stated in the previous section (Tables 16 and 17). These refer to

the themes that were found in the descriptions of the applications and secondary data. Eight main themes were found regarding this question: (1) Accountability, (2) Communication, (3) Citizen reporting, (4) Deliberation, (5) Monitoring, (6) Participation, (7) Information, (8) Service delivery and (9) Voting. The complete list of the apps in each theme is listed on Table 10 as well as the code and definitions of the themes then each theme is described together with an example.

T1: Enabling Accountability & Transparency: Accountability happens when stakeholders are held responsible for their actions. This theme represented the Apps which enabled citizens to monitor and report on issues about their cities. For example, Monitora Brazil was an app that informed citizens about infrastructure developments and aimed to promote transparency enabling citizens to monitor these endeavors.

The app DesenvolveBR is a pioneering program in digital governance. With it, the federal government improves and monitors the infrastructure projects in the country and citizens can follow the evolution of the infrastructural developments in their states and municipalities. The tool increases citizen participation in governmental management and amplifies transparency in government action. This app enables the citizen to verify information such as the situation, location and investments that were predicted to happen. It integrates social media and allows the citizen to send pictures, evaluations, comments and to share the information about these projects. (Monitora Brazil app description, 2018)

When a government is held accountable, the public, private and civil societies are expected to exercise their power responsibly and in conformity to a set of rules (McNeil, 2016). 18 apps were coded within the theme of Accountability. To be coded in this Theme, an app's description or the secondary data would inform citizens about civic issues that could enable them to hold their governments accountable. For example: The Monitora Brasilapp, for

example, allowed citizens to search for politicians and view their activities with regards to issues such as budget allocation, monitor the state of governmental processes via popular support and policymaking. This was done by allowing citizens to support social projects they deemed important: “If a project would have more than 20 thousand supporting citizens, it would be sent for legislative vote and could turn into a legislation” (Diario do Estado, 2017). Furthermore, it had claimed to promote transparency and enable citizens to make their governments accountable.

The app Monitora, Brasil!Exercise your civic rights, monitor, dialogue with members of the state and contribute to a more transparent and efficient legislative activity.
(Monitora Brasil app description, 2018)

Accountability can be synchronous or asynchronous. Synchronous accountability occurs when citizens report issues to the decision-makers in real-time, allowing governments to identify and possibly address these issues at their discretion and later give citizens feedback on what issues were addressed (Peixoto & Sifry, 2017). Monitora, Brasil app was thus an example of synchronous accountability. Asynchronous (or downwards) accountability can occur in real-time but was also less immediate. This flow of information and knowledge aimed to make governments more accountable by allowing citizens to understand the state of governance and to vote on the governmental measures they regarded as important.

Figure 28: Falando com o prefeito difital App

On the other hand, and example of asynchronous accountability was “Falando com o Prefeito Digital” (Figure 28).

This app allowed citizens to communicate with mayors about local issues and was an example of asynchronous accountability because even though citizens are able to report the issues they identify in real-time, these were then sent for analysis and then the results were fed-back through the app interface once the problem was addressed (Falando com o Prefeito Digital app description, 2018).

With this app, anyone who identifies a problem in their city, who needs information, who wants to give a compliment or give a suggestion to their government, can send a report that will be immediately sent to the sector that is responsible for receiving the protocol and solve the problem. The app allows you to send in pictures and your location through the GPS. You can take the picture on the spot or select an image from your gallery. The answers are received directly through the app until the problem is solved.

(Falando com o Prefeito Digital app description, 2018)

T2: Providing a platform for communication (COM): This theme refers to communication as the exchange of information between stakeholders (Communication, n.d. 2018). In the realm

of civics, it is a relational activity where stakeholders create and exchange information regarding civic issues (Hoffman, 2012). 63 apps were found in this theme. An app would be categorized as Theme #2 if it allowed users to share information and data (such as messages, images, videos and/or audio).

ComuniQ was an app that was classified in this Theme. It was developed for citizens to share news and information about their communities. They can share videos, photos, and audio. The app enables citizens to be the source of news regarding their communities.

> "O comuniQ é a nova forma dos pernambucanos compartilharem notícias, denúncias ou informações sobre a sua cidade, bairro ou comunidade e que podem virar notícia no Jornal do Commercio, TV Jornal, Rádio Jornal, Rádio JC News e Portal NE10. Exercer sua cidadania agora é rápido e fácil com o Comuniq do Sistema Jornal do Commercio de Comunicação!"
>
> [ComuniQ is the new way citizens from Pernambuco can share news, information and denounce issues in their city, neighborhood, or community, which can turn into news in the local newspapers Jornal do Comercio, TV Jornal, Radio Jornal, Radio JC News and Portal NE10. It is now fast and easy to exercise your citizenship with Comuniq from the Jornal do Commercio de Communicacao system.]
>
> (ComuniQ app description, 2018)

For example, the As Diferentonas app was categorized as enabling communication because it informs about the budgets sent to build infrastructure in the cities and allows citizens to report on irregular activities they observe (Figure 29).

> "O cidadão pode acompanhar o estado das iniciativas (convênios) de seu município, comparar o valor e cronograma da construção daquela praça de eventos com os valores e cronogramas de obras parecidas em outras cidades, e debater e denunciar fatos relacionados às iniciativas." [The citizens can monitor, inquire and check the

status of initiatives of their municipalities, compare the value and schedules of similar infrastructure projects in other cities and denounce issues in these public works.] (As Diferentonas app description, 2018)

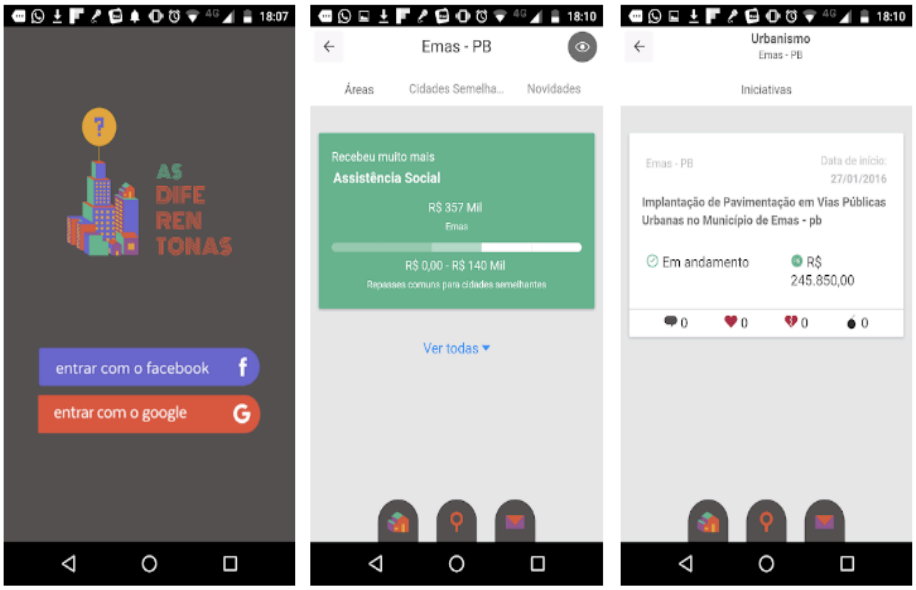


Figure 29: As Diferentonas App

T3: Providing tools for Civic reporting of local issues (CRP): Civic reporting refers to mechanisms that allow citizens to convey their opinion and provide feedback regarding civic issues by engaging with governments who can respond to citizens thus closing the feedback loop between citizens and governments. Civic reporting could enhance government capacity to use citizen feedback and transform them into policy action (McGee, Edwards, Hudson, Anderson, & Feruglio, 2018). For example, the secondary data used to confirm this finding, a newspaper article about the app Cidadao 4R explains that civic reporting and feedback loops can happen when the app is used. To use the service, the user should install the app (available for the Android platform and iOS) on a mobile device and can start to report about the problems he/she finds in the city. The reports are directly sent to local governments, that can then take

the necessary measures. According to the developers, the service works 24 hours per day. The reports are sent directly to the government sectors responsible to resolve that specific matter.

> "Cada informe recebe um número de protocolo, que pode ser acompanhado para saber o andamento da resolução. As notificações são monitoradas via Google Maps e enquadradas pelo tipo de serviço (limpeza pública, iluminação) – que também recebem diferentes prazos de resolução, de acordo com a complexidade. As solicitações podem ser acompanhadas pelos usuários de duas formas: e-mail ou pelo próprio app." [Each report receives a protocol number, that can be monitored on the app so the user can check if the problem has been addressed. Notifications are monitored via Google Maps and categorized by type of issue (public cleaning and waste, lighting) – that also receive different deadlines for resolution, according to its complexity. Users can check their requests in two ways: email or on the actual app. For example, the secondary data confirmed that several cities in the state of Sao Paulo are already using the system such as Adamantina, Andriadina, Borborema, Bom Jesus dos Perdoes, Capao Bonito e Porto Feliz. Any municipality can register for the service.]
>
> Secondary data source (Bentes, 2014)

T4: Enables deliberation of ideas (DEL): This theme refers to the process of considering the views, experiences and ideas of a group of individuals in a thoughtful and reasoned way to later proceed with voting and policymaking. (Nabatchi, 2012). An app was placed in this Theme if they explicitly mentioned information related to this type of reasoning in voting and policy making. Only 4 apps were in this theme (Colab.re, Mudamos+, Participa Br. And Sincov Cidadao).

The Mudamos+ app, explicitly mentions that citizens can vote and sign to petition for policies: "Com o aplicativo Mudamos você pode assinar projetos de lei de iniciativa popular

de forma eletrônica, tendo sua privacidade, autenticidade e transparência garantidas com a segurança da tecnologia blockchain." [With the app Mudamos, you can sign civic developed policies electronically, maintaining your privacy, authenticity, and transparency, with blockchain security.] (Mudamos+ app description, 2018) With the app, users can propose policies as well as vote for them.

The secondary data confirmed that users could propose new policies and deliberate about them. The platform also allows citizens to vote for new policies. For example, when a new idea is transformed into a policy project and it is mature enough to be presented to the public, Mudamos app adds these policy proposals so that citizens can vote for them. However, one of the main challenges was in framing new policies:

> "Mas, assim como acontece quando vem as novas tecnologias, vem os novos desafios. Vemos que a dificuldade que temos é relacionada a capacidade da sociedade de elaborar os projetos de lei. Alguns já chegaram, muito bons. Inclusive já estão em processo de coleta de assinaturas. Mas outros chegam só como ideias. Já chegaram num só dia 4.000 ideias de leis. Imagina! As pessoas querem participar, podem participar e falta agora resolver isso. [As it happens with any new technology, new challenges arise. We see that the difficulty we have is related to the capacity for society to elaborate policies. Some have arrived, really good ones. Actually, they are already available for public voting. But some just arrive as ideas. In one day, we received 4000 ideas for new policies, Imagine that! People want to participate; all we need to do is to solve this.] (Marlon Reis as cited in Trindade & Pamplona, 2017 para. 18).

Brito (2019) analyses Mudamos+ app and concludes that there is indeed participation in constructing and deciding on policy outcomes, however she proposes that this kind of participation happens individually, separately from larger social movements.

T5: Provides an environment for collaborative engagement (CE)

Participation or civic engagement happens when citizens, institutions and political systems form connections to provide a sense of power, problem-solving, deliberation, and conversation. They can take the form of volunteering, voting, or exchanging information. With the goal of collaboratively accessing and aiming to resolve community and urban issues. Nabatachi, (2012) purports that civic engagement enables stakeholders to combine skills, knowledge, and expertise to make a difference and improve the quality of life in communities. Citizens have the moral duty to see themselves as members of a larger social context and see themselves as actors in the issues that happen in these communities. Participation is an activity that intends to influence governments (Hoffman, 2012).

For example, the TCMRJ Visitas app, as Escolas, declares that one of its aims is to enable citizen participation to improve the quality of education in the municipality of Rio de Janeiro. "Este aplicativo só vem a reforçar este caráter participativo do Programa de Visitas às Escolas." [This app will reinforce the participatory character of the program, visit to the schools] (TCMRJ app description). The developers claim that they foster participation by allowing citizens to monitor the quality of municipal schools, adding their opinions about the quality of the schools and to reports on problems that the school is going through. The secondary data confirmed claim because, according to the program's developers, Marcus Silva, the main reason why they built the app, was to hear the citizens opinions, especially the students and parents, who are the ones who understand the most about what is happening (Atricom, 2016).

T6: Provides tools for dissemination of information (DI)

These apps support information delivery. For Arnstein (1969), this would be considered a low level of engagement. The app Coleta Seletiva Salvador informs citizens about the importance of recycling and separating waste. The app was developed to inform citizens where

they should properly dispose of their garbage: "O aplicativo servirá na orientação e identificação dos pontos de entrega voluntária de materiais recicláveis, bem como para indicar onde depositar corretamente medicamentos, óleo de cozinha, pilhas, baterias e eletrônicos." [The app will serve as a tool to inform and supervise citizens on where they can take their recyclable waste, as well as indicating where they can safely and correctly dispose of their medications, cooking oil, batteries.] (Coleta seletiva app description, 2018)

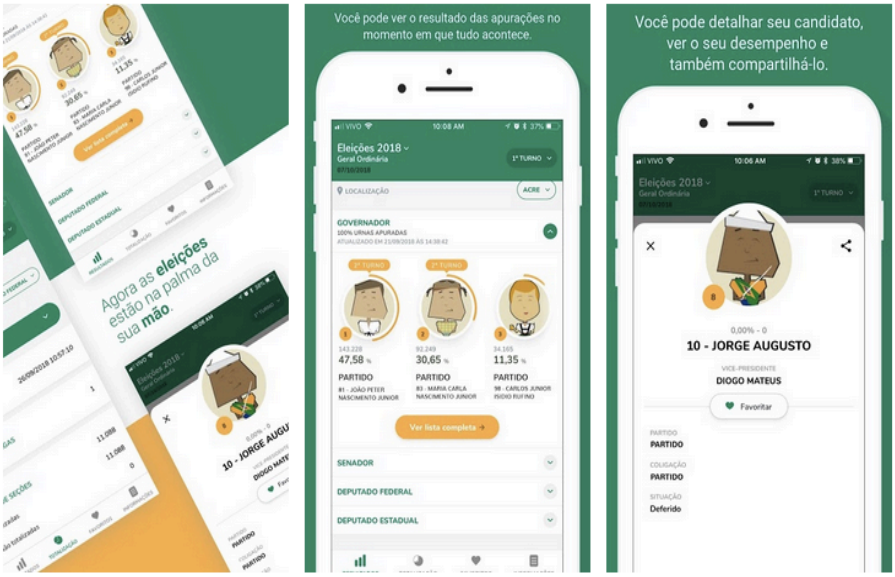


Figure 30: App Resultados 2018

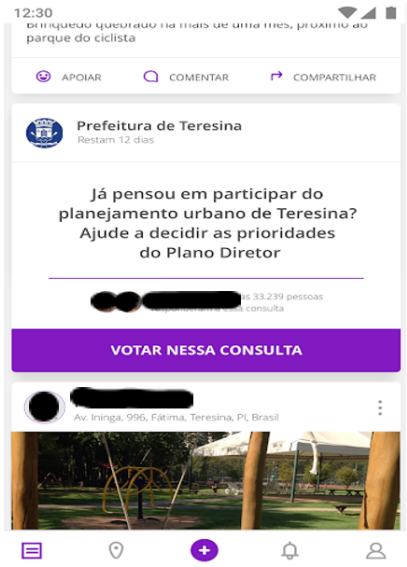
Another example of an app that aims primarily to inform is Resultados, which was created to inform citizens about the elections (Figure 30): " O Resultados 2018 é uma maneira simples de acompanhar a apuração das eleições em tempo real. 1) Conheça todos os candidatos para as eleições de 2018." [Resultados 2018 is a simple way to check the status of the elections. 1) get to know all the candidates for the 2018 Elections.] (Resultados 2018 app description, 2018)

T7: Delivery of Civic Services (CS): Apps that declared to provide services, such as e-documents, providing tools that aid in public transport. For example, the app SINESP Cidadao, that was mentioned in the previous section and had been downloaded over 10 million times,

provided services regarding vehicles: " Consulta Veículos: permite ao cidadão consultar a situação de roubo ou furto de qualquer veículo do Brasil. As informações são consultadas diretamente no banco de dados do Departamento Nacional de Trânsito (DENATRAN)." [Vehicle consultation: allows the citizen to check the situation regarding the theft of their cars for any vehicle in Brazil. The information is retrieved directly from the data bank of the National Transit Department (Denatran).] (Sinesp cidadao app description, 2018)

T9: Provides tools for voting (VOT): These apps offer tools that allow citizens to vote for projects, ideas and policies. Voting can be considered an important aspect of civics because it is a form of participation where citizens have the power to choose or to veto. Only four apps provided some form of voting mechanism (Colab.re, Mudamos+, Participa Br and Sincov Cidadao. Mudamos+ for example, offered a tool for citizens to vote on public policies. The idea is that citizens can become their own legislators (Mudamos, 2016).

Figure 31: Colab app voting option for public consultation



The Colab.re app, offers an option to vote on public consultations. For example, the Figure 30 illustrates a voting option for citizens to participate in the public consultations for urban planning in the city of Teresina.

Table 11: RQ1b. Codebook

#	Codes	Theme Name	Definition	Example	Number of Apps * (%)
1	A&T	Enabling Accountability & Transparency	Apps that enable citizens to hold their governments responsible for their actions.	• Information regarding government transparency • Information about the activities of their elected officials	31 (34.4)
2	COM	Providing a platform for Communication	Stakeholders exchange information regarding civic issues	• Communicating about policies • Communication about construction projects • Citizens communicating their concerns to local governments	63 (70.0)
3	CRP	Providing tools for Civic reporting of local Issues	Apps that provide mechanisms to allow citizens to convey their opinion and provide feedback regarding civic issues by engaging with governments who can respond to citizens thus closing the feedback loop between citizens and governments.	• Reporting issues directly with local governments • Citizens share media (photos, videos and written reports) about local issues	42 (46.7)
4	DEL	Enables Deliberation of ideas	Apps that enable citizens to voice their views, experiences and ideas and later allow them to vote on policies.	• Mobile public consultations • Anonymous voting for policies • Sign petitions	4 (4.4)
5	CE	Provides an environment for Collaborative Engagement	Collaboration between stakeholders to solve local issues by combining skills, knowledge, and expertise.	• Collaborative policy making • Stakeholders collaborate to solve local issues • Voting	44 (48.9)
6	DI	Provides tools for Dissemination of Information	Deliver information	• Where to donate blood • Results of elections	84(93.3)
7	CS	Delivery of Civic Services	Government service provision	• Sending documents • View status of applications for pensions	86(95.5)
8	VOT	Provides tools for voting	Allow citizens to vote on projects, policies and ideas.	• Voting on where to allocate budgets • Voting on policies	4(4.4)

5.2. Research Question 2

The next set if research questions explored the interactions between the stakeholders. These represented the flows of the data, information, and knowledge f when these apps were used (RQ. 2.a.) and the kinds of civic engagement that happened with these integrations (RQ 2.b.). This section was answered deductively with help of the TEPPCE framework. New themes emerged from this deductive analysis, and they were adopted and used to extend the TEPPCE framework to better reflect the data corpus collected for this research.

5.2.1. RQ2.a.

What are the information and codified knowledge flows that occur when these platforms are used?

The flows of data, information and knowledge occurred between the stakeholders introduced in chapter 3 (citizens, governments, and the private sector). The TEPPCE considered two themes referring to the flows in their data-corpus: (1) Citizen to Citizen (C2C) and (2) Government to Citizen (G2C). However, after careful reading and re-reading of the data for the Brazilian MCTs, additional themes emerged which represented the following flows which were not previously described in the TEPPCE. These were: (3) Citizen to Government (C2G); (4) Citizen to Private; (5) Private to Citizen and (6) Government to Private (Table 11).

T1: Citizen to Citizen (C2C): C2C interactions are a form of Do It Yourself (DIY) or self-service civics. It happens when citizens self-organize civic production of urban solutions. They are usually informal arrangements and governments have little or no involvement. Traditional examples of C2C interactions are neighborhood council meetings, neighborhood watch or car-pooling. When mediated by technologies, C2C flows may foster forms of civic mobilization, where data and information is exchanged between citizens, enhancing connections between citizens (Linders, 2012; Omidyar, 2016).

C2C interactions with mobile devices, have been especially useful in areas where the services provided by governments are insufficient and citizens have to take matters into their own hands. For example, Rio de Janeiro has had a long history of gun violence and government interventions have not been enough to keep the general population safe. To possibly address this, the app Onde tem Tiroteio Where is the Shooting (OTT), was developed by citizens who

wanted to leverage citizen knowledge concerning gun violence. It is an example of DIY civics, where citizens interact with each other and report the location, time and severity of shootings in Rio de Janeiro.

> " .. nossa dinâmica de trabalho, se baseia na segurança feita do cidadão para o cidadão (C2C), uma espécie de segurança "Smart", onde cada cidadão atualiza em tempo real a segurança em seu entorno, ajudando a ele e a todos os outros participantes de nossa rede dinâmica de" [Our work dynamic is based on a Citizen-to-Citizen form of public safety, a form of Smart safety, where each citizen can update information for their safety and the ones around them in real time. This helps the individual as well as all the other people that participate in our app with a dynamic network.] (OTT app description, 2018)

T2: Citizen to Government (C2G): There were 40 apps that enabled flows of data, information, and codified knowledge from citizens to government. Citizen to government flows have been regarded as facilitators for communication, engagement, and crowdsourcing of citizens to report, petition and design solutions for local issues (Omnydar, 2017). This form of interaction helps to codify citizen's knowledge about their cities and transmit it to the public sector, which has the ability and resources to address these issues. The main difference between this interaction and the previous C2C is that the government has the information with which it can take measures to solve the issues reported.

When developed by governments, Linders, (2012) called these interactions citizen sourcing and co-production, because he claimed they facilitated the frequency or quality of interactions between citizens and governments. In this flow, governments usually developed or provided the app, or they oversaw the outcome of the interaction and citizens provided their inputs to improve the situational awareness of governments.

The Desenvolve Brazil app was developed by the Ministry of Public Planning to allow citizens to report about infrastructures and public construction. At the time of its development, there were over 1.8 thousand unfinished construction sites in Brazil (Planalto, 2016). The developers of the app claimed that it would improve C2G interactions by integrating social media apps and allowing for citizens to interact with governments by sending their opinions and pictures: "It integrates social media and allows users to send in photos, evaluations, comments and to share the pages of the sites" (Desenvolve Brazil app description, 2018). However, TudoCelular, (2016) argued that it was mainly created to improve the image of the federal government, "Trying to improve its image, the Federal Government announces an app for citizens to monitor construction in the country" (TudoCelular, 2016. para 1). Furthermore, the outcome of these interactions was in the hands of the federal government.

The app perhaps enables governments to gather opinions from citizens. These mobile technologies help bridged the constraints of space and time and allow citizens to view, support, build from, interact, and collaborate, thus contributing to the dialogue amongst stakeholders.

For example, the Particity app was developed by the municipality of Cascavel to interact with citizens and learn more about civic issues by inviting citizens to share their opinions (Partiticty Cidadao app description, 2018). "The Particity app was developed for citizens to interact amongst themselves and with governments in real time, which may contribute to more efficient and collaborative forms of service design such as policy design, infrastructure consultations and e-participation." (Bagatoli, 2017)

T3: Government to Citizen (G2C): The app #EufacoPoa was developed by the city of Porto Alegre provided the population with information about municipal services such as the location of hospitals, mobility and municipal education networks (Castro, 2017; Rochol, 2017). At the time this app was analyzed, it represented an example of government to citizen flow because it

aimed to inform citizens but did not provide instruments for civic feedback. However, the mayor at the time, Mr. Nelson Marchez claimed that new features would be added in the future (Rochol, 2017)

Dunlavy & Margetts, (2010) argued that the G2C flows could enable more transparent governance. For example, the secondary source from the app #EuFacoPoa claimed to enable a form of transparency, providing citizens with information to hold their governments accountable for health services provision: “People will know where they are in line for access to public health services as well as the time, they need to wait to have the appointment. This transparency enables John and Mary to complain to the government about their waiting times” (As cited in Rochol, 2017. para 03)

G2C interactions also happen when governments provide information about the inner workings of its public affairs. Dunlavy & Margetts, (2010) refer to this as open book government. The app Avancar app informs citizens about the status of public infrastructure developments and allows citizens to express their opinions about these developments: “The goal of the initiative is to strengthen transparency and the communication channels with the population and in the first week, system e-Gov has already received 200 messages, 85 suggestions, 52 compliments, 45 requests, 21 complaints and 45 reports” (as cited in Controladoria Geral da Uniao. 2018. p. 02).

T4: Citizen to Private (C2P): This theme has similarities with the DIY civics of the C2C flow because individuals, businesses or non-for-profits create apps to solve their local problems that are not being addressed by governments. This is the case of security in the country (as with theme #13 Security for the first research question). For example, the app Bairro Seguro app is a type of mobile neighborhood watch system that was developed by a private security start-up.

“The start-up Investsys, launched the platform for residential security, that connects citizens to security services” (Vincentin, 2017. para. 01). It enables citizens to report security incidents and emergencies to security professionals in the Investisys network and aims to make neighborhoods safer. By July 2018, it had been used in Curitiba, Foz do Iguacu and Novo Hamburgo (Mendes, 2018). “This part of our day to day – safety vigilance, the police cannot do, this preventative work. This is a tech platform that connects residents, neighbourhoods and condominiums with security monitoring companies (Verdi, M. As cited in Mendes, 2018. para 02).

T5: Private to Citizen (P2C): Private to Citizen flows occur when the private sector uses government data to provide a service for citizens. For example, SIU Salvador was an app developed by the private company Tacom sistemas de bilhetagem inteligente to inform citizens about the public transport itineraries in Salvador city (Globo, 2014).

Another form of P2C flow referred to apps that connected private companies with civil society to address local issues was Bairro Seguro, which was an app built by a business to monitor building safety. According to the secondary data gathered, this app provides surveillance and security that the Police cannot do: "Essa parte corriqueira, do dia a dia, que é a vigilância, a polícia não consegue fazer, esse trabalho preventivo" (Mendes, 2018). Huggins (2010) investigates privatization of Brazilian public security and argues that the Brazilian government has failed to provide adequate social control, leading to the commercialization of public security and a need for citizens to provide alternatives to ensure their safety.

T6: Government to Private (G2P): Hemogram is an app that was created by the government of Curitiba in partnership with the Institute for Creative Cities to promote blood donations to local hospitals (public and private): Hemogram was developed by the Institute of Smart City,

it is a collaborative app, aimed to promote stimulate blood donation. It involves the population and the health organizations that administer the collection and distribution blood banks. (Hemogram App description, 2018)

Governments have provided repositories of open data that are made available online. For example, Proximo Onibus Curitiba is a mobility app that allows users to download online data and store them on their mobile devices to later view the bus routes offline. Offline application that allows you to check the bus schedules in Curitiba city. The app aims to inform the user about the timetables of the bus lines and the time it takes for the next bus to arrive in the bus stops. (Proximo Onibus Curitiba app Description, 2018)

Table 12. Themes related to Data, Information and Codified Knowledge flows

Table 13: RQ2a Codebook

#	Code	Theme Name	Definition	Example	Number of Apps* (%)
1	C2C	Citizen to Citizen	Citizens self-organize civic production of urban solutions.	• Flows of data and information reporting gun violence • Information flows to organize cultural events • Flows of data and information to organize public petitions	20 (22.2)
2	G2C	Government to Citizen	Governments provide information about services and inner workings of its public affairs.	• Information about local government services • Location of Hospitals • Governments providing open data • Information to promote government transparency	59 (65.5)
3	C2G	Citizen to Government	Citizen to government flows to facilitate communication, engagement and crowdsourcing of citizens to report, petition and design solutions for local issues	• Citizen's report about the status of public works • Citizens send information about local issues to governments	40 (44.4)
4	C2P	Citizen Private	Citizens inform local businesses	• Citizens inform private security networks about issues	18 (20.0)
5	P2C	Private to Citizen	Businesses provide citizens with data and services	• Local businesses share food with communities	34 (37.8)
6	G2P	Government to	Governments provide data	• Open government data used by	19

#	Code	Theme Name	Definition	Example	Number of Apps* (%)
		Private	and information for businesses	businesses to provide services	(21.1)

5.2.2. RQ2.b.

What types of engagement/ participation do these platforms enable?

This research question was answered deductively, in other words it was answered based on a pre-existing theme within the TEPPCE framework. However, the TEPPCE framework only considered participatory apps and it was found that apps that were not participatory, but considered tokenistic or purely informative, were still relevant to answer the research questions proposed in this thesis and were still considered apps that addressed civic purposes. Therefore, this research question, was answered based on the four modes of civic engagement provided in the TEPPCE and in addition, apps that weren't participatory in nature but served to address civic concerns and needs were kept in the data-corpus. These will be exemplified in the following sections of this chapter. The following Table 14 presents the codes and their definitions as well (deductive: M1, M2, M3 and M4 as well as the inductive: NP)

Table 14. Levels of engagement

#	Code	Theme Name	Definition	Example
a	NP	Non-Participatory	Apps that provide information and service delivery but do not allow for civic input.	• Information about government services • Apply for documents • View status of applications
b	M1	Mode 1	Apps where codified knowledge was created by the citizens and businesses and sometimes shared with local governments that would then decide what to do with that information. Flows: C2C, C2P and P2C	• Communication between citizens and businesses for security
c	M2	Mode 2	Data, information, and codified knowledge were provided by governments, citizens and businesses then searched for the information they needed, and sometimes providing feedback, comments or suggestions. Flows: G2C, G2P	• Government open data apps
d	M3	Mode 3	Government-Centric and Citizen-Sourced data	• Citizens and businesses

#	Code	Theme Name	Definition	Example
			where public agencies and citizens are near-equal agents and flows occur in both directions and all stakeholders are motivated by the common goal of addressing local issues. Public agencies informed the citizens and later, citizens provide their insights and knowledge as well as communicating amongst each other. Flows: G2C, G2P, C2G, P2G.	communicate with town halls • Citizens and businesses make requests to governments • Governments Provide information and feedback
e	M4	Mode 4	Developed Solutions occurred when all stakeholders are engaged to leverage collective citizen and business intelligence to address local issues. It is different from mode 3 because the outputs are actual solutions. Flows: C2C, G2C, G2P, C2G, P2G	• Collaborative policy design • Collaborative ideation for solutions • Voting tools

Mode 0 - the non-participatory apps: The TEPPCE did not include non-participatory apps. However, non-participatory apps can be created to deliver services or just inform citizens without providing any engagement tools such as voting. They were a result of inductive reasoning and are included here because they are still apps that address civic issues such as service-provision. For example: #EufacoPoa is an app that was developed by the Government of Porto Alegre with the initial intent to inform citizens about government services. It is purely informative and does not allow for completing feedback loop which is an important aspect of participation. "Este é o aplicativo oficial da Prefeitura de Porto Alegre. Seu objetivo é possibilitar aos cidadãos de nossa cidade uma forma mais fácil e ágil de acessar importantes informações e serviços públicos oferecidos pela prefeitura da capital." [This is the official app of Porto Alegre municipality. Its goal enables easier access to important information about services offered but the municipal government to citizens in an easy and fast way]. (#EuFaco Poa app description, 2018).

Zona Azul Facil app was created with open government data, as well as partnership with the local government to provide information about where to find parking spaces. This is not a participatory app, but it addresses a local issue that is typical of densely populated cities such as Sao Paulo. These are not participatory in nature.

Mode 1 the citizen-centric citizen sourced data (M1) The first mode in the TEPPCE refers to citizen-centric and citizen-sourced data. In the data corpus, it was found that just as in the TEPPCE, these MCTs were built and maintained by the civil society. They served as platforms for citizens to identify, discuss and generate ideas to address local issues. In this mode, codified knowledge was created by the citizens and businesses and sometimes shared with local governments that would then decide what to do with that information (Desouza & Bhagwatwar, 2014). If applied to the Arnstein's Ladder of Participation, Mode 1 would fit under the tokenism-consultation level, which represents a limited form of interaction between citizens and governments – not an ideal form of participation (Arnstein, 1969).

Onde Fui Roubado is a social and collaborative platform that maps, robbery, muggings, and other types of crimes in Brazilian cities. All occurrences are tagged and mapped anonymously, generating public data that help users identify areas with high crime rates. Today, Onde Fui Roubado is the largest public security collaborative platform in the world. It informs users about the criminal issues in 800 cities in Brazil. (OndeFuiRoubado app description, 2018) However, as it depends on volunteer data from citizens, regions with lower demographic density or low access to internet, have compromised data and do not reflect the criminal reality of those regions. (Brito, 2016. para. 4)

Mode 2 – Citizen-centric and government open data (M2): The TEPPCE framework referred to this second mode as: Citizen Centric and Government Open Data. The TEPPCE considered mode 2 to be citizen centric, because the data, information and codified knowledge were provided by governments, citizens then searched for the information they needed, and sometimes providing feedback, comments, or suggestions. This mode is also considered to be

tokenistic and at a consultation level of participation because the public agencies make the final decisions with respect to Arnstein's Ladder of Participation.

> "As Diferentonas ajudam ao cidadão a responder a uma pergunta: "No que minha cidade é a Diferentonas com relação aos recursos que recebe do governo federal?". Para isso, o aplicativo usa os dados abertos do governo federal sobre convênios realizados com os municípios e cruza esses dados com informações do SIAFI, IBGE e Firjan. Usando os dados sociodemográficos e econômicos é possível estimar se o quanto uma cidade recebeu em uma área (por exemplo, R$2M em esportes e lazer) é inesperado, quando comparado com o recebido por cidades semelhantes. Além disso, o cidadão pode acompanhar o estado das iniciativas (convênios) de seu município, comparar o valor e cronograma da construção daquela praça de eventos com os valores e cronogramas de obras parecidas em outras cidades, e debater e denunciar fatos relacionados às iniciativas." [As Diferentonas app helps citizens answer the question: what makes my city different from others with regards to the resources allocated to it from the federal government? For this, we use open Government data about the municipal partnerships and crosses these data with information from open government portals (SIAF, IBGE and Firjan). By using these social-demographic and economic data we can estimate how much budget was allocated to a city in certain areas (for example, R$ 2 million in sports and leisure) and compare the data with other cities of the same size. The citizen can also debate and report irregularities regarding how the budgets have been allocated.] (As Diferentonas app description, 2018)

With regards to the data, Linders, (2012) also mentioned this form of engagement as a Government as a Platform. This form enables citizens to access data and IT infrastructures to citizens (open data) with close to zero marginal costs to governments and can help citizens to become informed as well as producing solutions for public value. The app As Diferentonas app

was developed with government open data for citizens to use: “The information comes from the transparency portal of the open data initiative and from the partnership portal (Sincov)” (Orzil, 2016. para 3)

Mode 3 – Government-Centric and Citizen-Sourced data: The TEPPCE referred to mode 3 as Government-Centric and Citizen-Sourced data, where public agencies and citizens are near-equal agents and flows occur in both directions and all stakeholders are motivated by the common goal of addressing local issues. Public agencies informed the citizens and later, citizens provide their insights and knowledge as well as communicating amongst each other. For Desouza & Bhagwatwar, (2014), mode 3 involves a higher level of participation and is represented by the tokenism-placation level in Arnstein's ladder of participation. An example of this mode in this data corpus was Cidadao 4R: " Cidadão Online! A melhor ferramenta de comunicação com a Prefeitura! Uma das maneiras encontradas pela 4R Sistemas para ajudar as Prefeituras resolverem questões rotineiras com agilidade e eficiência foi a criação do aplicativo Cidadão Online 4R". **[**Online Citizen! The best tool to communicate with the town hall! Creating this app was one-way 4R systems found to help municipalities solve routine matters efficiently and effectively.] (Cidadaoo online4r app description)

> "Um problema qualquer, como um buraco, um semáforo com defeito ou vazamento de uma boca de lobo, pode ser facilmente resolvido se a Prefeitura estiver conectada com sua populaçãoCom a ferramenta Cidadão Online da 4R Sistemas, a Prefeitura inova com a prestação de serviços ao cidadão de forma ágil e eficiente.
>
> O cidadão, onde estiver, pode facilmente criar uma solicitação através do seu smartphone, contribuindo para a solução de problemas rotineiros da cidade. Enquanto isso, na Prefeitura, o servidor municipal administra a ferramenta recebendo todas as solicitações e as direciona para o setor competente, gerando um protocolo. O Cidadão

pode compartilhar a solicitação em sua rede social, classificar a satisfação do atendimento e acompanhar as tramitações de sua solicitação através do aplicativo, email e notificações push." [Any problem such as a pothole, a broken traffic light, or broken sewages can be easily fixed if the municipal government is connected to the population. With the Cidadao 4R tool, the municipal government can innovate and deliver agile and efficient services. Wherever the citizen is located, he or she can easily make a request through his or her mobile phone, thus contributing to solving routine local issues in their city. In the meanwhile, the municipal government administers the app and receives all the requests made by the citizens and delivers it to the sector that can solve the issues. The citizen can share the request in his or her social media and classify his/her level of satisfaction and follow the updates on his/her request with push notifications or email updates. (CidadaoOnline 4R App description, 2018).

Fala Cidadao app is another example that would fit in Mode 3 of the TEPPCE:

Fala Cidadao is a collaborative app aimed to help municipalities and citizens to communicate more efficiently. The population can create alerts that inform local governments about local issues, helping them to define problems and improvements that should be prioritized. (FalaCidadao app description, 2018).

The app SP156 facilitates communication between citizens and Sao Paulo municipal government (PMSP). With this app, citizens can contribute to managing their cities by requesting services, making complaints, and denouncing irregularities. They can also ask for updates on the status of their request (Sp156 app description, 2018).

Government-centric and Citizen-Developed Solutions (M4): In the TEPPCE framework, mode 4 or Government-Centric and Citizen-Developed Solutions occurred when all stakeholders were engaged to leverage collective citizen intelligence to address local issues. It

is different from mode 3 because the outputs are actual solutions. At the time Desouza & Bhagwatwar's, (2014) developed the TEPPCE, there had been a widespread adoption of Civic Hackathons around the USA. These resulted in collaborative ideas for MCTs.

Civic hackathons are events that are usually sponsored by governments and private companies, where citizens are invited to design solutions for urban issues. For example, the New York Big Apps was a hackathon that started in 2011 and was hosted by the New York city government. It invited citizens and businesses to collaboratively create innovative apps to address urban issues. Desouza & Bhagwatwar (2014), affirmed that these prototypes were the actual solutions which, in according to the authors, was the highest form of civic engagement found in their data.

In this research, we focused and analyzed mobile applications themselves and not the events that lead to their creation such as the above-mentioned hackathons. Therefore, the TEPPCE's definition for this theme, is not sufficient to describe the data corpus. Nevertheless, we noted that some apps, did indeed provide citizens with stronger forms of engagement and perhaps a level of citizen power. In this sense, it's suggested that to be categorized as an app that enables a high level of engagement, it provides some form of civic participation such as voting, deliberation and some form of communication. Only two apps were coded in this theme Mudamos+ and Sincov Cidadao.

Mudamos+ is an app where citizens would suggest, help to design and vote on public policies (Florin, 2017): "With the app Mudamos+, you can sign legislative projects and you have your privacy protected by blockchain technology" (Mudamos+ app description, 2018). There is still and optimist view about the creation of this app (Florin, 201) but there was no evidence of actual change in policies up to when this thesis was written. The idea was to provide some level of civic power and indeed it did enable citizens to create and vote for policies. However, no evidence was found of application of such policies thus far.

5.3. Research Question 3

What are the technology features of the platforms that enable these information and knowledge flows?

Previous studies in digital civics considered different technologies (such as messaging software, GPS devices, cameras) in isolation. Mobile devices offer these features in one handheld hardware and carry several network interfaces (WLAN, UMTS, Bluetooth, Infrared), GPS-receivers which allow ubiquitous access to the internet as well as enabling combined services using geo-referencing, voice annotation and capturing images (Reuver, Stein & Hampe, 2013). Geo-referencing features have granted a plethora of location-sensitive services (Appendix 3, shows a list of the features requires by Android Apps).

Smartphone features such as messaging and social media have enabled citizens to send feedback about the quality of services of governments in real time (Linders, 2012). Harman, Jia, & Zhang (2012) define a feature as the properties shared by a set of apps that are displayed as a set of words within the app description.

Software repositories offer rich information, the Google Play offered more information that would be interesting to explore than what the TEPPCE framework explored. During this phase, we found that information available such as permissions of the apps (access to hardware features such as camera, GPS, and others provided with us interesting information regarding apps.

To proceed with this analysis, all the features provided in Google Play (Appendix D) such as the descriptions, app version, theme defined by the developers, permissions, user rating, approximate number of downloads were collected for the repository and stored in an open office spreadsheet (https://bit.ly/3FQ3dL4).

Table 15. Technology Features required by the apps

#	Code	Theme	Definition	App Features (Number of apps)
1	C&E	Communication and engagement	Features that enable the interactions between the stakeholders, thus the flows of data, information, and knowledge	• Camera (20) • Phone (25) • SMS (3) • Microphone (7)
2	LOC	Location	Enable mapping of issues and support urban mobility	• GPS (69)
3	CON	Connectivity	Enable network connection. In a civic context, it enables real-time communication and data transfer between stakeholders.	• Bluetooth (2) • Network (89) • Wi-Fi (15)
4	PRI	Privacy	Apps that are able to access personal data. These have created concerns regarding user privacy.	• Accounts and Identity (25) • Calendar (4) • Contacts (24) • Device app and History (2) • Photos/ Media/ Files (69) • Storage (63)

*Apps could be included in multiple categories

Information about the features that the apps require were available in permissions section of the Google Play Store. To view the app's permissions, one must (1) open the Playstore app website, (2) go to an app's detail page and (3) under "Developer", tap "Permission details". The permissions are available to users to inform them about apps that want to access sensitive data (stored in the mobile devices) as well as the access to hardware features that provide access to the individual's location, files and media (Android Developers, 2018a). In the data corpus, the following features were available: accounts and identity, Bluetooth, calendar, camera, contacts, Global Positioning System (GPS) microphone, network, phone, photos/media/files, short message service (SMS), sleep, start-up, storage, vibration, wearable, sensors, Wi-Fi, device & app history, other, In-app purchases. The definitions of each theme can be found on Appendix D.

The categories provided by the app permissions represented the features that these apps required to function on the device. They were coded and inductively categorized into four themes: (1) Communication and Engagement (phone, SMS, microphone, camera); (2) Location

(GPS); (3) Connectivity (Wi-Fi, network, Bluetooth); (4) Privacy (device app and history, storage, photos/media/files, contacts, calendar, accounts, and identity. **Error! Reference source not found.** illustrates the coding of the themes that were categorized from the data corpus.

Theme #1: Communication and Engagement

Theme 1 represented the features that enabled interactions between the stakeholders, thus the flows of data, information and knowledge between citizens, government and the private sector. These apps required access to the following features: phone, SMS, microphone, and camera. Monitora Brasil and ComuniQ were the two apps that required all of these features.

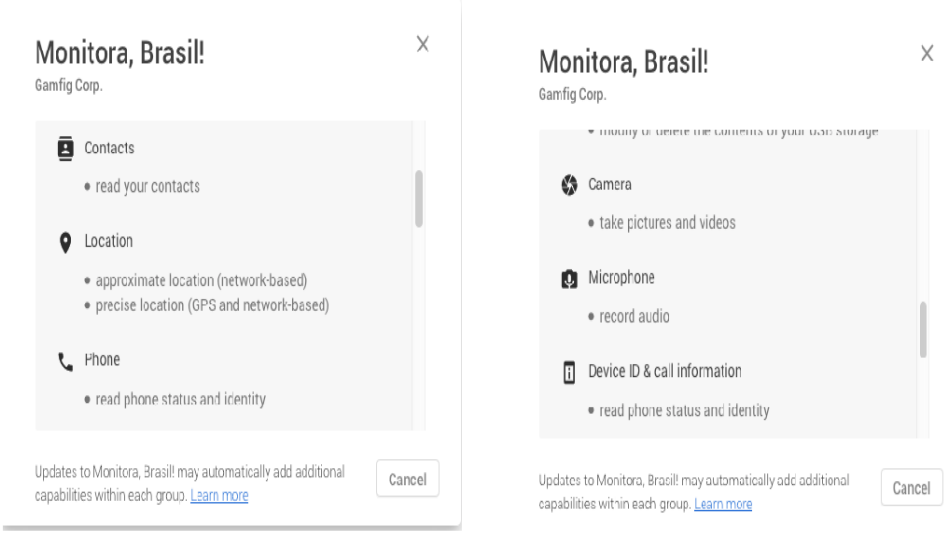


Figure 32: Monitora app permissions

Monitora Brasil app (Figure 30) enabled all of these features and it declared that citizens would be able to dialogue with members of parliament: “Exercise your citizenship, monitor and

dialogue with members of parliament and contribute to a transparent and efficient legislative activity."

Theme#2: Location

As mobile devices are equipped with GPS it is possible to locate the issues reported by the stakeholders. 69 apps enabled some form of location features. These enabled mapping and "in crisis situations or fragile states, interactive mapping can serve an immediate purpose, whether tracking aid flows, reporting on incitement, or organizing grassroots movements" (Gigler, 2014. p 03). The app Caca mosquito app required the use of GPS to be able to map areas where there were focus of the Aedes Aegypti mosquito, which transmits the dengue fever, Chikungunya fever and the Zica virus to humans were reported to be found.

The app Caca Mosquito aims to map the areas that may have focus of the Aedes Aegypti mosquito, the transmitter of Dengue fever, Chikungunya and Zika virus. The mapping is done with georeferencing, by using the GPS in the mobile device, the user does not need to identify him or herself. (Caça Mosquito app description, 2018)

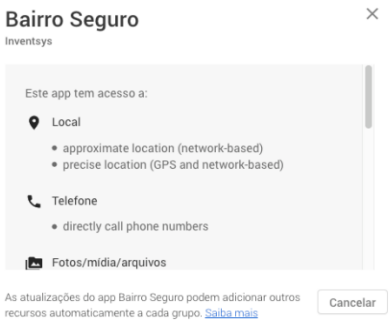


Figure 33: Screenshot of Bairro Seguro Permissions for access to features

Location features were also present in security apps such as Bairro Seguro, a privately developed app created to link security services in several cities in Brazil (Figure 31). It uses the GPS feature to locate security incidents that citizens reported: "Among the services that are

available, we allow citizens to register incidents direct contact with security agents" (Bairro Seguro app Description, 2018. para. 2).

Another application of location-enabled apps was to support urban mobility, such as CittaMobi, an app designed to predict the time a bus will arrive at a certain bus stop. "CittaMobi is your best route, it informs you about when your bus will arrive in real time." (CittaMobi app description, 2018. para 1).

Connectivity (T3): Mobile devices are able to connect to Wi-Fi, internet network and Bluetooth. From the data corpus, 89 of the apps in the data corpus enabled network connection. In a civic context, it enables real-time communication and data transfer between stakeholders.

The Fogo Cruzado app enables connectivity to the internet, which allows for real-time transmission of the information regarding the status of gun violence in Rio de Janeiro (Figure **34**). Network connectivity features helped deliver e-government services provided to the population. For example, the DetranSP app allows citizens to have access to government services regarding vehicle legal information:

> "With the app DetranSP for smartphones and tablets it is even easier to know the points in your driver's licence and possible fines the are registered in your vehicle. To have access to your information, all you have to do is use the same login as you use on the portal of DetranSP." (DetranSP app description, 2018).

One app that did not enable connectivity features after it was downloaded and installed on the mobile device was Direito Na Mao, a civic education app, that provided information about the policies created by the Member of Council Luiz Castro in the state of Amazonas: "Direito Na Mao is an app the was developed to inform about the policies developed by the congressman Luiz Castro, it is available to the population of the amazon as a civic instrument" (Direito Na Mao app description, 2018. para 1). Perhaps the reason for not enabling network

connectivity after the app was installed was because the data about these policies is stored on the device. However, we are unable to find evidence that explains why this app does not require some form of connectivity.

Figure 34: Fogo Cruzado app enables real-time information of gun violence in Rio de Janeiro

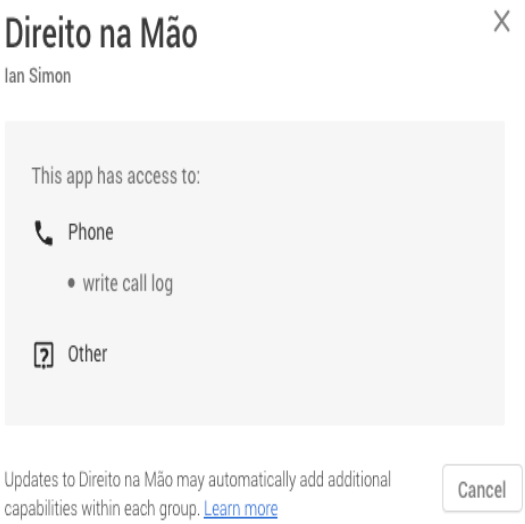


Figure 35: Permissions for features required by the app Direito na Mao

Privacy features (T4): Mobile devices store several privacy related features such as the identity of the owner of the device, device apps and history, storage of the device, photos, media, files, contacts, calendar and accounts and identity. Apps are able to access these features, which have created concerns regarding privacy as these features may provide private information about the users (Appendix D).

Transalvador NOA was an app created for urban mobility in Salvador city. In its permissions, it requests access to the calendar, where it can read and/or write events and read confidential information contained in the calendar. This raises questions as to whether it is necessary to have access to such user data for the objectives of transport in the city (Figure 36)

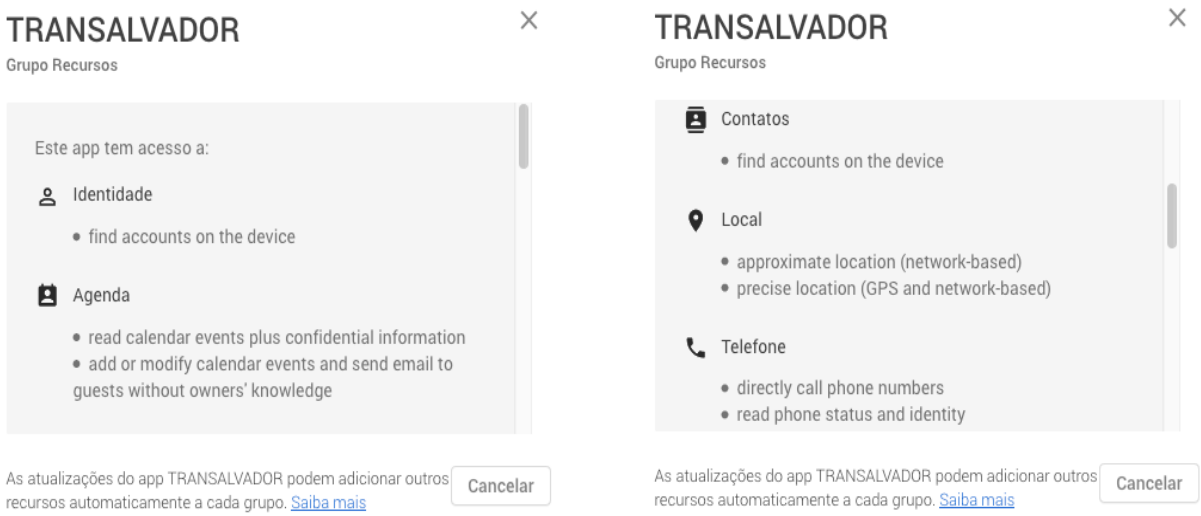


Figure 36: Permissions for features required by Transalvador NOA app.

The Portal do Patrimonio app was developed privately by the company Weway. It uses government open data to inform citizens about local cultural heritage sites in Rio de Janeiro. It also allows users to include information about these local sites. [O aplicativo Portal do Patrimonio, organizado pelo IPHAN-RJ, vem dar corpo a duas acoes principais: a divulgacao e promocao do patrimonio cultural protegido em todo estado do Rio de Janeiro e a busca por constituir uma rede participativa entre a federaÃ§Ã£o, estado e municÃ-pios na identificacao e divulgacao do acervo de bens que representam o patrimonio brasileiro]."Portal do Patrimonio

has two main goals: to inform about the cultural heritage in Rio de Janeiro State and to build a participatory network between the federation, the state and the municipalities to identify and spread the word about the cultural goods that represent the Brazilian state". (Portal do Patrimonio app description, 2018. para 01).

It is mainly an informative app, but it requests to use permissions that disclose user privacy. It has access to photos, media, files, identity, USB, storage, contacts and user accounts. It is questionable why having access to these features is necessary for the objectives of this app.

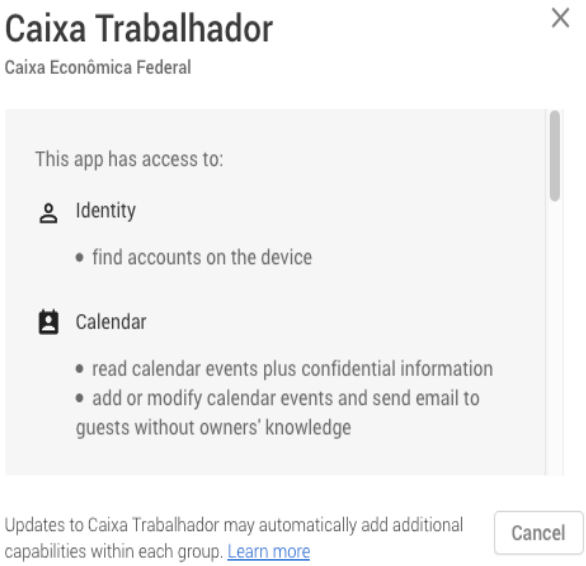


Figure 37: Caixa trabalhador app permissions for access to features

Caixa Trabalhador is an app developed by the government to inform citizens about their labor rights and benefits (Figure 37). It requires access to identity, accounts on the device, calendar (read and write over calendar events plus confidential information); to send email to guests without owners' knowledge; access to contact and accounts on the device as well as access to the photos, media, and files.

5.4. Results from the Formal Interviews

The interview protocol focused on four primary areas including 1) perspectives about the objectives of the MCT, 2) what kind of interactions happen when they are used, and 3) the technology resources used by the MCT, and 4) professional experience and personal perceptions about MCT. The survey instrument used in these interviews can be found in Appendix J of this dissertation. Follow-up questions were used to learn more about informants' role in the MCTs, perspectives about their impacts on society and what sector they represented (government, research, non-for-profit, user or other). Informants were encouraged to elaborate and express their personal perspectives about the MCTs.

The interviews were conducted with the stakeholders that developed, used, and owned the MCT. The contact was available on the landing page of the app description in the google Playstore. This was the contact information used to invite the informants to take part in the study. They were informants identified themselves as taking part in different roles in the MCTs. For example, one informant said he was a developer, user, and manager of the App. This is because anyone with knowledge of programing and app development can build an MCT. MCTs can be developed by people in grassroots movements, member of governments and businesses. The breakdown of informants helps validate RQ2 as different members of society can develop and use these MCTs. From the eight informants, 7 declared themselves as taking a managements role in developing and maintaining the MCS, 2 said they were Users, four were technology developers and 1 was a content creator and designer. From the nine informants, only 1 identified as a woman, the rest (8 informants) as male. This suggests a gender gap in development and managements of these MCTs. Of the informants, 3 belonged to the government, 3, were from businesses, one was a researcher and two belonged to non-for-profit organizations none of the interviewees were activist or journalists. Future research will benefit from gathering data from social movements and the media outlets such as news mediums.

The next part of the interview aimed to validate and flesh out additional empirical data about the MCTs that could further inform the data obtained from the app descriptions and secondary data. On the question about the scope of the apps (an app could address more than one issue). Most of the informants, five of them belonged to apps made for transport and mobility. This is an indication that MCTs built for transport have survived the longest due to the deficient transport infrastructure that exists in Brazilian cities. In second (four apps) were MCTs that provided or dealt with e-documents, three apps that addressed issues in health, one budgeting app, one culture app and one app that involved voting.

The informants spoke about the tactics used in the app to address the issues they identified in the previous section. The next research question (RQ1b) was how the app addressed the issues they identified in the previous section. Most of the MCTs (eight) were platforms that offered tools to disseminate information, five provided tools for communication. Five delivered services for example, App 86 POA informant claimed that the app provided information regarding the price of bus fares, three claimed that the apps provided transparency. The next question, inquired about civic participation. The informants responded that it did foster forms of participation. Cittamobi app respondents, for example, spoke about how the users included their input to improve the app design and service:

> "Então a gente capta as informações justamente do usuário e joga para dentro do aplicativo. Então recentemente a gente teve, se pegar o aplicativo no passado e pegar o aplicativo cinco meses atrás e pegar hoje mudou totalmente o layout do aplicativo. Então, a gente contratou algumas pessoas extras para criar gavetas do aplicativo, mudar layout, mudou como você visualiza determinados processos, mudou tudo, são coisas captadas pelo o usúario, são coisas que a gente trás do usuário. Quando o usuário elogia, olhe está dando certo. E quando o usuário critica, a gente tem que entender o que está

sendo criticado, justamente para poder adicionar dentro do aplicativo. Então o usuário reclamou que não estava conseguindo entender quando o ônibus estava em tempo real ou quando era só previsto. Aí colocamos um ícone, agora quando o ônibus está em tempo real fica uma anteninha alí piscando verde, quando o ônibus não está em tempo real fica uma anteninha cortada sem sinal. Opa, isso são coisas pegadas no campo. O usuário passa a dar sugestões porque é o usuário que vive o dia a dia, né e a gente trás isso para dentro de casa para as nossas sprints internas, para os nossos processos de desenvolvimentos internos e a gente tanto pode adicionar como um beta, como um piloto, para algumas pessoas, para alguns usuários, enquanto alguns processos simples a gente libera em prod, em produção. Daí para o usuário já usufrui daquilo que foi criado novamente." (CITTAMOBI app survey response)

The following question inquired about the technology features of the MCTs. According to the respondents, the WIFI (eight respondents) and network were an important feature. This is because the apps require internet connection to access the services. CITTAMOBI transport app was the only app from the respondents of the survey that did not require access to the network for come features to work. According to the informant, the app can work with or without internet. If a passenger needs to take a bus, but does not have internet, and there is no WIFI connection around the bus stop, he or she can still take the bus and the credits are taken from his phone wallet:

" E o que é que acontece? Aí a gente se pergunta, pô Romário mas aí talvez para a estrutura do Brasil é meio complicado porque talvez que são celulares com mais tecnologia que teria esse tipo de processo. Não, hoje a gente não utiliza o RFID, a gente usa o Bluethooth. Daniele comenta: ahh, pra fazer o pagamento? Exatamente., a gente usa o Bluetooth." [And what happens? Then we wonder, put Romário but then maybe

for the structure of Brazil is kind of complicated because maybe they are cell phones with more technology that would have this kind of process. No, today we don't use RFID, we use Bluetooth. Daniele comments: ahh, to do the payment? Exactly, we use Bluetooth.] (CITTAMOBI, Informant)

It was an important technological innovation, where they developed to universalize the payment of bus tickets by mobile phone. It uses Bluetooth for this purpose which allows simple cell phones to have access to this payment method

Cade Meu Onibus, was another transport and mobility app that provided services to help users know when their next bus would arrive, uses the camera, so that users can sense complaints about the condition of the busses, for example, if it has a broken window "Além do GPS é o uso da galeria de fotos. Quando o usuário envia uma reclamação gestão ou até denuncia ele pode anexar uma foto" [In addition to GPS is the use of the photo gallery. When the user submits a management complaint or even reports it can attach a photo].

Chapter 6. Summary of the results

This section summarizes findings from the study of Brazilian MCTs. In the first section 5.1. I propose a multi-faceted taxonomy composed of five facets of classification for the MCTs. Then I talk about the MCTs and their multi-faceted nature. Then a comparison between the findings from the TEPPCE framework are contrasted with the results from the MCTs in Brazil is presented and finally, the main findings from the formal interviews are presented to answer the research questions proposed in this research.

6.1. A Multifaceted Taxonomy of the Brazilian MCT

Classification systems are "the primary intellectual technologies or organizing principles used by Library and Information Studies professionals". Chan (2007, p.309), defines classification as “the process of organizing knowledge into some systematic order” (As cited by Rubin, 2017 p.307). Taxonomies are classifications or categorization systems used to support indexing, retrieval, and organization of information (Hedden, 2010).

A facet or classification rule uses semantic categories that are distinguishable. Facets are a useful way to organize data because they are flexible and can deal with messy, overlapping, ill-defined data and information such as mobile civic apps. Another benefit is that MCTs are constantly evolving because Mobile applications go through several updates and changes, often several times in one year. The facets are relatively easy to add, remove, or modify to accommodate changes in the classification scheme. Multi-faceted taxonomies use more than one classification scheme or facet that are clearly distinguishable from other facets (Dalkir, 2017 p.152)

After analysis of the data-corpus. Figure 38 shows the five-faceted taxonomy of the Brazilian MCTs was created to classify the different categories found in the Brazilian MCTs. The First facet refers to the scope of the MCT, in other words it classifies the typed of local

issues the app is intended to address and answers a question of What. It was found that there are ten local issues the MCTs refer to. The second facet refers to the approaches used to address the local issues proposed. The third included the actors or stakeholders found to interact when the MCT was used. The fifth are the technology features and finally the levels of engagement.

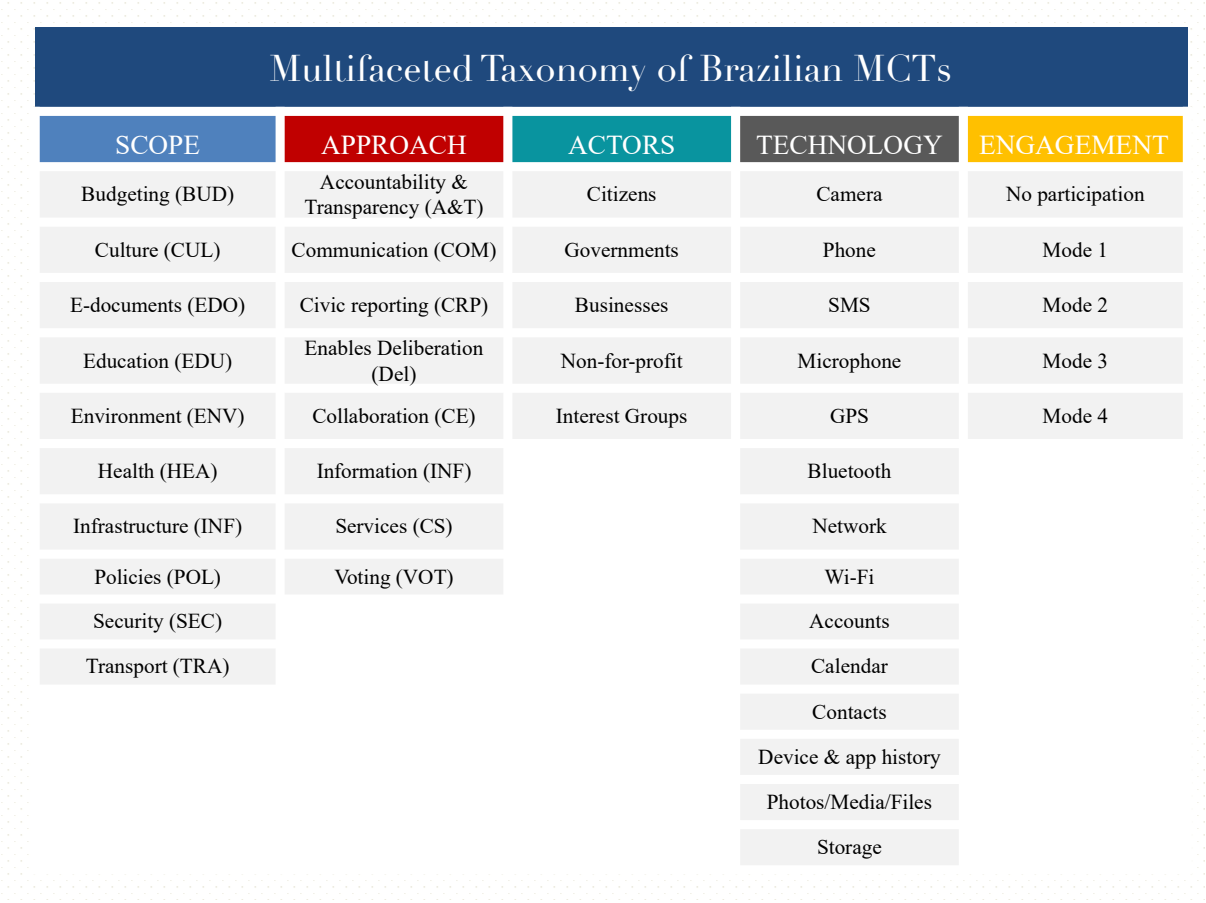


Figure 38. Taxonomy of Brazilian MCTs

In this research, the multifaceted taxonomy helped to develop, analyze, and guide the responses to the formal interviews. It served as a framework to build knowledge about these MCT. It may also serve as a guide for future researchers who wish to find and analyze other MCTs in different countries (Figure 38).

6.1.1. Apps that offered more than one category from each facet and Apps with

Multiple Facets

The facets and categories from the taxonomy are not mutually exclusive. The apps analyzed in this research can belong to several categories of a facet. And the apps enable more than one facet as well. Appendix M, lists all the facets for each app. For example, the app Colab.re aggregates several services in one app, is covers local issues (Facet: Scope, local issues covered Infrastructure, Education, Health and Environment RQ1a) and enables citizens to perform different activities, for example, citizens can inform local about local issues in their neighborhood's authorities (Facet: Approach CRP Civic reporting of problems RQ1b); the local government is informed about the issue (Facet Actors: Interaction C2G RQ2a). The local government can then respond to the user's request giving the citizen feedback on the status of their request (Facet Actors: Interaction G2C RQ 2a). For this, it uses the GPS to inform the location of the issue. It also offers a platform for mediating civic engagement and deciding on the outcome of local issues. This is a feature for public consultations where citizens can vote on the priorities for the local issues (Figure ((Facet Participation: Mode 4) (Colab.re, 2021).

6.2. Brazilian MCTs Vs TEPPCE framework

The research questions 1.a. and 1.b. were inspired by the TEPPCE framework, were answered deductively and inductively. The TEPPCE was a helpful framework to respond to research questions 2.a. and 2.b. as it provided a typology to follow with regards to the interactions that these platforms enabled. Research question 3 was answered inductively.

Research question 1 divided in two main questions and aimed to explore the objectives of the Brazilian MCTs. Question 1.a. inquired about which issues these platforms aimed to address. The deductive framework, TEPPCE categorized these as attractors and local issues but did not specify the type of local issues that were addressed. Table 16 illustrates the themes present in the TEPPCE and the themes found in the Brazilian MCTs.

Table 16. TEPPCE vs Brazilian MCTs: Attractors and Local Issues

TEPPCE		Brazilian MCTs	
Attractors /Objectives	Local issues	Issues they aimed to address (Attractors)	Budgeting
	Information access and sharing		Culture
	Monetary incentives		e-Documents
			Education
			Environment
			Health
			Infrastructure
			Policies
			Security
			Transport, Mobility

Research question 1.b. How do they claim to address these issues? The TEPPCE framework approached this in the form of the goals of each app. And gave a brief description of how each MCTS declared it was addressing their goals. This was not sufficient to answer the research questions and therefore this question was answered inductively. The following table illustrates the differences between the TEPPCE and the Brazilian MCTs. The definitions for each theme appeared in Chapter 4 (Table 11).

Table 17. TEPPCE vs Brazilian MCTs Goals of the ICTs

TEPPCE		Brazilian MCTs	
Goals	Each platform in the TEPPCE had a different approach to address the issues. For example, the app Speakup Austin app allowed citizens and public agencies to post ideas for projects, vote. (Desouza & Bhagwatwar, 2014. p. 33).	Goals	Promote accountability and transparency
			Enable communication
			Civic reporting of problems
			Deliberation
			Collaboration
			Dissemination of information
			Public service delivery

			Voting

The Interactions that happen when using these apps were explored the topics of the flow and the four-mode typology from the TEPPCE framework. Research question 2.a. asked what are the information and codified knowledge flows that occur when these platforms are used? Table 18 illustrates the findings for the Brazilian MCTs and compares them with the TEPPCE.

Table 18. TEPPCE vs Brazilian MCTs: Flows

TEPPCE	Brazilian MCTs	
Flows	Themes: Flows	Code
Citizen to Citizen	Citizen to Citizen	C2C
Government to Citizen	Citizen to Government	C2G
	Citizen to Private	C2P
	Government to Citizen	G2C
	Government to Private	G2P
	Private to government	P2G

An important difference between the TEPPCE and the Brazilian MCTs is that the interactions that occurred in the platforms from the TEPPCE were all among citizens and between governments and citizens. They did not find platforms that were privately developed thus there were no interactions between governments and businesses or citizens and businesses in the TEPPCE. Table 18 illustrates the flows between stakeholders in the TEPPCE and in the Brazilian MCTs.

2.b Do these platforms enable engagement? What types of engagement do they enable?

The TEPPCE framework classified the levels of civic engagement in four modes. All of them were participatory. However, apps that were considered non-participatory according to the TEPPCE supported the scope of digital civics. For the Data corpus in this research, 27 (30%) apps were considered non-participatory. This means that they were used for purposes other

than public consultations, changing policies or changing planning outcomes as discussed in the literature review. For example, the apps Detran RN, Detran SP, BusCode POA and Zona Azul Facil, were urban mobility apps that provided civic services but did not not include participation features. For example, BusCodePOA, and Cittamobi, helped users know when the next bus would come and this, helped them stay in a secure place until the bus would arrive. Zona Azul facil was another example of a non-participatory app, it helped users find locations to park in Sao Paulo. It was developed by citizens and then its services were used by the local government to source parking spaces (Appendix L).

For example, informational apps. Bombeiros Parana app was Fire brigade application for the government of Parana state to inform citizens of possible dangers, send alerts to population, and inform about security precautions citizens can take. This was also a non-participatory app, but it informed citizens about the weather conditions and safety information for bathers who wanted to visit the beach in real-time.

Design participation: There was also another type of participation that occurred in Brazilian MCTs. When users participated to improve the design or usability of the app. In the results chapter, CITTAMOBI interviewee explains how their team of developers, join to read users reviews and use them to enhance the platform, according to the users' requests. Gun, 2020

Table 19. TEPPCE vs Brazilian MCTs: Civic Engagement

TEPPCE		Brazilian MCTs	
Model	Name	Theme	Name
		Mode 0	Non-participatory, Information, Services, M-Government
Mode 1	Citizen-centric and citizen-sourced data (C2C)	Mode 1	C2C flows DIY Government
Mode 2	Citizen centric and government open data (G2G)	Mode 2	C2C, C2P, P2C

Mode 3	Government centric and citizen sourced Data (G2C)	Mode 3	G2C, C2G, P2G, G2P
Mode 4	Government centric and citizen developed solutions (G2C2G)	Mode 4	G2C, C2G, P2G, G2P

In this research, we focused and analyzed mobile applications themselves and not the events that lead to their creation such as the above-mentioned hackathons. Therefore, the TEPPCE's definition for this theme, is not sufficient to describe the data corpus. Nevertheless, we noted that some apps, did indeed provide citizens with stronger forms of engagement and perhaps a level of citizen power. In this sense, it's suggested that to be categorized as an app that enables a high level of engagement, it provides some form of civic participation such as voting, deliberation and some form of communication. Only two apps were coded in this theme Mudamos+ and Sincov Cidadao.

The TEPPCE focused on both desktop and mobile applications. In 2014, when the TEPPCE was developed, the technology features found were different from the features in mobile apps from the Google Playstore in 2018 when this study's data was collected. (Table. 20).

Table 20. TEPPCE vs Brazilian MCTs: Technology Features

TEPPCE	Brazilian MCTs	
Technological features	Theme	Technological features
Real-time information feeds	Communication and engagement	Phone
Discussion board		SMS
Voting tools		Microphone
Website only		Camera
Social Network	Location	GPS
Website for information convenience	Connectivity	Wi-fi
e-mails		Network
Messaging		Bluetooth
Interactive analysis tools	Privacy	Device app and history

TEPPCE	Brazilian MCTs	
Post sorting		Storage
News feed		Photos / Media / Files
Calendar		Contacts
Maps		Calendar
Comments		Accounts and Identity
Submission system		

6.3. Summary

This research started in 2012, at the time, there was optimism and an explosion of efforts to create MCTs, due to the potentials of the technology convergence of different technologies that these devices provide. Many of the apps, were created by grassroots and volunteers. These were young and enthusiastic developers that met at hackathons and Hackfests to develop useful applications for the population on weekends working voluntarily, As Diferentonas app was one of those developed by volunteers. However, after the formal interview data collection it was found that few of these applications survived. Perhaps because of the challenges of maintaining these apps and the updates that are required over without consistent financial and technical support from government, private companies, and Businesses.

It was also found that developing these apps, was very stimulating and present technological challenges, that attract many young people interested in developing applications voluntarily to help people and society. But the day-to-day software maintenance requires financial resources and organization that volunteer groups are not the able to provide. According to the informant from As Diferentonas APP:

> 00:00:10 EN “eu morava na Holanda, e participei de um evento que não se chamava Hackatom, eu acho que se chamava Hackfest, mas não tenho certeza, era um evento de fim de semana...eu participei com eles de um music day, onde tive contato que podia passar um fim de semana, com outras pessoas que você não conhecia, mas que

compartilhavam interesses de desenvolver tecnologia como diversão...aquilo me tocou muito a ideia era que eu podia me divertir desse jeito fazendo tecnologia, sem compromisso que não era encomendada por ninguém, não tinha contrato, nenhum arranjo financeiro ou acadêmico associado.“ [00:00:10 EN "I lived in Holland, and attended an event that was not called Hackaton, I think it was called Hackfest, but I am not sure, it was a weekend event... I participated with them on a music day, where I had contact that I could spend a weekend with other people you did not know, but who shared interests to develop technology as fun... it touched me a lot the idea was that I could have fun like this doing technology, without commitment that was not commissioned by anyone, had no contract, no financial arrangement or academic associated."]

However, not all the grassroots apps faded into oblivion due to lack of support. One interesting example was that of the app Onde Tem Tiroteio (OTT). It was created in 2017, after a group of four friends suffered from several Arrastoes. Arrastao is a form of crime or mass robbery that frequently happens in large Brazilian cities. It happens when a large group or gang violently and swiftly intimidate and use violence against citizens in traffic jams, crowded beaches, or metro stations (Carneiro, 2010).

OTT was created to alert citizens of these Arrastoes and violent gun shootings that happen daily in the more that 1074 favelas around Rio de Janeiro (UltimoSegundo, 2021). The manager of the app explained its objectives: “Primariamente Segurança e secundário é a parte de informações sobre transporte, não transporte público, mas em relação ao trânsito mesmo, para auxiliar as pessoas a saírem porque é correlacionada ao arrastão. Quanto maior o trânsito maior possibilidade de ter arrastão então, por isso a gente envolve essa parte de trânsito”. [Primarily Safety and secondary is the information part about transport, not public transport, but in relation to the same traffic, to help people leave because it is correlated with trawlers.

The greater the traffic the greater the possibility of having trawlers then, so we involve this part of traffic.] (OTT Informant)

This app today is a success story. It has over 4 million active users and 500,000 downloads. It continues to be maintained independently, such as a Grassroot APP. On important factor is the interaction between. People who live in the favelas can communicate with people communing nearby and warn them of dangerous situations:

> "Acredito que sim, sim. A gente tem visto as respostas do setor público, se ajudam de uma certa forma. Um exemplo né no Complexo do Alemão está havendo um tiroteio, as pessoas começam a comentar demais, mais especificamente na rua tal. Aí uma pessoa fala estou voltando do serviço agora, o morro, eu posso subir o morro? Não, não sobe ainda não, está tendo um tiroteio, espera mais um pouco. E as pessoas perguntam como é que está o clima aí em cima? Não, já está legal, as pessoas já estão na rua, os bares estão abrindo, pode vir. Então existe essa comunicação. As pessoas começam a se ajudar dentro do próprio aplicativo. Então a gente está chegando num ponto aonde a gente sempre quis chegar. Os cidadãos se ajudando." [I think so. We have seen the responses of the public sector, help each other from in certain ways. An example right in complexo do Alemão is having a shooting, people begin to comment too much, more specifically in the street such. Then a person says I'm coming back from work now, the hill, can I go up the hill? No, don't go up yet, it's there is a shooting, wait a little longer. And people ask how's the weather up there? No, it's cool, people are already on the street, the bars are opening, you can come. So, there's this communication. People start helping each other within the proprio app. So, we're getting to a point where we've always wanted to get to. Citizens helping each other] (OTT app Interview with stakeholder. Rio de Janeiro, October, 2022)

Another interesting finding from the surveys was the App E-Titulo, which was first intended to inform citizens of the places where they could vote, turned into an official identity document because it started using biometric data that was stored in the Electoral files in the app to ensure that each voter was unique. This became a trust feature and now the app is used as an official identity document:

> "… existe um projeto muito importante dentro da justiça eleitoral, que a biometria de todos os eleitores do país. Atualmente, o Brasil possui 213 milhões de pessoas, desses 213 milhões de pessoas, aproximadamente 150 milhões já são eleitores, constam no cadastro eleitoral e cerca de 120 milhões de eleitores já possuem a biometria coletada pela justiça eleitoral." [... there is a very important project within the electoral justice, that biometrics all voters in the country. Currently,Brazil has 213 million people, of these 213 million people, approximately 150 million are already voters, are in the electoral register and about 120 million voters already have biometrics collected by the electoral justice.] (Interview response from E-titulo app stakeholder. Rio de Janeiro, October, 2022)

The app also added a photo of the user and recently it has been accepted as a travel document:

> "So if you want to travel here to Brasilia for example and present a document, you can present the E-Title on mobile…Então essa incorporação da foto foi um avanço interessante porque aí o aplicativo passou a ser de uma certa forma um documento de identificação. Muitas pessoas, passaram a usar embora não seja essa a finalidade do aplicativo E-Título oficial, nunca foi, ele passou a ser utilizado na prática como um documento de identificação…". [So this embedding of the photo was an interesting advance because then the application became in a way an ID. Many people, have come to use although it is not the purpose of the application E-Title official, never was, it

came to be used in practice as an ID...]So if you want to travel here to Brasilia for example and present a document, you can present the E-Title on mobile] (E-titulo interview response from stakeholder, Rio de Janeiro, October, 2022)

This gives insights into how these apps evolve over time. It was found that apps started as information platforms, much like web portals. But with time, due to user input and incorporating more of the devices' features (camera, sensors, and GPS) more functionalities were added.

Chapter 7: Discussion

7.1. Introduction

The purpose of this research was to explore the Mobile Civic Technologies (MCTs) in Brazil that were available in the Google Android Playstore. The aim was to further understand the key objectives and characteristics of mobile technology enabled civics in Brazil. A qualitative thematic analysis approach was used to gather and analyze software repository and secondary data. This was done through multiple iterations and careful analysis of the data as well as systematically categorizing the findings both deductively and inductively. The data collected from the 90 MCTs were purposefully sampled from the Google Android Playstore and analyzed iteratively.

This research accessed multiple facets of the MCTs in Brazil through several data-sources, Appstore data, news sources, interviews, emulating the apps, documental evidence and formal interviews. There were three outcomes from this thesis: (1) A multifaceted taxonomy of Brazilian MCTs; (2) The validation of the TEPPCE framework and (3) An adaptation of a data science workflow for qualitative research. The data was validated with triangulation from documental sources and formal interviews.

The TA method was applied using both deductive and inductive approaches. The conceptual framework as described in chapter 2 was inspired by the Technology-enabled Participatory Platforms for Civic Engagement (TEPPCE) framework by Desouza & Bhagwatwar, (2014) developed in the US. This was considered an appropriate deductive framework to use because as an emerging field, it accessed technology-enabled civic engagement systematically, and the concepts it provided served as a basis to map the MCTs in Brazil.

This study confirmed the literature presented in chapter 2. Research Question 1 (RQ1) explored the question of what by asking what the objectives of the MCTs are. It extended previous research by informing the specific issues that the MCTs aimed to address. Desouza and Bhagwatwar's (2014) TEPPCE found three main objectives: local issue, information and sharing, and monetary incentive. Here, the MCTs addressed ten different objectives that the MCTs addressed (Table 16). Furthermore, I found in this research that MCTs often have more than one objective. For example, the app Colab.re aimed to address all the themes found in the objectives (Table 10).

Research question 2, explored the questions of who and how. RQ2.a. extended the TEPPCE framework because it was found that the stakeholders who exchange data, information and codified knowledge were citizens (members of the civil society and non for profit), governments and businesses. The TEPPCE mentioned citizens and governments and spoke about one-way interactions, for example Citizen to Citizen and Citizen to Government. In the data-corpus I found examples of these one-way interactions especially on informative apps (coded INF on the final taxonomy of Brazilian MCTs). To illustrate this, the MCT called Monitora Brazil was an app that aimed to improve government transparency by informing citizens of the actions taken by their government officials. However, the time the data was collected and analyzed, it did not give citizens the ability to report or give feedback to governors. For Macintosh & Whyte, (2006) this is a form of top-down engagement, because the government has control over what information is shared and controls the ability of citizens to input their opinions.

Peixoto & Sifry, (2017) spoke about the importance of closing a feedback loop of information sharing when citizens inform governments of local issues. This was confirmed in the MCTs from this study. For example, the MCT, Eu Cidadao provided a channel for communicating with local governmental authorities because citizens can send in complaints,

requests, and suggest improvements for the city, neighbourhood, or street. It enabled feedback on the status of the citizen's requests and history of requests. it was important to provide feedback to citizens after they inform local governments of the issues. RQ 2b Linders, extended the four-mode engagement in the TEPPCE by including non- participatory MCTs. It was found that these MCTs provided information and public services to citizens but did not offer a means to participate. They can be considered civic apps because they offer services to citizens. For example, E-titulo allowed citizens to find the locations for voting in the elections and later served as an official identity document in smartphones, which citizens could use to travel and as official proof of identity.

Research question 3, addressed the question of how. It explored the technology features that were enabled when the MCTs were used. The results from this study extended the TEPPCE because previous studies in digital civics considered different technologies (such as messaging software, GPS devices, cameras) in isolation. Mobile devices offer these features in one handheld hardware and carry several network interfaces (WLAN, UMTS, Bluetooth, Infrared), GPS-receivers which allow ubiquitous access to the Internet as well as enabling combined services using geo-referencing, voice annotation and capturing images (Reuver, Stein & Hampe, 2013). Geo-referencing features have granted a plethora of location-sensitive services (Appendix 3, shows a list of the features requires by Android Apps). Apps such as Onde tem Tiroteio (OTT) used the GPS to help users report local shootings in real-time, helping people to commute in safety.

7.2. Key Findings

The MCTs themes informed about the context of mobile apps for civic engagement in Brazil at the time this research was done. The first research question shed light on the kinds of issues these apps were built to address and how they claimed to address these issues. The second research question explored the stakeholders who were involved in the flows of data, information, and knowledge, as well as the level of engagement according to the TEPPCE framework. And the last research question explored the technological features of these apps. The TEPPCE was an interesting framework because it classified technology-enabled civic engagement by updating Arnstein's well-known ladder of citizen participation. The research questions were first addressed deductively using a qualitative analysis approach. However, the TEPPCE framework was only used for platforms in the USA. In Brazil, new categories emerged because it is a different country, with different issues.

The first finding was regarding the several local issues that the apps aimed to address. The TEPPCE did not specify these issues and previous research had studied each app in isolation (DiSalvo & Jenkins, 2017; Peacock, Anderson, & Crivellaro, 2018). Another conclusion was that civic apps were no longer only browser-based, they were becoming mobile, and more citizens and governments were leveraging the features of these devices to help with service delivery, civic engagement, and knowledge exchange.

Another finding is that several new themes emerged from this analysis. For example, when analyzing the flows of data, information, and knowledge TEPPCE additional inductive themes emerged as they represented flows that were not described in the TEPPCE Citizen to Government (C2G) and Citizen to Private. And non-participatory apps can be created to deliver services or just inform citizens without providing any engagement tools such as voting. They were a result of inductive reasoning and are included here because they are still apps that address civic issues such as service provision.

The new themes that emerged from the analysis during the time of this research, advance current knowledge about these apps, because no previous research had applied the TEPPCE in a different context other than the USA. However, because the TEPPCE framework was developed in 2014 and it analyzed both browser and mobile apps and because these apps are evolving constantly, it was insufficient to inform about the data-corpus in this research. Thus, the findings from this research extend this framework.

An important finding from these themes (Table 8) is that they reflect how the MCTs were used to address social issues in Brazilian cities at the time of this research. For example, from 2015 to 2016, Brazil was plagued with infestations of the Aedis Aegipti Mosquito, which is responsible for transmitting diseases such as the Dengue fever, Zica virus, Chicungunya fever and yellow fever (Womack, 1993 & Malone et al. 2016). In 2016, 1.3 million people were infected and 3.4 thousand died from Dengue fever. In addition, 174 thousand people were affected by the Zica virus in Brazil (Globo, 2016). The Dengue fever can kill and the Zica virus is especially dangerous for pregnant women because it is related to microcephaly at birth as well miscarriages. To date, the most effective way to prevent the spread of the Aedis Aegipti mosquito has been to avoid exposure and by identifying and eliminating mosquito breeding areas (Hennessey, Fischer & Staples, 2016.). The apps Goiania Contra o Aedis and Caca Mosquito were created to collaboratively locate the areas that could house these mosquitoes and allowed citizens to report areas that could be a focus for the spread of the Aedis Aegipt. They used location, pictures and messaging for this.

Figure 37 is a mind map summarizing the findings after thematic analysis was used as a methodology to categorize that MCTs in Brazil. It differs significantly from the TEPPCE first because the TEPCCE did not identify what kind of local issues that the platforms aimed to address. This is a contribution to the research community of Civic Technologies because it was known that there were platforms that aimed to address local issues, but it was not known what

kind of local issues the apps aimed to address. The following mind-map serves to view the local issues these MCTs app descriptions and secondary data declared to address and how they declared they would address these issues. It is presented in two branches reflecting the findings of RQ 1.a. what local issues the apps aimed to address and RQ 1.b. how the app descriptions and secondary data claimed they would address such issue.

Figure 39: Summary of themes for research questions 1.a. and 1.b.

The themes were generated from the app descriptions and from the secondary data that was collected. The TEPPCE was an interesting initial framework to use because it updated Arnstein's well-known ladder of civic engagement in the context of technology -enabled forms of civic engagement. However, the focus was on mobile enabled engagement, therefore, the TEPPCE four-mode typology was insufficient to provide a portrait of the data corpus (Figure 36).

The first addition to the TEPPCE framework was Mode 0. This refers to the apps that do not enable forms of engagement such as deliberation or voting, but nevertheless they support aspects of civic life which may lead to engagement in the future.

This research analyzed mobile applications themselves and not the events that lead to their creation such as the above-mentioned hackathons. Therefore, the TEPPCE's definition

for this theme, is not sufficient to describe the data corpus. Nevertheless, I noted that some apps, did indeed provide citizens with stronger forms of engagement and perhaps a level of citizen power. In this sense, it's suggested that to be categorized as an app that enables a high level of engagement, it provides some form of civic participation such as voting, deliberation and some form of communication. Only two apps were coded in this category Mudamos+ and Sincov Cidadao.

Mudamos+ is an app where citizens would suggest, help to design and vote on public policies (Florin, 2017): "With the app Mudamos+, you can sign legislative projects and you have your privacy protected by blockchain technology" (Mudamos+ app description, 2018). There is still an optimist view about the creation of this app (Florin, 2017) but there was no evidence of actual change in policies up to when this thesis was written. The idea was to provide some level of civic power and indeed it did enable citizens to create and vote for policies. However, no evidence was found of application of such policies thus far.

The findings outlined in the results, tell a story about the state of Mobile Civic Technologies in Brazil available in Google Play in 2018. Mobile CT has grown considerably in the past five years and continues to grow (Omnydar, 2017). Mobile apps combine information from the public and private sectors, which mediate communications, aid in action, and aim to innovate by addressing issues that the public sector has struggled to address by exchanging information and codified knowledge with mobile devices. It is important however, to note that as any technology, there are both opportunities and risks.

Research question 1.a. and 1.b. were answered using inductive thematic analysis on MCTs data. The TEPPCE was a helpful framework to respond to research questions 2.a. and 2.b. as it provided a typology to follow with regards to the interactions that these platforms enabled. However, the Brazilian MCTs, needed a different approach to their taxonomy. Research question 3 was also answered inductively.

7.3. Contribution to research

This research contributes to the Digital Civics (DC) and Community Informatics (CI) body of knowledge as it builds and extends on existing scholarship in these fields. The research culminates in an extended classification that characterizes Mobile Civic Technologies in Brazil. This is a contribution because no study attempted to classify these MCTs at the time this research was conducted. This classification organized the MCTs into groups as these categories were identified. Policymakers and mobile app developers can use the findings from this research to aid in decision-making and scientists as a starting point for other research questions. By answering the research questions proposed in this research, the scholarly contributions will include: 1) Creation of a Multifaceted Taxonomy of Brazilian MCTs, 2) Validation and extension of the TEPPCE framework; 3) Application of workflow of data science to qualitative inquiry and 4) Assessment of perceptions of stakeholders from the MCTs.

This thesis contributes to research and practice. Scholarly contributions included. The findings from this research make an important contribution to the body of knowledge in digital civics (DI) and community informatics (CI) as it builds and extends on existing scholarship in these fields. The research culminates in an understanding about Mobile Civic Technologies that affords researchers and practitioners a way of looking at CT created for mobile devices and extends the existing TEPPCE typology for CTs.

One of the results of this research was a Multifaceted taxonomy for Brazilian MCTs. It also contributes to other researchers by adapting a data science workflow previously used in Computer Science for research in that discipline (Figure 11, Adapted from Guo 2013). This workflow helped to systematically code and classify the MCTs in Brazil (Chapter 3 section 2.3. describes its operationalization in detail). This is an addition to thematic analysis application because in previous research, TA has been described as several steps. The Thematic analysis workflow is a contribution because no study to date had presented the methodology using this

systematic workflow for qualitative inquiry. This technique may facilitate future work that uses thematic analysis and has limited resources because this workflow can be adapted to other research questions.

Another contribution is an extension of TEPPCE to the assessment of Civic Technologies to mobile civic technologies in Brazil. To do this analysis this framework was directed at classifying the Civic Technologies producing an extended framework that attended the MCTs in Brazil. This framework was validated by applying the thematic analysis methodology together with triangulation to classify and validate the 90 MCTs in Brazil. c) Fulfilling a gap in the literature about the characteristics of MCTs and the description of the of the concepts used in several research areas such as community informatics, digital civics, and technology-mediated civic engagement, aiming to identify the adequate concepts to address the research questions. The analysis of all these concepts combined had not been found in previous literature. This is a contribution because it can be used by other scholars to contextualize work in digital civics.

For practice, this thesis contributes with and a deeper understanding of the mobile civic platforms which will aid developers and policymakers when developing new apps for civic purposes. The themes in the findings serve as guidelines for practitioners when developing or updating new platforms for civic purposes (Chapter 4) By using thematic analysis with the data from Google Play Store and validating the findings with triangulation. It was possible to perform and exploratory study with a large number of applications within the limited resources available for this research. This is a contribution because previous research analyzed CTs and MCTs on a small number of case studies.

7.2. Limitations

The study's first limitation is that only publicly accessible information, were selected for the first part of the study. Moreover, since these apps were selected based on the definitions in the Digital Civics research area, and this is a relatively new community of research, expectations may become different for other fields such as public policy, geography, and urban planning. Furthermore, in this dissertation, we exemplify and focus on this specific population of apps at this specific point in time. Apps change and get updated frequently and this research community could benefit from longitudinal studies to examine the lifecycle of these platforms.

Disadvantages were found in the Playstore data which included inconsistent platform descriptions and frequent changes due to number of comments among other parameters. The research questions were addressed with the data collected from the Playstore and the secondary data on the MCTs.

Another limitation in this study was that using thematic-based methods to analyze the data, homogenizes researcher biases. In other words, limitations with a theme-based method for categorizing and analyzing data include limiting the analysis to the researcher's trajectories and perspectives. Furthermore, it is a painstaking method which requires many iterations, reading and re-reading of the data.

The sampling of this study is not a representative one as it contains multiple mobile applications as Civic Technologies. Furthermore, the purpose of this study was not to statistically validate its findings nor to highlight the CTs quantitatively but to delve into a deeper understanding of the characteristics and state of these platforms at a given period using a qualitative approach

The sample used for this study represented a small microcosm of the entire CT ecosystem in Brazil because many of the CTs in Brazil are still in the form of websites and portals and have not yet been transformed into mobile applications. This is just a set of the

MCTs that were available for download and use, during the time of this research. Regardless, with the information retrieved, it was possible to highlight several issues, common to the current social-political scenario in Brazil, such as the apps that allow citizens to monitor their elected officials (Monitora Brasil app); apps that addressed public health (Goiania Contra o Aedes app).

7.3. Conclusion

This dissertation is an exploratory qualitative study of mobile civic technologies (MCTs) in Brazil with the intent of validating and extending an existing classification framework in the research area of digital civics. This first chapter outlines the dissertation, background of the study, specifies the problem and describes its significance. Then presents an overview of the methodology that explored and classified 90 MCTs in Brazil and concludes with the contributions and delimitations of the study.

During the time this research was conducted, there was an explosion of apps aiming to address civic matters and there were no existing frameworks that systematically explored Mobile Civic Technologies. During the time this research was proposed there was a gap in the research community and a need to create and validate frameworks and classifications to characterize these ICTs. Due to this research gap, the theoretical framework: Technology Enabled Platforms for Civic Engagement – TEPPCE that explored Civic Technologies was applied and extended to address the case of mobile civic technologies. The chosen method to conduct this study was qualitative and the approach used was Thematic Analysis (TA).

The aim was to understand the variety of mobile civic applications at the time this research was conducted. During this period there were several Mobile Civic Technologies created by grassroots movements, non-for-profit organizations, businesses as well as

governments. These were developed for several purposes such as exchanging codified knowledge, information, generating data and collaborative deliberation in civic matters.

Interest in this subject emerged in disciplines such as Information Studies (Gurstein, 2000; Hagen et. Al, 2015; McDonald, 2013; Nemer, 2017), Communications (Emmer & Kunst, 2018). Computer Science (Boehner & DiSalvo, 2016; Harding, Knowles, Davies & Rouncefield, 2015), Geography, Urban Informatics (Forth, 2009), Urban Planning (Fathejalali & Jain, 2019) and Political Science (Linders, 2012). With this interdisciplinary interest, several terms and approaches emerged aiming to better understand civics mediated by information and communication technologies. The following section includes the background to this study and explores concepts that help to better understand the topic under study such as the interdisciplinarity of this subject, the, previous studies that aimed to classify this phenomenon, the method used to address the gap in the research and the contributions of this thesis.

This is a thesis in Library and Information Studies and the objective was to classify the MCTs in Brazil. This classification is to serve as a guide for mobile civic researchers and practitioners as they develop new platforms for civic purposes. The central research objective was to explore the Brazilian MCTs within the topics discussed in chapter 1 in the theoretical framework. More specifically, the objectives, the interactions, and the technology features of these applications. To help address the gaps in this research area regarding the three topics, the following research questions were subsequently identified to assist this research: 1.a. What civic issues do these platforms address? 1.b. How do they claim to address these issues? 2.a. What are the information and codified knowledge flows that occur when these platforms are used? 2.b. Do these platforms enable civic engagement? What types of engagement do they enable? RQ 3: What are the technology features of these platforms that enable these information and knowledge flows?

This chapter includes an overview of the thesis, a summary of the findings from the research and contains the main contributions for research and practice, limitations of the study, recommendation for future studies and the conclusion.

7.4. Future Research

"Thinking that democracy can be reduced to a computer problem can be a dangerous distraction. The reality is that many of the "answers" we seek can only be determined through seeing how new systems are used, and this use is likely to vary from cultural context to cultural context."

Schuler, (2018)

This research could be extended in several ways. First, by applying the themes found here in contexts other than Brazil. Secondly, by exploring the differences in characteristics of these apps over time during their lifecycle, for example, #EuFacoPoa app that was launched in 2017 and started out as an informative app about health services (Rochol, 2017). Then later that year it incorporated features that enabled information about urban mobility and the municipal education network (Castro, 2017). Furthermore, the issues of civic life may not be answered by building more apps, but instead by understanding them better to develop useful apps and further research is needed to identify the best practices of these apps.

As mentioned in Chapter 2, Simon, Bass, Boelman & Mulgan (2017) advocate that emerging Civic Technologies may potentially invigorate democratic institutions because local government seem keen to engage citizens in their developments. However, they also admit that it might be too soon to understand their impact. Therefore, the CI and DC research community could benefit from analyzing the impact of the MCTs from this data corpus in future research. For example, in the year 2019 researchers from all over the world gathered at the Organization for Economic Co-operation and Development (OECD) in Paris to discuss the potential impact

of these technologies. This also testifies that during the development, application and writing of thesis it was too early to inquire about the implications and impacts of these platforms (TICTEC, 2019; Rumbol & Shaw, 2019).

7.5. Final remarks

This research was conducted during a time where there was an explosion in the development of mobile apps aiming to address civic matters and there were no existing frameworks to systematically classify Mobile Civic Technologies. This was the first attempt to classify MCTs in Brazil.

It was also designed at a time of optimism regarding the possibilities of mobile ubiquitous data, information and codified knowledge for democratic governance and urban management. Issues of privacy, surveillance and changes in governance paradigms may affect the directions of mobile civics developments. Nevertheless, the open-source model of the Google Playstore, allows anyone to develop and launch their application to the software repository.

There is still optimism regarding the use of Mobile Civic Technologies for civic engagement and urban management. In fact, public, private, commercial and research efforts have been evolving in parallel. However, few rigorous research has examined these platforms extensively, and developing these platforms can be a costly endeavor, especially if interdisciplinary stakeholders are involved. Therefore, understanding these apps, their objectives and features may help practitioners when developing new Mobile Civic Technologies.

In the past five years, we have witnessed an increase in scholarly work in which researchers analyzed small samples of civic applications (both web and mobile). Some apps

developed by governments seemed to become obsolete after changes in governance and as new budget priorities took place (Apps Cidade Inteligent, Amazonas na palma da mao). They also lack updates and soon disappeared from the app stores (see Appendix G: List of apps that were no longer available after the second round of data collection). Moreover, apps changed frequently as so many Android compatible devices became available (Simon, 2018).

It analyzed evidence from online data of ninety mobile ICT mobile apps in Brazil designed to improve urban service delivery and enable civic engagement. Even though these initiatives vary with respect to specific objectives they aimed to address, they all have a common denominator, which is to use mobile platforms to engage citizens in public policies, services and contribute to addressing local issues (Peixoto & Sifry, 2017). The analysis examined these Civic Technology initiatives, using aiming to understand more about their objectives, interactions, and technology.

As the findings revealed, the MCTs themes, not only inform the context of mobile use for civic engagement and urban issues, but they also informed about the agents or stakeholders that have used data to spread awareness about the issues at hand such as when citizens report on violent areas (for example, Onde Tem Tiroteio app). The first outcome of this research was a description of the 90 Android MCTs that exists in Brazil. These descriptions were complemented and validated by classifying them according to the four modes of engagement they foster, according to the TEPPCE framework. This is a contribution to theory because the TEPPCE had not yet been adopted in contexts other than the USA and validating this may help future researchers in the Digital Civics domain.

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Appendix (A): Short Descriptions of apps in English

Brief description each of the 90 sampled apps, this is a translated summary of the app descriptions provided by the app developers.

Table 21. Summary of app description in English

#	Name	Brief Description
1	#3ConfJuv	Engagement platform for youth (from 15 years of age) to include their opinions about the National Youth Plan as part of nation-wide efforts to update the 2004 national youth legislation (Brazil, 2017)
2	App Barueri	Local Issue reporting app where citizens can include their opinions about local governance in developed by the local government of Barueri city.
3	App do Cidadao	Governmental service app to unify local government services. E-Government services platform. For tax, national identification, election information, voting.
4	As diferentonas	Application created with open government data that estimates municipal allocated budgets and informs citizens on where these budgets are being allocated. It also enables citizens to report and debate about these budget allocations
5	Avancar	Inform citizens about federal infrastructure developments by showing images and maps of construction, building developments and infrastructure projects.
6	Bairro Seguro	Application created for urban public and private security cameras. Enables reporting local issues and surveillance for security.
7	BH Resolve	Local municipal application for the city of Belo Horizonte. Aimed to unify the following services: Finances, Urban regulation, public transport, health, Social policies, youth.
8	Bombeiros Parana	Fire brigade application for the government of Parana state to inform citizens of possible dangers, send alerts to population, and inform about security precautions citizens can take.
9	BusCode POA	The BusCode POA is an application developed to help users of public transportation in Porto Alegre created by a citizen with open Government data. Allows for offline access.
10	Caca Mosquito	Maps areas with Aedes aegypti focus. This mosquito can spread the dengue fever, Chikunguyna and Zika virus. There have been several outbreaks in Brazil in the recent years. Citizens take picture of locations where they suspect having presence of the mosquito and the information is sent to local authorities to take precautions.
11	Cade o Meu Onibus	SINETRAN is a public association that delivers digital smart city transport solutions for Amazonian citizens. The app informs citizens about bus routes in real time and allows them to send suggestions to the public transport services.
12	Cade O onibus	Public transport applications that at the time supported the cities of Sao Paulo, Teresina, Rio de Janeiro and Curitiba. The app intended to let citizens search for bus routes, see the location of buses in real time, see the trajectory to get to the locations they need to get to.
13	Caixa Trabalhador	Informs citizens about the labor rights, benefits and duties. App developed by a federal bank called Caixa Economica.
14	Calculadora Cidadao	App developed by a federal bank that informs citizens about financial information.
15	Carteirada do bem	Rio de Janeiro Government app created to inform citizens about government related services in transport and leisure.
16	Cataki	Helps locate citizens who collect recycling materials and deliver recycling material.
17	Central 156	Communication channel between citizens and governments that helps citizens to register complaints and issues to the local government.
18	Cidadao Online 4r	Communication channel between citizens and government regarding local issues. Objective to link local government with the population. Citizens can classify their level of satisfaction with the local government and share in social media.

#	Name	Brief Description
19	CittaMobi	Public transport information (closest bus stops, stops adapted wheel chairs.) in real time with sensors and GPS tracking on buses the information is given by the transport agencies.
20	Colab.re	Civic app for citizen participation in public policies. Connects citizens and the public sector. It aimed to enable citizens to collaborate in informing local government about local issues and urban management. Aimed to promote transparency and engage citizens in participating to improve local issues for collaborative urban management.
21	Coleta seletiva Salvador	Governmental app for informing citizens about the importance of waste management. It shows the locations of recycling and donation bins as well as appropriate places to dispose of medical waste around Salvador city.
22	Comida Invisivel	Aims to reduce food waste and improve meal distribution by linking supermarkets, restaurants, hotels, bars. To local non-governmental organizations. The aim is to aid food donation to under-privileged communities.
23	comuniQ	Information sharing platform for citizens to report local issues. The objective is to strictly inform citizens as it serves as a journalism platform for Pernambuco State. Citizens can send audios, videos and texts about events in their cities.
24	Copel Mobile	Platform that informs citizens about their energy consumption and sends notifications regarding power cuts. It also allows citizens to report issues regarding energy supply failures to governmental authorities in charge of public lighting.
25	Delegacia online RJ	Access to security services such as contacting police about crimes, communicating loss of documents such as identification, driver's licence.
26	Denuncia Ambiente	Allows citizens to report on environmental crimes related to the local fauna, flora, vegetation, water, soil, air, and fire. Citizens can send pictures anonymously (or they can identify themselves). The data remains confidential, and the app offers real time updates about the issue that was reported.
27	Desenvolve Brasil	Digital governance application for monitoring infrastructure projects and citizens can follow the progress of these projects. The app aims to improve transparency (by informing citizens) and to enable participation by allowing them to post comments, share information on social media, evaluate government actions and share information.
28	Detran RN	Administrative and executive transit authority application for the government of Rio de Janeiro for checking documents, service status.
29	Detran SP	eGovernment application for checking online documentation related to transit for viewing parking fines.
30	Df Aguas Claras	Gov Tech app for the city of Aguas Claras. It informed citizens of the local services available.
31	Direito Na Mao	Amazonian app that informs citizens about the laws created by the congressman Luiz Castro.
32	e-Titulo	App that works as E-document that enables citizens to vote in the elections. Provides information about voting locations.
33	Eleicoes 2016	Gov Tech application that informed citizens about the elections that occurred in 2016, provided informational videos, and access to other governmental applications.
34	Eu Cidadao	Chanel for communicating with local governmental authorities. Citizens can send in complaints, requests, and suggest improvements for the city, neighbourhood, or street. Enables feedback on the status of the citizen's requests and history of requests.
35	Fala Cidadao	Collaborative app for citizens and governments to communicate. Citizens can create alerts about local issues, thus informing local authorities. And local authorities select the problems as to their level of urgency.
36	Fala limoeiro	Citizens send picture informing about a local issue. The app was developed and distributed by the municipal government of Limoeiro.
37	Falando com o prefeito digital	App created by a business (iTCast), that enable citizens to participate in solving local issues by informing municipal government about local issues. Citizens can identify problems, communicate them to local governments and get feedback on the status of the issue they reported.

#	Name	Brief Description
38	Falaparnamirim	Citizens inform local governments about local issues in the city of Parnamirim.
39	Fiscalizatu	Application where citizens can invigilate issues regarding public transport in Porto Alegre city.
40	Fogo Cruzado	Collaborative platform that enables citizens to register shootings in real time. Aims to combat urban violence, one of the pressing problems that Brazilian cities face. Every-time a citizen witnesses (sees or hears) a mass shooting he can report it by filling out a form on the app and the notification is published on a publicly available website and mobile app. The goal of the app is to give real time information and to provide a panorama of urban violence for outlining public policies regarding security.
41	Goiania Contra Aedes	Application that enables citizens to inform places with traces of the Aedes Aegypti mosquito (transmits the zika fever, yellow fever and dengue) in Goiania city.
42	Hemogram	Inform citizens about the importance of donating blood to local hospitals. Locates locations where citizens can donate blood. Was developed but the institute for smart cities.
43	inforMe Denuncias	Citizens report on several types of crimes which are directly sent to the local police and authorities. The developers ensure that the information remains protected. The service is available nation-wide but originated in the Amazonian State.
44	Limpa Rapido	Integrates urban waste management information in real time. Informs citizens of the location of garbage collector vans, local information about garbage disposal and best practices for waste management.
45	Malalai	Security app for virtual company while walking or commuting in dangerous locations. Allows authorized people know the user's location and notifies them upon arrival to the desired location. Also informs the user of safer routes according to their destination.
46	Menor Preco Nota Parana	eGOV app from Parana state that stimulates citizens to request official receipts and make sure establishments pay taxes. It allows citizens to collaborate and share information about products to get the best prices. It offers a search for the lowest prices in their areas, uses the GPS to locate where the closest establishment have the desired product and allows users to share that information.
47	Meu Ambiente	Allows citizens report on environmental crimes.
48	Meu Digisus	Provides information about local public health services and personalized health history and information. Provides locations of the nearest hospitals and health clinics.
49	Meu onibus	Public transport bus information platform with real-time information about bus locations and timetables of buses.
50	Moda Livre	App that informs citizens if fashion retailers have been adhering to ethical practices. It informs of the companies that have been under legal disputes concerning labor rights with the national ministry of education. It also classifies companies as to their level of ethical conduct and transparency of their practices.
51	Monitora Brasil	Tool for citizens to monitor politicians. It informs if the authorities have been making progress toward their electoral promises, their rankings on twitter and other information that could possibly enable increased transparency.
52	MPRJ	Provides information about the local government in the State of Rio de Janeiro the intent is to inform citizens about policies and budget allocation and attempt to ensure that the local government is adhering to their best practices.
53	MT Cidadao	Gov Tech platform that provides government services for mobile devices in the state of Mato-Grosso.
54	Mudamos+	Participation app for citizens to vote on legislations proposed by citizens. The information is anonymous and uses blockchain to ensure privacy and security. This project received funding from the google impact challenge.
55	Nota Parana	Fiscal civics platform that aims to stimulate citizens to request receipts from businesses and encourage them to pay taxes. This program gives citizens prizes in tax returns for the times that they request receipts.

#	Name	Brief Description
56	Onde fui Roubado	Collaborative app that mapped the places where people were robbed or mugged. The incidents are displayed on maps anonymously.
57	Onde Votar	Gov Tech application that informs voters about the places where they can vote.
58	Onibus ao vivo	Live information about buses and trains. Informs citizens about the location of bus stops.
59	OTT (Onde Tem Tiroteio)	Collaborative information sharing platform that provides real-time information about gun violence.
60	Participa BR	Participatory app that aims for collaborative policymaking. Citizens interact in real-time in the public discussions available at http://participa.br/
61	Particity	Citizens report on local issues and receive updates about the status of solving these issues. The objective was to strengthen the bonds between citizens and the local governments.
62	Patrimonio PE	Information about important historical locations in Pernambuco.
63	Poa Transito	Public transport app developed with government open data.
64	Portal do patrimonio	Cultural and historical information platform. Informs citizens about local cultural protected cultural patrimony in Rio de Janeiro.
65	Porto Alegre #EuFaçoPOA	Egov application that provides information about access to local government services (Porto Alegre State)
66	Pra Cima	Allows citizens to contact local government (Cuiaba municipality) about local issues
67	Prefeitura de Porto Alegre	eGov platform that informs citizens about local government services (Porto Alegre).
68	Proximo Onibus Curitiba	Application that works without access to the internet and informed citizens about bus routes and bus times in the city of Curitiba.
69	Radar Cidadao	Platform that allows citizens to report several local issues for improving urban life.
70	Recicla Retro Recife	Serious game to educate citizens about recycling.
71	Reclame Aqui	Customers can report about the quality-of-service provision in real time. Enables communication and feedback.
72	Relix	Finds recycling bins around the sates of Pernambuco and Alagoas.
73	Resultados	Informs about election results.
74	Rota Da Reciclagem	Informs about recycling bins and locations and allows citizens to include information about recycling cooperatives and individuals who collect recycling material. Educates on how people can recycle. Developed by Tetrapak.
75	Rua BH	Information about cultural activities and places (such as theatres, galleries,) in the city of Belo-Horizonte.
76	Sempre Alerta	Collaborative monitoring platform for security purposes. Citizens can report on violent areas, depending on the city, the platform communicates with local security authorities. Aims to promote citizen engagement and uses data from several sources (data from sensing devices, radio, open government data and citizen input data). Claims to leverage citizen knowledge about their spaces to aid in improving local security. For example, the mail delivery person, has information about certain habits around the places they deliver, janitors have information about the habits and customs of the people that live int the apartment buildings. Therefore, all the stakeholders are important sources of data to inform about possible safety concerns.
77	SIC.SP	Provides citizens with information about ongoing administrative process (such as information, citizens requested.). Aims to abide by the Federal Law n. 12.527 18th nov, 2011 that created a service for citizens right for access to government information

#	Name	Brief Description
78	Sigep	E-gov service app that informs about the status of government run pension system.
79	Sincov Cidadao	E-gov platform to inform about government services and allows citizens to report on several local issues.
80	Sinesp Cidadao	E-gov service that allows citizens to find information about transit safety. Informs about car robbery, status of administrative transit information.
81	SIU Salvador	App that informs citizens about the approximate time of arrival for public transport. It uses biometric data to access busses. This app was originally built for Salvador city.
82	SOS Infancia	Articulate, sensitize and mobilize governmental institutions the civil society, representatives of employers and workers eradicate child labor in the State of Mato Grosso.
83	SP Servicos	E-government platform that enables citizens to use governmental services in the State of Sao Paulo.
84	sp156	E-Government service that enables citizens to participate in tracking and reporting various local issues in Sao Paulo city.
85	Sr. cidadao	General information about politicians. The goal of this app is to improve transparency and accountability. Provides access to information about the policies that these representatives voted for; allows citizens to vote for their favourite politicians and to post their information on social media.
86	Tarifa taxi POA	Porto Alegre city app that helps citizens to estimate taxi prices.
87	TCMRJ - Visitas as escolas	Platform that helps to monitor the quality of public schools in Rio de Janeiro city. Aims to improve public education in the city by auditing and visiting local schools. Also enables citizens to participate in this process by enabling them to send their concerns about specific schools.
88	Transalvadr Noa Cidadao	Informational and collaborative platform that enables citizens to make requests with regards to public transport in the city of Salvador.
89	Visit Natal	Informational app about the main historical and tourist sites in the city of Natal.
90	Zona Azul Facil	Urban transit application that enables vehicle drivers to pay and find parking in the city of Sao Paulo.

Appendix (B): Apps in each theme

Objectives

RQ. 1.a. What Civic Issues do these platforms aim to address?

Table 22. What civic issues themes

#	Theme Name	App # (Appendix A) *
1	Budgeting	4, 5, 15, 20, 52, 53, 55, 62, 71, 79, 83, 84 (12 13%)
2	Culture	1, 2, 15, 20, 21, 23, 39, 51, 55, 62, 63, 65, 66, 67, 69, 71, 75, 76, 83, 84, 89 (21 23%)
3	E-documents	3, 13, 20, 25, 29, 30, 55, 62, 71, 78, 80, 88 (12 13%)
4	Civic Education	1, 2, 15, 20, 23, 31, 32, 35, 37, 38, 39, 42, 51, 52, 53, 55, 56, 58, 62, 63, 65, 66, 67, 70, 72, 74, 75, 83, 84, 85, 87, 88, 89 (34 37%)
5	Environment	1, 2, 7, 16, 17, 18, 20, 21, 36, 37, 38, 39, 45, 48, 51, 53, 55, 56, 62, 66, 67, 69, 70, 71, 72, 74, 83, 84 (28 31%)
6	Health	1, 2, 10, 15, 18, 20, 22, 23, 35, 36, 37, 38, 39, 42, 43, 49, 53, 55, 62, 66, 67, 69, 71, 82, 83, 84, 87 (27 30%)
7	Infrastructure & Acces-sibility	5, 7, 16, 17, 18, 20, 21, 23, 24, 27, 31, 35, 36, 37, 38, 39, 45, 54, 55, 62, 66, 67, 69, 71, 76, 83, 84, 87, 88, 90 (30 33%)
8	Policies	1, 2, 20, 28, 32, 52, 53, 55, 61, 62, 66, 67, 71, 79, 85, 87 (16 18%)
9	Security	1, 2, 6, 8, 10, 20, 25, 28, 35, 36, 37, 38, 39, 41, 44, 46, 43, 53, 55, 57, 60, 62, 66, 67, 69, 71, 76, 77, 80, 82, 83, 84 (31 34%)
10	Transport, Mobility	1, 2, 5, 7, 9, 11, 12, 17, 19, 20, 23, 29, 30, 31, 35, 36, 37, 38, 39, 40, 41, 46, 50, 54, 55, 59, 62, 64, 66, 67, 68, 69, 71, 75, 81, 83, 84, 86, 88, 89, 90 (41 46%)

*Apps could be coded in multiple categories

1.b. How do they claim to address these issues?

Table 23. How do the developers of the apps claim to address the issues in RQ. 1.a.

#	Theme Name	App # (Appendix A) *
1	Accountability and transparency	20, 27, 32, 35, 36, 37, 38, 41, 42, 52, 53, 56, 61, 62, 84, 84, 87, 88 (18 20%)
2	Communication	1, 2, 4, 6, 7, 8, 9, 10, 11, 15, 16, 17, 18, 19, 20, 22, 23, 25, 26, 27, 28, 29, 30, 35, 36, 37, 38, 39, 40, 41, 42, 43, 44, 45, 46, 47, 48, 50, 53, 55, 57, 60, 61, 62, 65, 66, 67, 69, 71, 73, 76, 79, 80, 84, 85, 87, 88 (58 64%)
3	Civic reporting of problems	2, 4, 6, 7, 10, 11, 12, 16, 17, 18, 20, 22, 23, 25, 26, 27, 35, 36, 37, 38, 39, 40, 41, 42, 44, 46, 48, 53, 57, 60, 61, 62,65, 67, 69, 71, 76, 79, 82, 84, 87, 88 (42 47%)
4	Deliberation	20, 55, 61 (3 3%)
5	Collaborative	1, 4, 10, 11, 12, 16, 17, 18, 20, 21, 22, 25, 26, 27, 35, 36, 37, 40,

	civic engagement	41, 42, 46, 48, 53, 55, 57, 60, 61, 62, 67, 69, 71, 72, 74, 76, 79, 82, 84, 85, 87, 88 (40 44%)
6	Dissemination of Information	1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20, 21, 22, 23, 24, 25, 26, 27, 28, 29, 30, 31, 32, 33, 34, 35, 36, 37, 38, 39, 40, 41, 42, 43, 44, 45, 46, 47, 48, 49, 50, 51, 52, 53, 54, 55, 56, 57, 58, 59, 60, 61, 62, 63, 64, 65, 66, 67, 68, 69, 70, 71, 72, 73, 74, 75, 76, 77, 78, 79, 80, 81, 82, 83, 84, 85, 86, 87, 88, 89, 90 (90 100%)
7	Service delivery	2, 3, 4, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20, 21, 22, 24, 25, 26, 27, 28, 29, 30, 32, 33, 34, 35, 36, 37, 38, 39, 40, 41, 42, 44, 45, 46, 47, 48, 49, 50, 51, 52, 53, 54, 55, 56, 57, 58, 59, 60, 61, 62, 63, 64, 65, 66, 67, 68, 69, 70, 71, 72, 73, 75, 76, 77, 78, 79, 80, 81, 82, 83, 84, 85, 86, 87, 88, 89, 90. (84 93%)
8	Voting	20, 55, 61 (3 3%)

*Apps could be coded in multiple categories

RQ. 2.a. What are the information and codified knowledge flows that occur when these platforms are used?

Table 24. Themes related to Data, Information and Codified Knowledge flows

#	Theme Name	App # (Appendix A) *
1	Citizen to Citizen (C2C)	1, 4, 10, 11, 12, 16, 22, 40, 42, 44, 45, 50, 51, 55, 56, 59, 61, 71, 76, 85 (20 22%)
2	Government to Citizen (G2C)	3, 4, 5, 7, 8, 9, 10, 11, 13, 14, 15, 17, 19, 21, 26, 27, 28, 29, 30, 31, 32, 33, 34, 35, 36, 37, 38, 39, 40, 41, 43, 48, 50, 52, 53, 54, 55, 57, 60, 61, 62, 63, 64, 65, 66, 67, 71, 72, 73, 77, 78, 79, 80, 83, 84, 85, 87, 88, 89 (57 66%)
3	Citizen to Government (C2G)	1, 2, 3, 7, 10, 11, 12, 16, 17, 18, 25, 26, 27, 34, 35, 36, 37, 38, 39, 40, 41, 42, 43, 47, 52, 54, 55, 60, 61, 64, 66, 69, 71, 72, 79, 80, 84, 87, 88, 89 (40 44%)
4	Citizen to Private (C2P)	6, 22, 23, 40, 42, 43, 56, 60, 68, 69, 71, 72, 74, 76 (14 16%)
5	Private to Citizen (P2C)	6, 9, 19, 22, 23, 24, 42, 44, 46, 49, 50, 55, 58, 59, 63, 68, 70, 71, 72, 74, 75, 76 (22 24%)
6	Government to Private (G2C)	3, 23, 55, 68, 72, 75, 76, 81, 88, 89, 90 (12 13%)

*Apps could be coded in multiple categories

RQ. 2.b. Do these platforms enable civic engagement? What types of engagement do they enable?

Table 25. Levels of engagement

#	Theme Name	App # (Appendix A) *
1	Non-Participatory	2, 3, 5, 6, 7, 8, 9, 14, 15, 19, 24, 29, 30, 31, 32, 33, 34, 49, 65, 81, 83, 89, 90
2	Mode 1	16, 22, 23, 28, 43, 45, 46, 47, 50, 51, 52, 59, 57, 60, 70, 71,

#	Theme Name	App # (Appendix A) *
		72, 74, 86
3	Mode 2	4, 10, 12, 13, 21, 41, 44, 63, 76, 77, 82
4	Mode 3	1, 11, 17, 18, 25, 26, 27, 35, 36, 37, 38, 39, 40, 42, 48, 53, 54, 56, 58, 61, 62, 66, 67, 69, 73, 78, 84, 87, 88
5	Mode 4	20, 55, 79

*Apps could be coded in multiple categories

RQ. 3. What are the technology features of the platforms that enable these information and knowledge flows?

Table 26. Technology Features required by the apps

Inductive Theme	Sub-theme	App # (Appendix A) *
(1) Communication and engagement	Camera	10, 19, 20, 23, 26, 28, 32, 34, 36, 46, 51, 53, 54, 55, 61, 65, 67, 76, 85, 88 (20 22%)
	Phone	2, 3, 6, 8, 15, 16, 18, 19, 23, 29, 31, 33, 36, 41, 43, 45, 48, 51, 57, 63, 64, 83, 86, 88, 90 (25 28%)
	SMS	46, 47, 67 (3 3%)
	Microphone	15, 23, 26, 51, 66, 76, 79
(2) Location	GPS	1, 2, 3, 6, 8, 10, 11, 13, 16, 17, 18, 19, 20, 21, 23, 24, 26, 27, 28, 29, 30, 32, 34, 35, 36, 37, 38, 39, 40, 42, 43, 44, 45, 46, 47, 48, 49, 51, 53, 54, 55, 56, 58, 59, 61, 62, 63, 64, 65, 66, 67, 68, 71, 72, 74, 75, 76, 78, 79, 81, 82, 83, 84, 85, 86, 88, 89, 90
(3) Connectivity	Bluetooth	45, 78
	Network	1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20, 21, 22, 23, 24, 25, 26, 27, 28, 29, 30, 32, 33, 34, 35, 36, 37, 38, 39, 40, 41, 42, 43, 44, 45, 46, 47, 48, 49, 50, 51, 52, 53, 54, 55, 56, 57, 58, 59, 60, 61, 62, 63, 64, 65, 66, 67, 68, 69, 70, 71, 72, 73, 74, 75, 76, 77, 78, 79, 80, 81, 82, 83, 84, 85, 86, 87, 88, 89, 90.
	Wi-Fi	4, 13, 22, 42, 46, 48, 53, 57, 58, 69, 80, 84, 85, 89, 90
(4) Privacy	Accounts and Identity	13, 20, 23, 24, 27, 28, 30, 36, 37, 44, 45, 46, 48, 55, 57, 58, 59, 61, 63, 64, 68, 70, 79, 83, 88
	Calendar	13, 23, 36, 88
	Contacts	13, 20, 23, 24, 27, 29, 31, 36, 43, 45, 46, 48, 51, 55, 58, 61, 63, 64, 68, 71, 79, 83, 88
	Device & app history	22, 23
	Photos/Media/Files	1, 5, 6, 8, 10, 11, 13, 14, 15, 16, 17, 18, 19, 20, 21, 22, 25, 26, 27, 28, 29, 30, 32, 34, 35, 36, 37, 38, 39, 41, 42, 43, 44, 46, 47, 48, 49, 51, 53, 54, 55, 56, 57, 58, 61, 63, 64, 65, 66, 67, 68, 69, 71, 73, 74, 76, 78, 79, 80, 81, 82,

Inductive Theme	Sub-theme	App # (Appendix A) *
		83, 84, 85, 86, 87, 88, 89, 90
	Storage	1, 5, 11, 13, 15, 17, 19, 20, 21, 22, 23, 25, 27, 29, 30, 32, 34, 35, 37, 39, 41, 43, 44, 46, 47, 48, 49, 51, 53, 54, 55, 56, 57, 58, 59, 61, 63, 64, 65, 66, 67, 68, 69, 71, 73, 74, 76, 78, 79, 80, 81, 82, 83, 84, 85, 86, 87, 88, 89, 90

*Apps could be coded in multiple categories

Appendix C: Codebook

Technology Features

The following table are the definitions for each of the features required by the apps (Android Developers, 2018b)

Table A.3. Technology Features required by the apps

FEATURES	DEFINITION
Accounts and Identity	The app can use the devices' owner's identity and profile information. Access to identity features access may include the ability to: Locate accounts on the device; read the owner's contact information; modify the owner's contact; add or remove accounts; access to the accounts on the device.
Bluetooth	An app can access and control the Bluetooth on the device, which includes broadcasting to or getting information about nearby Bluetooth devices.
Calendar	The app can use the device's calendar information, which may can include Reading calendar events and confidential information as well as to add or modify calendar events and send email to guests without owners' knowledge
Camera	Access to camera signifies the ability to take pictures and record videos.
Contacts	Access to use and find the registered google accounts on the device and the ability to read and modify personal contacts.
Location	An app can the device's approximate location (network-based); precise location (GPS and network-based); Access extra location provider commands; GPS access
Microphone	Access to the device's microphone; change audio settings and record audio.
Network	Allows the app to use the settings that control the mobile device; data connection and potentially the data that the device receives.
Phone	The app can use the device's phone and its call history. Directly call phone numbers; Read and Write call log (example: call history); Make calls without the owner's intervention; add voicemail and answer phone calls.
Photos/Media/Files	An app can use files or data stored on the device. Photos/Media/Files access may include the ability to: Read the contents of the USB storage (example: SD card); Modify or delete the contents of your USB storage; Format external storage and to mount or unmount external storage
SMS	The app can use the device's text messaging (SMS) and/or multimedia messaging service (MMS and has the ability to use text, picture, or video messages.
Sleep	Prevent device from sleeping
Startup	The app automatically starts to run when the mobile device is turned on.
Storage	Some apps require access to external memory drives. Ability to read and write contents storage and USB storage
Vibration	Allows and app to control vibration and to provide haptic feedback
Wearable Sensors	Allows the app to access data from wearable sensors, such as heart rate monitors. Can receive periodic updates on physical activity levels.

FEATURES	DEFINITION
Wi-Fi	Allows access the device's Wi-Fi connection information, such as the name(s) of connected devices; access and view Wi-Fi connections.
Device & app history	An app can do one or more of the following: Read sensitive log data; Retrieve system internal state; Read your web bookmarks and history; Retrieve running apps
Other	An app can use custom settings provided by your device manufacturer or application-specific permissions. If an app adds a permission that is in the "Other" group, the user is asked to review the change before downloading an update. Other access may include the ability to: Read and write in the owner’s social stream (on some social networks); access subscribed feeds; Control Flashlight; Draw over other apps; Install Shortcuts; Toggle Sync on/ off; In-app purchases; Read Google service configuration; Read Google service configuration.
In-app purchases	An app can ask you to make purchases inside the app.

Appendix D: Playstore Data

Category	Definition	Notes
Playstore Category	Category pre-determined by the Android Playstore and chosen by the developer.	Defined by the developer and is not so useful to our research because these categories are not related to Digital civics even though the platforms themselves can be considered Digital Civics platforms
Description	Description of the app provided by the developers.	Provides the description of the platform. Many times, it is very informative and gives several characteristics of the application that has helped in our analysis
App Review	Users score how the perceive the quality of the platform	Users rate the platform on a Linkert scale (1 to 5 rating – 1 means low, 5 means high)
Reviews and user Comments	Users write about their opinions using the platform.	Useful because TEPPCE did not take this into consideration. The number of reviews is a useful measure for understanding the platform's popularity/ adoption. This varies based on each platform.
Last Update	The date the platform was last updated.	This is useful to know because we can infer whether a platform has been maintained and gives us clues as to its longevity and support from its users and developers. Secondary data has been useful to provide us with information on when the platform was built. For example: a platform that was launched in 2012 and its last update was in 2017.
Size (MB)	Provide the size of the app once installed in the mobile device. Usually presented in Mega-bites (MB)	Kept in the data corpus but not used in our analysis
# Installs >=	Provides the approximate number of installations at a certain moment. The numbers vary from 50, 100, 1000, 10000..., 1.000.000	Informs about the popularity of the app. Which may provide indications about how useful it is for the community.
Version	Refers to the version of the application defined by the developer. Each developer seems to propose a different count for the version of the platform.	This is not very informative, does not seem to have a standard. We kept it in the data corpus but was not used in the analysis, Varies with each platform. 1.0; 3.0; 0.4.5
Requires android	Also named system requirements, this refers to the version of the operating system that is supported by the platform. Systems requirements refer to the last update from which a certain platform can be installed in	In the case of mobile platforms, frequent updates require that users update their operating systems as well as having updated versions of the mobile devices.

Category	Definition	Notes
	that mobile operating system.	
Content Rating	Are classifiers provided by the app developer that informs the user about (Google, 2018a)	Civic applications are typically rated for users of all ages (Everyone) and above 12 years of age. For the Brazilian Google Playstore this means the content rating is “L”: means that the content is available to children of all ages; “10+” means that the app may provide some kind of mild offensive language (Google, 2018a)
Interactive Elements		
Permissions	Refers to the access to hardware and software features that an app requires for its use. Users can look at these permissions to see if they agree with what kinds of features it will require from the mobile device (Google, 2018b)	This is useful information to understand what hardware (camera, GPS, microphone) and software (files, media,) features are required to use the app. This is informative for this research as it enlightens about the data flows and hardware that is used. Helped to answer research question 3.
Offered By (Founders)	This refers to the institution or individual who owns the right to the app.	Helps to define if the app was built by citizens, government, or businesses.
Developer	Refers to the company or individual who coded the app.	This provides indication of the type of partnership for example, a private institution may have developed an app for the public sector who offers it to citizens. Or it can be an app developed and offered by the public sector.
URL	Is the Uniform Resource locator of the webpage that offers this app. It is usually the website of the official project that initiated the app.	Useful to retrieve the official site where the app originated.

Appendix E: Overview of the apps

Google play does not inform the total number of times an app was downloaded, but it does inform an approximate number of downloads. The most downloaded app was SINESP Cidadao, an eGovernment mobile application that provide services that allows citizens to find information about safety, it informs about car robbery and status of administrative transport information.

Table 6.1. Top ten most downloaded apps

#	Name	Approximate number of installations
1	Sinesp Cidadao	10,000,000
2	Caixa Trabalhador	5,000,000
3	e-Titulo	5,000,000
4	Cade O onibus	1,000,000
5	CittaMobi	1,000,000
6	Detran SP	1,000,000
7	Detector	1,000,000
8	Resultados	1,000,000
9	SP Servicos	1,000,000
10	Eleicoes 2016	500,000

Table 6.2. Least downloaded apps

#	Name	Approximate number of installations
1	Falando com o prefeito digital	50
2	Bombeiros Parana	100
3	Direito Na Mao	100
4	Goiania Contra Aedes	100
5	Pra Cima	100
6	Recicla Retro Recife	100
7	Sincov Cidadao	100
8	Bairro Seguro	500
9	Cidadao Online 4r	500
10	Eu Cidadao	500

Appendix F: Examples cited in the main text – Portuguese language app descriptions

Objectives

1.a. What were the issues that these platforms have aimed to address?

Theme	Examples	
Accessibility	Cidadao 4R	Um problema qualquer, como um buraco, um semáforo com defeito ou vazamento de uma boca de lobo, pode ser facilmente resolvido se a Prefeitura estiver conectada com sua população.
Budgeting		
Culture	Visit Natal	O Visit Natal é o aplicativo de turismo oficial da Prefeitura Municipal do Natal, desenvolvido em parceria com a Universidade Federal do Rio Grande do Norte (UFRN), possuindo como objetivo principal auxiliar o turista em visita à cidade a melhor aproveitar sua viagem. O guia turístico inclui informações sobre os principais atrativos histórico-culturais e naturais, eventos, compras, além de informações sobre os serviços turísticos e não turísticos disponíveis na cidade.
e-documents	Sinesp Cidadao	O SINESP Cidadão é um módulo do Sistema Nacional de Informações de Segurança Pública que permite ao cidadão brasileiro acesso direto a serviços da Secretaria Nacional de Segurança Pública do Ministério Extraordinário da Segurança Pública.
	aplicativo do cidadão	O aplicativo do cidadão foi desenvolvido com o intuito de unificar os serviços mais importantes para o povo brasileiro.
Education	TCMRJ	Aplicativo sobre as condições das escolas públicas municipais da cidade do Rio de Janeiro...Participe, enviando uma solicitação a respeito de quaisquer problemas acerca da educação pública municipal, da Educação Infantil ao 9º ano do Ensino Fundamental.
Elections	Mudamos +	O app ainda conta com uma função de re-direcionamento integrada para o site does TSE para aqueles que não tem o título eleitoral em mãos para checar – é inclusive bem mais cômodo por esse caminho. (Florin, 2017)
	Monitora Brasil	O aplicativo Monitora, Brasil ! é uma ferramenta que possibilita a qualquer pessoa pesquisar e monitorar o que os Deputados Federais e Senadores estão fazendo na Câmara dos Deputados e no Senado. É possível verificar a assiduidade, os projetos propostos, rankings, Twitter e outras informações. Os dados são extraídos do site da Câmara dos Deputados, Senado Federal, TSE e Transparência Brasil. Exerça sua cidadania, monitore, dialogue com os Parlamentares e contribua para uma atividade legislativa mais transparente e eficiente.
Energy	Copel Mobile	Confira os serviços disponíveis: consultar desligamentos programados; consultar desligamentos não programados (emergenciais);

Theme	Examples	
		informar falta de energia; receber notificação informando falta de energia na região; emitir segunda via em PDF e copiar o código de barras; registrar solicitações na Ouvidoria da Copel.
Environment	Coleta Seletiva Salvador	A Prefeitura Municipal de Salvador reconhece an importância da coleta seletiva como instrumento político, social e econômico de estruturação do planejamento urbano e da gestão dos Resíduos Sólidos na cidade. Para isso, definiu-se pela implantação de um programa de coleta seletiva, inicialmente disponibilizando ao cidadão Pontos de Entrega Voluntária - PEV, distribuídos por diversos locais da cidade com o objetivo de destinar os materiais recicláveis gerados em suas residência e local de trabalho.
Fiscal	Caixa Trabalhador	Ficou mais fácil saber sobre os seus diretos de trabalhador. As informações que você precisa sobre Seguro-Desemprego, PIS e Abono Salarial estão nesse aplicativo desenvolvido pela Caixa. Com alguns toques você acessa o calendário de pagamentos e ainda visualiza a situação dos benefícios. O aplicativo também reúne as perguntas mais frequentes sobre cada benefício para que você não tenha dúvidas. Se precisar, use também o mapa e encontre a Caixa mais próxima de você. Com tudo à mão, você fica mais seguro e informado.
Health	Hemogram	O Hemogram, desenvolvido pelo Instituto das Cidades Inteligentes, é um aplicativo colaborativo cuja intenção é promover e incentivar a doação de sangue envolvendo a população e as organizações de saúde que mantém os bancos de sangue e os postos de coleta e distribuição.
	Goiania contra o aedes	Aplicativo utilizado para que o cidadão de Goiânia possa fazer denúncia sobre focos do Aedes Aegypti, com opção de anexar fotos.
Infrastructure	Avancar	Rodovias, creches, aeroportos e muito mais. Mais de 7 mil obras estavam atrasadas, atrasando também a vida dos brasileiros. Com o programa Avançar, serão mais de R$ 130,97 bi em investimentos para a execução de rodovias, creches, aeroportos, habitações e muito mais. Agora que você já conhece o Avançar, o programa que avança o Brasil, conheça também o aplicativo oficial. Use o aplicativo para: Pesquisar obras por geolocalização; Acompanhar de perto qualquer os empreendimentos; Ver fotos e informações sobre as obras.
Policies	Colab.re	Caso a sua prefeitura esteja conectada à plataforma, você ainda pode participar de consultas para tomadas de decisão de uma maneira fácil e dinâmica. Imagine a Prefeitura da sua cidade querendo decidir onde abrir novas ciclofaixas e você podendo dar sua opinião diretamente pelo aplicativo! No Colab, tudo isso é possível! Acreditamos na gestão colaborativa das cidades, com cidadãos mais engajados e governos mais participativos.

Theme	Examples	
	Mudamos+	Com o aplicativo Mudamos você pode assinar projetos de lei de iniciativa popular de forma eletrônica, tendo sua privacidade, autenticidade e transparência garantidas com a segurança da tecnologia blockchain.
Security	Malalai	Seja qual for o meio de transporte e rota, escolha alguém da sua confiança para acompanhar seu deslocamento e ser notificado automaticamente por mensagens sobre sua localização. Ah, o MalalaiApp avisará quando você chegar! ;)
	OTT	Fundada em Janeiro de 2016 por quatro amigos preocupados com o crescimento descontrolado da violência no estado do Rio de Janeiro, a OTT-Brasil tem como principal missão retirar todos os cidadãos das rotas dos arrastões, das falsas blitzen e das balas perdidas, com informações que são colhidas, analisadas e divulgadas num curtíssimo espaço de tempo.
	Fogo Cruzado	O aplicativo vai ajudar a aprofundar o debate sobre segurança pública, permitindo que a população dos bairros mais afetados pela lógica da Guerra se manifeste de forma concreta e segura. É uma ferramenta para que a população mostre, através do aplicativo, todas as vezes em que é colocada no meio do “Fogo Cruzado”. O app permite que qualquer cidadão compartilhe dados toda vez que presenciar ou ouvir um tiroteio. Ao preencher um formulário simples e seguro, a informação é transformada pelo app em uma notificação em um mapa. Assim, de forma interativa com a população, os mapas gerados pelo aplicativo podem ser agregados e combinados a informações de outras áreas, tais como a saúde e educação. Nesse processo, vamos obter aos poucos um retrato mais real da violência armada na cidade o que será útil para delinear políticas públicas mais abrangentes e eficazes de enfrentamento ao problema.
Transport, Mobility		

1.b. How do they claim to address these issues

Theme	Examples	
Accountability	Monitora Brasil!	O aplicativo Monitora, Brasil! ...Exerça sua cidadania, monitore, dialogue com os Parlamentares e contribua para uma atividade legislativa mais transparente e eficiente.
	Falando com o prefeito digital	Com esse aplicativo, qualquer pessoa, ao identificar um problema na cidade, precisar de informações ou quiser elogiar ou dar uma sugestão ao governo, poderá enviar um relato que será encaminhado imediatamente ao setor responsável, recebendo um protocolo para acompanhar a solução do problema. O aplicativo permite o envio de fotos e a localização através do GPS. A foto poderá ser tirada na hora ou selecionada na galeria de fotos. As respostas enviadas pelo órgão serão recebidas diretamente pelo aplicativo até a solicitação estar resolvida.
Communication	ComuniQ App	O comuniQ é a nova forma dos pernambucanos compartilharem notícias, denúncias ou informações sobre a sua cidade, bairro ou comunidade e que podem virar notícia no Jornal do Commercio, TV Jornal, Rádio Jornal, Rádio JC News e Portal NE10. Exercer sua cidadania agora é rápido e fácil com o Comuniq do Sistema Jornal do Commercio de Comunicação!
	As diferentonas	O cidadão pode acompanhar o estado das iniciativas (convênios) de seu município, comparar o valor e cronograma da construção daquela praça de eventos com os valores e cronogramas de obras parecidas em outras cidades, e debater e denunciar fatos relacionados às iniciativas.
Civic reporting	Cidadao 4R	Para utilizar o serviço, o internauta baixa e instala o aplicativo (disponível para plataforma Android e iOS) no celular e passa a relatar os problemas que ele observa na cidade. O relatos são encaminhados diretamente à prefeitura, que toma as devidas providências. Segundo os desenvolvedores, o serviço funciona 24 horas por dia. As ocorrências informadas pelos usuários são encaminhadas para os setores ou secretarias responsáveis por resolver aquela questão. Cada informe recebe um número de protocolo, que pode ser acompanhado para saber o andamento da resolução. As notificações são monitoradas via Google Maps e enquadradas pelo tipo de serviço (limpeza pública, iluminação) – que também recebem diferentes prazos de resolução, de acordo com a complexidade. As solicitações podem ser acompanhadas pelos usuários de duas formas: e-mail ou pelo próprio app. Cidades do interior paulista já estão usando o sistema, como Adamantina, Andradina, Borborema, Bom Jesus dos Perdões, Capão Bonito e Porto Feliz. Qualquer prefeitura pode se cadastrar no serviço. A solicitação pode ser feita no site do serviço.

Theme	Examples	
		Bentes, (2014)
	Mudamos+	Com o aplicativo Mudamos você pode assinar projetos de lei de iniciativa popular de forma eletrônica, tendo sua privacidade, autenticidade e transparência garantidas com a segurança da tecnologia blockchain.
Monitorung and auditing	Desenvolve BR	O aplicativo DesenvolveBR é um programa pioneiro na governança digital. Por meio dele, o governo federal aprimora e monitora os empreendimentos de infraestrutura no País e o cidadão acompanha a evolução das obras nos estados e municípios. A ferramenta amplia a participação do cidadão na gestão governamental e torna mais transparente as ações do governo. Com o app é possível verificar informações como situação, localização e investimentos previstos. Integrado às redes sociais, permite o envio de fotos, avaliações, comentários e compartilhamento das páginas dos empreendimentos.
Participating	Visitas as escolas	Este aplicativo só vem a reforçar este caráter participativo do Programa de Visitas às Escolas.
Informing	Coleta Seletiva	O aplicativo servirá na orientação e identificação dos pontos de entrega voluntária de materiais recicláveis, bem como para indicar onde depositar corretamente medicamentos, óleo de cozinha, pilhas, baterias e eletrônicos.
	Resultados 2018	O Resultados 2018 é uma maneira simples de acompanhar a apuração das eleições em tempo real. 1) Conheça todos os candidatos para as eleições de 2018.
	Sinesp Cidadao	Consulta Veículos: permite ao cidadão consultar a situação de roubo ou furto de qualquer veículo do Brasil. As informações são consultadas diretamente no banco de dados do Departamento Nacional de Trânsito (DENATRAN).
Voting	Colab.re	
	Sicov Cidadao	
	Mudamos+	

Interactions

2.a. What are the information and codified knowledge flows that occur when these platforms are used?

Theme	Examples	
Citizen to Citizen (C2C)	OTT	.. nossa dinâmica de trabalho, se baseia na segurança feita do cidadão para o cidadão (C2C), uma espécie de segurança “Smart”, onde cada cidadão atualiza em tempo real a segurança em seu entorno, ajudando a ele e a todos os outros participantes de nossa rede dinâmica de

Theme	Examples	
Citizen to Government (C2G)	Desenvolve Brasil	
	Particity	
Government to Citizen (G2C)	#EuFacoPoa	
	Avancar	
Citizen to Private (C2P)	Bairro Seguro	
Private to Citizen (P2C)	SIU Salvador	(Globo, 2014)
	Comida Invisivel	
Government to Private (G2P)	Hemogram	
	Proximo Onibus Curitiba	Aplicação Offline para consulta de horários de ônibus em Curitiba. O aplicativo tem o objetivo para que o usuário possa realizar a consulta de uma linha de ônibus e verifique o tempo que falta para há próxima saída dos pontos cadastrados pela URBS.

2.b. What types of engagement do they enable?

Theme	Examples	
Mode 0	#EuFAcoPoa	Este é o aplicativo oficial da Prefeitura de Porto Alegre. Seu objetivo é possibilitar aos cidadãos de nossa cidade uma forma mais fácil e ágil de acessar importantes informações e serviços públicos oferecidos pela prefeitura da capital.
	Zona Azul Facil	
Mode 1	Onde Fui Roubado	O Onde Fui Roubado é uma plataforma social colaborativa que mapeia roubos, furtos e outros tipos de crimes em cidades brasileiras. Todos os registros são sinalizados em um mapa de maneira anônima, gerando assim dados públicos que ajudam os usuários a conhecerem áreas com altos índices de criminalidade em sua localidade. Hoje o Onde Fui Roubado já se configura como maior plataforma colaborativa na área de segurança pública do mundo, disponibilizando ao seu usuário registros de crimes em mais de 800 cidades no Brasil. No entanto, como depende da boa vontade de voluntários, em algumas regiões com menor densidade demográfica ou até acesso a internet, os dados ficam comprometidos e não mostram algo próximo da realidade no mapa com pontos coloridos.

Theme	Examples	
		(Brito, 2016. para 4)
Mode 2	As Diferentonas	As Diferentonas ajuda ao cidadão a responder a uma pergunta: "No que minha cidade é a diferentona com relação aos recursos que recebe do governo federal?". Para isso, o aplicativo usa os dados abertos do governo federal sobre convênios realizados com os municípios e cruza esses dados com informações do SIAFI, IBGE e Firjan. Usando os dados sociodemográficos e econômicos é possível estimar se o quanto uma cidade recebeu em uma área (por exemplo, R$2M em esportes e lazer) é inesperado, quando comparado com o recebido por cidades semelhantes. Além disso, o cidadão pode acompanhar o estado das iniciativas (convênios) de seu município, comparar o valor e cronograma da construção daquela praça de eventos com os valores e cronogramas de obras parecidas em outras cidades, e debater e denunciar fatos relacionados às iniciativas. “As informações virão do Portal da Transparência, do Portal de Dados Abertos e do Portal de Convênios (Siconv).” (Orzil, 2016. para 3)
Mode 3	Cidadao Online 4R	Cidadão Online! A melhor ferramenta de comunicação com a Prefeitura! Uma das maneiras encontradas pela 4R Sistemas para ajudar as Prefeituras resolverem questões rotineiras com agilidade e eficiência foi a criação do aplicativo Cidadão Online 4R. Um problema qualquer, como um buraco, um semáforo com defeito ou vazamento de uma boca de lobo, pode ser facilmente resolvido se a Prefeitura estiver conectada com sua população. Com a ferramenta Cidadão Online da 4R Sistemas, a Prefeitura inova com a prestação de serviços ao cidadão de forma ágil e eficiente. O cidadão, onde estiver, pode facilmente criar uma solicitação através do seu smartphone, contribuindo para a solução de problemas rotineiros da cidade. Enquanto isso, na Prefeitura, o servidor municipal administra a ferramenta recebendo todas as solicitações e as direciona para o setor competente, gerando um protocolo. O Cidadão pode compartilhar a solicitação em sua rede social, classificar a satisfação do atendimento e acompanhar as tramitações de sua solicitação através do aplicativo, email e notificações push.

Theme	Examples	
	Fala Cidadao	O FALA CIDADÃO é um Aplicativo colaborativo com o objetivo de auxiliar prefeituras e cidadãos a terem uma comunicação mais eficiente. A partir de alertas criados pela população, a administração da cidade terá mais facilidade para definir quais problemas e melhorias que merecem atenção prioritária.
	SP 156	O aplicativo SP156 facilita a comunicação entre o cidadão e a Prefeitura de São Paulo (PMSP). Com ele, os cidadãos podem contribuir com a gestão da cidade a partir da solicitação de serviços, reclamações e denúncias, e podem acompanhar suas solicitações.
Mode 4	Mudamos+	
	Sincov Cidadao	

Features

R.Q. 3. What are the technology features these platforms enable for these information and knowledge flows?

Theme	Examples	
Communication and Engagement	Monitora Brasil	Exerça sua cidadania, monitore, dialogue com os Parlamentares e contribua para uma atividade legislativa mais transparente e eficiente.
Location	Caca mosquito	O aplicativo Caça Mosquito tem o objetivo de mapear zonas com focos do mosquito Aedes aegypti, transmissor da Dengue, da febre Chikungunya e do vírus Zika. O mapeamento é feito por meio de geolocalização, utilizando o GPS do aparelho celular, e o usuário não precisa divulgar a sua identidade.
Connectivity	DetranSP	Com o novo aplicativo do Detran.SP para tablets e smartphones, ficou ainda mais fácil verificar a pontuação de sua CNH e possíveis multas registradas em seu veículo. Para ter acesso às consultas, basta utilizar a mesma senha do portal do Detran.SP. Se você ainda não é cadastrado, entre em www.detran.sp.gov.br.
	Direito na Mao	o direito na mão é um aplicativo desenvolvido com leis de autoria do deputado Luiz Castro, disponibilizado à população amazonense como instrumento de cidadania.
Privacy	Portal do Patrimonio	O aplicativo Portal do Patrimônio, organizado pelo IPHAN-RJ, vem dar corpo a duas ações principais: a divulgação e promoção do patrimônio cultural protegido em todo estado do Rio de Janeiro e a busca por constituir uma rede participativa entre a federação, estado e municípios na identificação e divulgação do acervo de bens que representam o patrimônio brasileiro.

Appendix G: List of Acronyms

CI	Community Informatics
CT	Civic Technologies
CSCW	Computer Supported Cooperative Work
DC	Digital Civics
GIS	Geospatial Information Systems
HCI	Human-Computer-Interaction
ICTs	Information and Communications Technologies
KBS	Knowledge-based systems
KBUD	Knowledge-Based Urban Development
KM	Knowledge Management
LIS	Library and Information Science
MCTs	Mobile Civic Technologies
NFPR	National Front of Popular Resistance
OS	Operating System
OECD	Organization for Economic Co-operation and Development
PCT	Participatory Civic Technologies
PB	Participatory Budgeting
SI	Social Informatics
UI	User Interface

Appendix H: List of definitions

Accountability - When actors are held responsible for their actions. In other words, when public, private and civil societies are held responsible to exercise their power in conformity to a set of rules (McNeil, 2016).

Category - Categories summarize the similarly coded data. They represent the outcome of coding in qualitative research (Saldana, 2009. p.21).

City - The city is used interchangeably with the terms towns and municipality are large and permanent human settlements which generally have a particular administrative, legal, or historical status based on local law (Gregory et. al, 2009; Kuper, 2013; Municipality, n.d.). The year 2007 was, according to the United Nations (UN), the first time in history that more than half of the world's population lived in urban areas (Cities). In developed countries, urban occupation has often exceeded 75%. The significant population densities of cities, together with the widespread availability of wireless and digital infrastructure, and the large-scale adoption of mobile and wireless technologies by citizens make the urban landscapes rich territories for research in emerging social phenomena consequences due to the use of technology. Forth (2009), views cities as living organisms and ICTs can be used to understand the metropolitan needs, challenges, and opportunities. In attempting to manage cities more effectively and efficiently. Several definitions have been used to refer to cities: province, region, department, county, prefecture, district, municipalities, township, town, borough, parish, municipal government, local governments, shire, village, and local service district (Longworth, 2006; Local government, n.d).

Civics - Refers to the rights and duties of citizens who have the right to vote, participate in town hall meetings, receive education about their rights and responsibilities and volunteer for public outreach or services (Boehner & Disalvo, 2016).

Civic Engagement - Civic engagement or civic participation happens when citizens, institutions and political systems form connections to provide a sense of power, problem-solving, deliberation and conversation. It can take the form of volunteering, voting, exchanging information with the goal of collaboratively accessing and aiming to resolve community and urban issues. Nabatachi, (2012) defends that civic engagement enables stakeholders to combine skills, knowledge, and expertise to make a difference and improve quality of life in communities. Civic individuals have the moral and duty to see themselves as members of a larger social context and as actors in the issues that happen in their communities.

Code -Refers to a word or short phrase that captures the essence, attributes and essential elements contained in a section of written or visual data. Codes are applied and reapplied to qualitative data in a process called coding. Coding allows the researcher to group similar data into categories (Saldana, 2009. p.03, 21).

Coding - The objective of coding is to condense and arrange data systematically to provide meaning and categorize findings towards a system or classification (Saldana, 2009. p.08). It is used in qualitative research during the analysis phase of the research. Stuckey, (2014) suggests three steps to code data: (1) reading through the data; (2) categorizing the data into categories or codes and (3) using analytic memos to interpret and clarify the findings. The coding

can be done from a single word to a page of text as well as from moving images. The coding method entails searches for patterns in the data and enables the researcher to organize the coded data into categories (Saldana, 2009. p. 03).

Community - Communities are at the foundation of human activity and are also challenging to define (McDonald, 2013). In 1955, George H., gathered 94 different definitions of community in social sciences. As a conclusion he found that the only convergence among those definitions was that they always referred to people. For Siemens (2006) a community refers to a set of interest areas that allow people to interact, share, dialog and think together. For Lave and Wenger (1991), a community does not need to be a defined group that is easy to identify, neither do they have to be physically present for it to be considered a community. It is important, however that individuals participate in common activities and that they share understanding of what they are doing as well as the meaning of their activities in the context of their communities. McDonald, (2013) combined several definitions for community in one: "A physical or virtual location, which has clearly defined boundaries; populated with inhabitants and groups, who share a common bond of place and background, needs and relationships, who wish to enrich their own well-being". This is a useful definition for this research because he considers that individuals share commonalities within their communities and physical or virtual and it stresses the importance of relationships and bonds between people, thus representing people's wish to participate in their communities.

Community Informatics (CI) - Is the field of research in Information Science concerned with the use of Information and Communication Technologies (ICTs) to enable the participation of local communities (Gurstein, 2007). Topics in CI include: grassroots computing, electronic community networking, community-based technologies, civic technologies and community technologies. CI researchers have investigated how ICTs have been used to support local economic development, social justice, political empowerment, and other goals related to community development. Furthermore, many have identified CI as the research area that investigates technology mediated activities of stakeholders such as: "community leaders and activists, non-profit groups, policymakers, users/citizens, and the range of academics working across (and integrating) disciplines as diverse as Information Studies, Management, Computer Science, Social Work, Planning and Development Studies" (Bytheway, Rhinesmith & Wolfe, 2015. p.01).

Data - In qualitative research, data can include documents, websites, emails, videos, photographs, interview transcripts, photographs, images and participant observation (Saldana, 2009).

Data corpus - Refers to all the data collected for a qualitative research study (Braun & Clarke, 2006)

Democracy - Is also referred to as the "rule by the people". It is a system of government that enables the members of a political community (citizen) to be involved directly or indirectly in making collective decisions. In democracies there has to be a considerable amount of autonomy of citizens from the state, as well as a substantial degree of influence of citizens and organizations on public policy making (Lane & Ersson, 1995, p. 309. As cited in Antiroikko, 2004. p. 32).

Deliberation - Broadly refers to the process of considering the views, experiences and ideas of a group of individuals in a thoughtful and reasoned way to later proceed with voting and policy-making. (Nabatchi, 2012).

Digital Citizenship - In 1949, Marshall, (1992, p.8) defined citizenship as the capacity to provide all members of a political community with civil, political, and social rights including the right to share membership, social heritage and live the life of a civilized being according to the standards prevailing in that society. Bringing this definition up to date, when citizens use ICTs to mediate their communication about their political and social rights, they are as a result, exercising citizenship. Mossberger, Tolbert, & McNeal, (2007) define digital citizenship as a capacity to participate in society online. They argue that ICTs and the internet are facilitators to promote membership and participation of individuals within society (Warschauer 2003; Mossberger, Tolbert, & McNeal, 2007).

Geospatial Information Systems (GIS) - Refer to computer systems that can assemble, store, manipulate and display geographically referenced information. They have become important tools for complex decision making. The ability to associate data about social, environmental and economic activities to a location has significantly changed the way people deal with policy planning design, transport networks, present data about consumer preferences, manage logistics, deal with emergencies, disasters and many other human activities ranging from food production to humanitarian aid (Nascimento & Raghavan, 2008).

Hackathons - Are computer programming events that bring professionals together to prototype ICT applications for a specific purpose. City hackathons (such as the ecohackmtl.org and hackinghealth.ca) were events where citizens joined to build applications in search for possible technological solutions for the challenges they faced in the city. In these hackathons citizens had a context for sharing, articulating and externalizing individuals' knowledge through dialogues amongst participants (Briscoe, 2014) For, example, at ecohackmtl.org developers, activists, researchers, environmentalists and citizens participated to build applications to improve sustainability. In this event, specialists in urban agriculture, urban greening, cycling advocacy, alternative energy and experts in web design, the programming language python, and open data were invited to help build CT applications that would improve sustainability in the city of Montreal, Canada (Ecohack, 2014).

Inclusiveness - When marginalized or excluded citizens are included in the governing process. McNeil, (2016) defends that citizen participation works to the benefit of all citizens as well as for the excluded.

Knowledge-Based Urban Development (KBUD) - Is a model that encourages knowledge production and circulation in cities. It has been regarded as an attempt to enhance knowledge transfer between institutions to create added value and foster problem-solving. It focuses on knowledge intensive institutions such as universities and knowledge-based institutions as the important sources of added value to cities (Yigitcanlar et al., 2018).

Participation mechanisms - Can include public hearings, citizen forums, community or neighborhood meetings, community outreaches, citizen advisory groups, individual citizen representation citizen surveys and focus groups, the internet, and e-mail have also been used as mechanisms for civic participation (Wang, 2001).

Participatory - To be considered participatory, an activity has to be characterized by involving participation, providing the opportunity for individual participation (Participatory. n.d.). Public participation refers to the involvement of citizens in service delivery and management decisions in cities. Participation happens when there are participation mechanisms available and when citizens and public officials have participation needs (King, Feltey, & Susel, 1998; Wang, 2001).

Responsiveness - The ability of governments to design and implement public policies. The process by which government designs and implements public policies that are founded on citizen input, needs and wishes. For responsiveness to happen, citizens' input has to result in change, just listening to citizens does not result in a responsive governance (McNeil, 2016).

Social Informatics - Research that examines the social aspects of computerization with an interdisciplinary approach to the design, uses and consequences of information technologies taking into account the interaction with institutional and cultural contexts (Kling, Rosenbaum & Sawyer, 2005).

Theme - "A theme captures something important about the data in relation to the research question, and represents some level of patterned response or meaning within the data set." (Braun & Clarke, 2006. P. 10) They are the result of the categories and codes originated during coding of qualitative data (Saldana, 2009. p. 13). Themes can be deductive or inductive. Deductive themes originate from previous theories and inductive themes are strongly linked to the data and is not wed to pre-existing coding frameworks (Braun & Clarke, 2006).

Transparency - Actions made in the pursuit of making information accessible to the public domain to be used by citizens and policy makers (Mansuri & Rao, 2012; McNeil, 2016).

Urban Computing - Is a field of study that focuses on the use of technology in public spaces such as cities, parks and suburbs as well as the interaction between humans and these environments. It is an interdisciplinary field connected by geographers, computer scientists, engineers, social scientists, artists, architects, urban planners, & interaction designers (Paulos, 2008).

Urban Informatics - Interdisciplinary field that uses ICTs and data to better understand how cities work to access a wide range of issues affecting the everyday lives of citizens and the long-term health and efficiency of cities from morning commutes to emergency preparedness to air quality (Forth, 2009).

Appendix I - Ethics approval

McGill

Research Ethics Board Office
James Administration Bldg.
845 Sherbrooke Street West. Rm 325
Montreal, QC H3A 0G4

Tel: (514) 398-6831

Website: www.mcgill.ca/research/research/compliance/human/

Research Ethics Board 2
Certificate of Ethical Acceptability of Research Involving Humans

REB File #: 21-05-014

Project Title: Exploring Mobile Civic Technologies in Brazil - A Thematic Analysis

Principal Investigator: Daniele Menezes Nascimento

Department: School of Information Studies

Status: Ph.D. Student

Supervisor: Professor Kimiz Dalkir

Approval Period: June 28, 2021 – June 27, 2022

The REB 2 reviewed and approved this project by delegated review in accordance with the requirements of the McGill University Policy on the Ethical Conduct of Research Involving Human Participants and the Tri-Council Policy Statement: Ethical Conduct for Research Involving Humans.

Georgia Kalavritinos
Ethics Review Administrator

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* Approval is granted only for the research and purposes described.
* Modifications to the approved research must be reviewed and approved by the REB before they can be implemented.
* A Request for Renewal form must be submitted before the above expiry date. Research cannot be conducted without a current ethics approval. Submit 2-3 weeks ahead of the expiry date.
* When a project has been completed or terminated, a Study Closure form must be submitted.
* Unanticipated issues that may increase the risk level to participants or that may have other ethical implications must be promptly reported to the REB. Serious adverse events experienced by a participant in conjunction with the research must be reported to the REB without delay.
* The REB must be promptly notified of any new information that may affect the welfare or consent of participants.
* The REB must be notified of any suspension or cancellation imposed by a funding agency or regulatory body that is related to this study.
* The REB must be notified of any findings that may have ethical implications or may affect the decision of the REB.

Appendix J - Formal Interview Consent form

School of Information Studies McGill University https://www.mcgill.ca/sis/

Participant Consent Form
Researchers: Daniele M. Nascimento, Ph.D. Candidate, School of Information Studies, McGill University, daniele.nascimento@mail.mcgill.ca,
Supervisor: Kimiz Dalkir, Director of the School of Information Studies McGill University, kimiz.dalkir@mcgill.ca
Title of Project: Exploring Mobile Civic Technologies in Brazil - A Thematic Analysis
Sponsor(s): Coordenação de Aperfeiçoamento de Pessoal de Nível Superior or CAPES Foundation
Purpose of the Study: You have been identified as someone who has a role relevant developing or designing the Mobile Civic Technology (MCT) application (App) (name of application). This research project explores the MCTs in Brazil. I am a Ph.D. student who is trying to learn more about these applications and understand what types of civic activities exist when these apps are used, which app features are used to engage with citizens, which stakeholders (Citizens, Government and Private Sectors) are involved when these apps are used and what are your impressions of the use of these apps for civic purposes.
Study Procedures: Your participation in this study will consist of an initial interview where you will be asked questions regarding 1) What are the objectives of these apps, 2) Who are the stakeholders that used this app, and 3) What technological features of these apps, enable civic activities and any additional information or material you'd like to provide regarding our efforts to study the way civic engagement is approached with your app. This initial interview will be recorded with your consent, take place at a time and of your convenience, will be done online and should last no more than an hour.
Voluntary Participation: Your participation is totally voluntary and may refuse to participate in part of the study, may decline to answer any question, and may withdraw from the study at any time, for any reason. If you decide you would not like to participate all information regarding your engagement will be deleted, and no records will be kept other than an entry that you would not like to be contacted or take part in any further part of this project.
Potential Risks: There are no anticipated risks to you by participating in this research.
Potential Benefits: The primary goal of this research is to explore the characteristics and inventory the mobile applications developed in Brasil for civic purposes. Our intent is to provide a framework for MCTs created for civic information and knowledge exchange; understand the technological features used to engage with citizens, and insights on any experiences where public input was gathered on these applications for civic purposes.
Compensation: There is no compensation being offered or implied with your participation in this study.
Confidentiality: Most of the information we will gather from you will pertain to the mobile application (name of the app) concerning civic engagement. Some personal information like your name, job title, and personal opinions will also be collected. All information will be stored in password-protected files and further be deidentified from you by random assignment of participant identification numbers. All notes, recordings, or other collected material in physical form collected as part of your participation will be secured in and digital encrypted file safe where only the approved researcher may have access to, or, destroyed if they are not encrypted (e.g., written notes during the interview or physical documents you may provide). Your information with not be shared with other interview subjects or people aside from the primary researcher of this project, but you can request copies of your own files to use as you wish.
In most cases, it would be helpful for us to record the interview that will be transcribed at a latter point. The original audio file will be deleted, and the transcripts of our interaction securely stored as stated above. You, of course, can refuse to answer any question, have any information documented, or be recorded during any part of this interview.
You consent to be interviewed
Yes: □ No: □
You consent to be audio recorded

Yes: □ No: □
You consent to be identified by name in reports.
Yes: □ No: □
You consent to have your organization's name used.
Yes: □ No: □

Questions: If you have any question regarding this study, please feel free to contact the primary researcher, Daniele M. Nascimento, directly at +55 61 982085442 or daniele.nascimento@mail.mcgill.ca
If you have any ethical concerns or complaints about your participation in this study and want to speak with someone not on the research team, please contact the McGill Ethics Manager at 514-398-6831 or lynda.mcneil@mcgill.ca.
Please sign below if you have read the above information and consent to participate in this study.
Agreeing on to participate in this study does not waive any of your rights or release the researchers from their responsibilities.
A copy of this consent form will be given to you, and the researcher will keep a copy.
Participant's Name:

Appendix K - Interview Instrument

School of Information Studies
McGill University
https://www.mcgill.ca/sis/

Interview: Mobile Civic Technologies in Brazil
App Name:
City:
Affiliation:
Date the app was created: ___/___/___

Introductory Statement
Thank you for accepting to participate in my research. But before we start, would you please sign the consent form devised to meet our human subject requirements? To help with my notes, I would like to record our conversations today. I would like to assure you that only researchers on this project will have access to the recordings which will be destroyed after they are transcribed. In summary, this form states that all information will be held confidential, your participation is voluntary, and you may stop at any time. This interview will last approximately one hour. During this time, we have several questions that we would like to cover. If time begins to run short, I may ask to jump ahead and complete the questions.
You have been selected to speak today because, you have been identified as someone who has a role relevant developing or designing the Mobile Civic Technology (MCT) application (App) (name of application). This research project explores the MCTs in Brazil. I am a Ph.D. student who is trying to learn more about these applications and understand what types of civic activities exist when these apps are used, which technological app features are used to engage with citizens, which stakeholders (Citizens, Government and Private Sectors) are involved when these apps are used and what are your impressions of the use of these apps for civic purposes.

Your participation in this study will consist of an initial interview where you will be asked questions regarding the objectives of this app, the interactions that happen when these apps are used and what technological features of these apps to enable civic activities and any additional information or material, you'd like to provide regarding our efforts to study the way civic activity is approached with your app. This initial interview will be recorded with your consent and will take place at a time and of your convenience, it will be done online and should last no more than an hour.

Perspectives about the objectives of the app

The following questions aim to provide an understanding about the civic goals of these apps

1. What kind of local civic issues does this app aim to address? Please check all that apply.
    - ___ Budgeting
    - ___ Culture
    - ___ E-documents
    - ___ Education
    - ___ Environment
    - ___ Health
    - ___ Infrastructure and Accessibility
    - ___ Policies
    - ___ Security
    - ___ Transport & Mobility
    - ___ Other (Please specify)

2. How does your app address the local civic issues identified above? Please check all that apply.
    - ___ Enabling accountability and transparency
    - ___ Providing a platform for communication
    - ___ Providing tools for civic reporting of local issues
    - ___ Enabling deliberation of ideas
    - ___ Providing an environment for collaborative engagement
    - ___ Providing a tool for dissemination of Information
    - ___ Delivery of civic services
    - ___ Providing tools for voting
    - ___ Other (please specify)
3. Is there anything that I missed in the question above?

Perspectives about the interactions that happen when these apps are used

4. Who are the stakeholders that interact when your app is used?
    - ___ Citizen to Citizen (C2C)
    - ___ Citizen to Government (C2G)
    - ___ Citizen to Private Sector (C2P)
    - ___ Government to Government (G2G)
    - ___ Government to Private sector (G2P)
    - ___ Private Sector to Citizen (P2C)

5. Does your app enable civic engagement? If so, please elaborate.
6. Is there anything that I missed in the question above with regards to the interactions that happen when the app is used?

Perspectives about the technology features of the app

7. What are the technology features from the mobile devices that enable digital civics? Please select all that apply.
    - ___ Camera
    - ___ Phone

___ SMS
___ Microphone
___ Global Positioning System (GPS)
___ Bluetooth
___ Network
___ Wi-Fi
___ Access to Accounts and Identity
___ Access to Calendar
___ Access to Contacts
___ Access to photos and Videos
___ Access to device storage

8. Would you like to add any information about the technology features of the app?

Perspectives about the impacts of the app

9. Please indicate the degree to which you agree or disagree with the following statements about the app's impact.

	Disa-gree	Some-what disagree	Neither agree nor disagree	Some-what agree	Agree
The app is useful for society	O	O	O	O	O
The app serves a civic purpose	O	O	O	O	O
I am personally satisfied with the impacts of this app	O	O	O	O	O

10. Do you have any additional comments you'd like to make relevant to this survey or research project?

Personal Background

11. Please indicate what role you served for the app.

___ Technology developer
___ Government or policy-maker
___ Manager
___ Designer, creator
___ User

12. Which of the following sectors do you fit in

___ Government
___ Journalist
___ Activist
___ Non-for-profit
___ Academic researcher

13. What sex do you identify with?

O Female
O Male
O Other

Appendix L - Number of Themes per App

RQ1. Number of Themes Per App

RQ1b. How do they claim to address these issues?

	Theme	Accountability and transparency	Tools for communication	Civic reporting of issues	Collaborative engagement	Enables deliberation of ideas	Dissemination of Information	Civic service delivery	Voting Tools	
#	Code	A&T	COM	CRP	CE	DEL	DI	CS	VOT	Count
1	#3ConfJuv		x		x		x			3
2	App Barueri		x	x			x	x		4
3	App do Cidadao						x	x		2
4	As diferentonas	x	x	x	x		x	x		6
5	Avancar	x					x			2
6	Bairro Seguro		x	x			x	x		4
7	BH Resolve		x	x			x	x		4
8	Bombeiros Parana		x				x	x		3
9	BusCode POA		x				x	x		3
10	Caca Mosquito		x	x	x		x	x		5
11	Cade o Meu Onibus		x	x	x		x	x		5
12	Cade O onibus			x	x		x	x		4
13	Caixa Trabalhador						x	x		2
14	Calculadora Cidadao						x	x		2
15	Carteirada do bem		x				x	x		3
16	Cataki		x	x	x		x	x		5
17	Central 156		x	x	x		x	x		5
18	Cidadao Online 4r	x	x	x	x		x	x		6
19	CittaMobi		x				x	x		3
20	Colab.re	x	x	x	x	x	x	x	x	8
21	Coleta seletiva Salvador				x		x	x		3
22	Comida Invisivel		x	x	x		x	x		5
23	comuniQ	x	x	x			x			4
24	Copel Mobile						x	x		2
25	Delegacia online RJ		x	x	x		x	x		5
26	Denuncia Ambiente		x	x	x		x	x		5
27	Desenvolve Brasil	x	x	x	x		x	x		6
28	Detector		x				x	x		3
29	Detran RN		x				x	x		3
30	Detran SP		x				x	x		3
31	Df Aguas Claras						x			1

RQ1b. How do they claim to address these issues?

	Theme	Accountability and transparency	Tools for communication	Civic reporting of issues	Collaborative engagement	Enables deliberation of ideas	Dissemination of Information	Civic service delivery	Voting Tools	
#	**Code**	**A&T**	**COM**	**CRP**	**CE**	**DEL**	**DI**	**CS**	**VOT**	**Count**
32	Direito Na Mao	x					x	x		3
33	e-Titulo						x	x		2
34	Eleicoes 2016						x	x		2
35	Eu Cidadao	x	x	x	x		x	x		6
36	Fala Cidadao	x	x	x	x		x	x		6
37	Fala limoeiro	x	x	x	x		x	x		6
38	Falando com o prefeito digital		x	x			x	x		4
39	Falaparnamirim	x	x	x			x	x		5
40	Fiscalizatu		x	x	x		x	x		5
41	Fogo Cruzado	x	x	x	x		x	x		6
42	Goiania Contra Aedes	x	x	x	x		x	x		6
43	Hemogram		x				x			2
44	inforMe Denuncias		x	x			x	x		4
45	Limpa Rapido		x				x	x		3
46	Malalai		x	x	x		x	x		5
47	Menor Preco Nota Parana		x				x	x		3
48	Meu Ambiente		x	x	x		x	x		5
49	Meu Digisus						x	x		2
50	Meu onibus		x				x	x		3
51	Moda Livre	x					x	x		3
52	Monitora Brasil	x					x	x		3
53	MPRJ	x	x	x	x		x	x		6
54	MT Cidadao						x	x		2
55	Mudamos+	x	x		x	x	x	x	x	7
56	Nota Parana	x					x	x		3
57	Onde fui Roubado	x	x	x	x		x	x		6
58	Onde Votar						x	x		2
59	Onibus ao vivo						x	x		2
60	OTT (Onde Tem Tiroteio)		x	x	x		x	x		5
61	Participa BR	x	x	x	x	x	x	x	x	8
62	Particity	x	x	x	x		x	x		6
63	Patrimonio PE						x	x		2
64	Poa Transito						x	x		2
65	Portal do patrimonio		x	x			x	x		4
66	Porto Alegre #EuFaçoPOA		x				x	x		3
67	Pra Cima	x	x	x	x		x	x		6
68	Proximo Onibus Curitiba						x	x		2
69	Radar Cidadao	x	x	x	x		x	x		6
70	Recicla Retro Recife						x	x		2

RQ1b. How do they claim to address these issues?

	Theme	Accountability and transparency	Tools for communication	Civic reporting of issues	Collaborative engagement	Enables deliberation of ideas	Dissemination of Information	Civic service delivery	Voting Tools	
#	**Code**	**A&T**	**COM**	**CRP**	**CE**	**DEL**	**DI**	**CS**	**VOT**	**Count**
71	Reclame Aqui		x	x	x		x	x		5
72	Relix		x		x		x	x		4
73	Resultados	x	x				x	x		4
74	Rota Da Reciclagem	x			x		x			3
75	Rua BH						x	x		2
76	Sempre Alerta	x	x	x	x		x	x		6
77	SIC.SP						x	x		2
78	Sigep						x	x		2
79	Sincov Cidadao	x	x	x	x		x	x		6
80	Sinesp Cidadao		x				x	x		3
81	SIU Salvador						x	x		2
82	SOS Infancia			x	x		x	x		4
83	SP Servicos						x	x		2
84	sp156	x	x	x	x		x	x		6
85	Sr.cidadao	x	x		x		x	x		5
86	Tarifa taxi POA						x	x		2
87	TCMRJ - Visitas as escolas	x	x	x	x		x	x		6
88	Transalvador Noa Cidadao	x	x	x	x		x	x		6
89	Visit Natal						x	x		2
90	Zona Azul Facil						x	x		2

RQ2. Number of themes per app

RQ2a. What are the information and codified knowledge flows that occur when these apps are used?								
	Theme	Citizen to Citi-zen	Gov to Citizen	Citizen to Gov	Citizen to Other	Other to Citizen	Gov to Private	
#		C2C	G2C	C2G	C2P	P2C	G2P	Count
1	#3ConfJuv	x		x				2
2	App Barueri			x				1
3	App do Cidadao		x	x			x	3
4	As diferentonas	x	x					2
5	Avancar		x					1
6	Bairro Seguro				x	x		2
7	BH Resolve		x	x				2
8	Bombeiros Parana		x					1
9	BusCode POA		x			x		2
10	Caca Mosquito	x	x	x				3
11	Cade o Meu Onibus	x	x	x				3
12	Cade O onibus	x		x				2
13	Caixa Trabalhador		x					1
14	Calculadora Cid		x					1
15	Carteirada do bem		x					1
16	Cataki	x		x				2
17	Central 156		x	x				2
18	Cidadao Online 4r			x				1
19	CittaMobi		x			x		2
20	Colab.re							0
21	Coleta seletiva Salv		x					1
22	Comida Invisivel	x			x	x		3
23	comuniQ				x	x	x	3
24	Copel Mobile					x		1
25	Delegacia onlRJ			x				1
26	Denuncia Ambiente		x	x				2
27	Desenvolve Brasil		x	x				2
28	Detector		x					1
29	Detran RN		x					1
30	Detran SP		x					1
31	Df Aguas Claras		x					1
32	Direito Na Mao		x					1
33	e-Titulo		x					1
34	Eleicoes 2016		x	x				2
35	Eu Cidadao		x	x				2
36	Fala Cidadao		x	x				2
37	Fala limoeiro		x	x				2
38	Fal prefeito dig		x	x				2
39	Falaparnamirim		x	x				2
40	Fiscalizatu	x	x	x	x			4
41	Fogo Cruzado		x	x				2

RQ2a. What are the information and codified knowledge flows that occur when these apps are used?								
	Theme	Citizen to Citi-zen	Gov to Citizen	Citizen to Gov	Citizen to Other	Other to Citizen	Gov to Private	
#		**C2C**	**G2C**	**C2G**	**C2P**	**P2C**	**G2P**	**Count**
42	Goiania Con Aedes	x		x	x	x		4
43	Hemogram		x	x	x			3
44	inforMe Denuncias	x				x		2
45	Limpa Rapido	x						1
46	Malalai					x		1
47	Menor Preco Nota			x				1
48	Meu Ambiente		x					1
49	Meu Digisus					x		1
50	Meu onibus	x	x			x		3
51	Moda Livre	x						1
52	Monitora Brasil		x	x				2
53	MPRJ		x					1
54	MT Cidadao		x	x				2
55	Mudamos+	x	x	x		x	x	5
56	Nota Parana	x			x			2
57	Onde fui Roubado		x					1
58	Onde Votar					x		1
59	Onibus ao vivo	x				x		2
60	OTT		x	x	x			3
61	Participa BR	x	x	x				3
62	Particity		x					1
63	Patrimonio PE		x			x		2
64	Poa Transito		x	x				2
65	Portal do patri		x					1
66	#EuFaçoPOA		x	x				2
67	Pra Cima		x					1
68	Prox Onibus Curi				x	x	x	3
69	Radar Cidadao			x	x			2
70	Recicla Retro Re					x		1
71	Reclame Aqui	x	x	x	x	x		5
72	Relix		x	x	x	x	x	5
73	Resultados		x					1
74	Rota Da Reciclagem				x	x		2
75	Rua BH					x	x	2
76	Sempre Alerta	x			x	x	x	4
77	SIC.SP		x					1
78	Sigep		x					1
79	Sincov Cidadao		x	x				2
80	Sinesp Cidadao		x	x				2
81	SIU Salvador						x	1
82	SOS Infancia							0
83	SP Servicos		x					1
84	sp156		x	x				2
85	Sr.cidadao	x	x					2

RQ2a. What are the information and codified knowledge flows that occur when these apps are used?								
	Theme	Citizen to Citizen	Gov to Citizen	Citizen to Gov	Citizen to Other	Other to Citizen	Gov to Private	
#		**C2C**	**G2C**	**C2G**	**C2P**	**P2C**	**G2P**	**Count**
86	Tarifa taxi POA						x	1
87	TCMRJ		x	x				2
88	Transalvador Noa		x	x			x	3
89	Visit Natal		x	x			x	3
90	Zona Azul Facil						x	1

RQ2b.

RQ2b. Do these MCTs enable civic engagement? What types of civic engagement do they enable according to the TEPPCE?								
			No Particip	TEPPCE MODE 1	TEPPCE MODE 2	TEPPCE MODE 3	TEPPCE MODE 4	
#		**Mode**	**NP (0)**	**M1**	**M2**	**M3**	**M4**	**Count**
1	#3ConfJuv	3				x		1
2	App Barueri	0	x					1
3	App do Cidadao	0	x					1
4	As diferentonas	2			x			1
5	Avancar	0	x					1
6	Bairro Seguro	0	x					1
7	BH Resolve	0	x					1
8	Bombeiros Parana	0	x					1
9	BusCode POA	0	x					1
10	Caca Mosquito	2			x			1
11	Cade o Meu Onibus	3				x		1
12	Cade O onibus	2			x			1
13	Caixa Trabalhador	2			x			1
14	Calculadora Cidadao	0	x					1
15	Carteirada do bem	0	x					1
16	Cataki	1		x				1
17	Central 156	3				x		1
18	Cidadao Online 4r	3				x		1
19	CittaMobi	0	x					1
20	Colab.re	4					x	1
21	Coleta seletiva Salvador	2			x			1
22	Comida Invisivel	1		x				1
23	comuniQ	1		x				1

RQ2b. Do these MCTs enable civic engagement? What types of civic engagement do they enable according to the TEPPCE?								
			No Participation	TEPPCE MODE 1	TEPPCE MODE 2	TEPPCE MODE 3	TEPPCE MODE 4	
#		Mode	NP (0)	M1	M2	M3	M4	Count
24	Copel Mobile	0	x					1
25	Delegacia online RJ	3				x		1
26	Denuncia Ambiente	3				x		1
27	Desenvolve Brasil	3				x		1
28	Detector	1		x				1
29	Detran RN	0	x					1
30	Detran SP	0	x					1
31	Df Aguas Claras	0	x					1
32	Direito Na Mao	0	x					1
33	e-Titulo	0	x					1
34	Eleicoes 2016	0	x					1
35	Eu Cidadao	3				x		1
36	Fala Cidadao	3				x		1
37	Fala limoeiro	3				x		1
38	Falando com o prefeito digital	3				x		1
39	Falaparnamirim	3				x		1
40	Fiscalizatu	3				x		1
41	Fogo Cruzado	2		x				1
42	Goiania Contra Aedes	3				x		1
43	Hemogram	1	x					1
44	inforMe Denuncias	2			x			1
45	Limpa Rapido	1		x				1
46	Malalai	1		x				1
47	Menor Preco Nota Parana	1		x				1
48	Meu Ambiente	3				x		1
49	Meu Digisus	0	x					1
50	Meu onibus	1		x				1
51	Moda Livre	1		x				1
52	Monitora Brasil	1		x				1
53	MPRJ	3				x		1
54	MT Cidadao	3				x		1
55	Mudamos+	4					x	1
56	Nota Parana	3				x		1
57	Onde fui Roubado	1		x				1
58	Onde Votar	3				x		1
59	Onibus ao vivo	1		x				1
60	OTT (Onde Tem Tiroteio)	1		x				1

RQ2b. Do these MCTs enable civic engagement? What types of civic engagement do they enable according to the TEPPCE?								
			No Participip	TEPPCE MODE 1	TEPPCE MODE 2	TEPPCE MODE 3	TEPPCE MODE 4	
#		**Mode**	**NP (0)**	**M1**	**M2**	**M3**	**M4**	**Count**
61	Participa BR	3				x		1
62	Particity	3				x		1
63	Patrimonio PE	2			x			1
64	Poa Transito	2			x			1
65	Portal do patrimonio	0	x					1
66	Porto Alegre #EuFaçoPOA	3				x		1
67	Pra Cima	3				x		1
68	Proximo Onibus Curitiba	1		x				1
69	Radar Cidadao	3				x		1
70	Recicla Retro Recife	1	x					1
71	Reclame Aqui	1	x					1
72	Relix	1	x					1
73	Resultados	3				x		1
74	Rota Da Reciclagem	1		x				1
75	Rua BH	1		x				1
76	Sempre Alerta	2			x			1
77	SIC.SP	2			x			1
78	Sigep	3				x		1
79	Sincov Cidadao	4					x	1
80	Sinesp Cidadao	3				x		1
81	SIU Salvador	0	x					1
82	SOS Infancia	2			x			1
83	SP Servicos	0	x					1
84	sp156	3				x		1
85	Sr.cidadao	1		x				1
86	Tarifa taxi POA	1		x				1
87	TCMRJ - Visitas as escolas	3				x		1
88	Transalvador Noa Cidadao	3				x		1
89	Visit Natal	0	x					1
90	Zona Azul Facil	0	x					1
	Count		27	19	11	30	3	
	%		30%	21%	12%	33%	3%	

RQ3. Number of themes per app

RQ3. What are the technology features of these platforms?

		Communication and engagement				Location		Connectivity		Privacy						
Code ->		**C&E**				**LOC**		**CON**		**PRI**						
#	Feature	Camera	Phone	SMS	Micro-phone	GPS	Blue-tooth	Net-work	Wi-fi	Ac-counts &ID	Calen-dar	Con-tacts	Device app and history	Pho-tos/Me-dia and Files	Storage	Count
1	#3ConfJuv					x		x						x	x	4
2	App Barueri		x			x		x								3
3	App do Cidadao		x			x		x								3
4	As diferentonas							x	x							2
5	Avancar							x						x	x	3
6	Bairro Seguro		x			x		x						x		4
7	BH Resolve							x								1
8	Bombeiros Parana		x			x		x						x		4
9	BusCode POA							x								1
10	Caca Mosquito	x				x		x						x		4
11	Cade o Meu Onibus					x		x						x	x	4
12	Cade O onibus							x								1
13	Caixa Trabalhador					x		x	x	x	x	x		x	x	8
14	Calculadora Cidadao							x						x		2
15	Carteirada do bem		x		x			x						x	x	5
16	Cataki		x			x		x						x		4
17	Central 156					x		x						x	x	4
18	Cidadao Online 4r		x			x		x						x		4
19	CittaMobi	x	x			x		x						x	x	6
20	Colab.re	x				x		x		x		x		x	x	7

RQ3. What are the technology features of these platforms?

		Communication and engagement				Location		Connectivity		Privacy						
	Code ->	**C&E**				**LOC**		**CON**		**PRI**						
21	Coleta seletiva Salvador					x		x						x	x	4
22	Comida Invisivel							x	x				x	x	x	5
23	comuniQ	x	x		x	x		x		x	x	x	x		x	10
24	Copel Mobile					x		x		x		x				4
25	Delegacia online RJ							x						x	x	3
26	Denuncia Ambiente	x			x	x		x						x		5
27	Desenvolve Brasil					x		x		x		x		x	x	6
28	Detector	x				x		x		x				x		5
29	Detran RN		x			x		x				x		x	x	6
30	Detran SP					x		x		x		x		x	x	6
31	Df Aguas Claras		x													1
32	Direito Na Mao	x				x		x						x	x	5
33	e-Titulo		x					x								2
34	Eleicoes 2016	x				x		x						x	x	5
35	Eu Cidadao					x		x						x	x	4
36	Fala Cidadao	x	x			x		x		x	x	x		x		8
37	Fala limoeiro					x		x		x				x	x	5
38	Falando com o prefeito digital					x		x						x		3
39	Falaparnamirim					x		x						x	x	4
40	Fiscalizatu					x		x								2
41	Fogo Cruzado		x					x						x	x	4
42	Goiania Contra Aedes					x		x	x					x		4
43	Hemogram		x			x		x				x		x	x	6

RQ3. What are the technology features of these platforms?

		Communication and engagement				Location		Connectivity		Privacy						
	Code ->	**C&E**				**LOC**		**CON**		**PRI**						
44	inforMe Denuncias					x		x		x				x	x	5
45	Limpa Rapido		x			x	x	x		x		x				6
46	Malalai	x		x		x		x	x	x		x		x	x	9
47	Menor Preco Nota Parana			x		x		x						x	x	5
48	Meu Ambiente		x			x		x	x	x		x		x	x	8
49	Meu Digisus					x		x						x	x	4
50	Meu onibus							x								1
51	Moda Livre	x	x		x	x		x				x		x	x	8
52	Monitora Brasil							x								1
53	MPRJ	x				x		x	x					x	x	6
54	MT Cidadao	x				x		x						x	x	5
55	Mudamos+	x				x		x		x		x		x	x	7
56	Nota Parana					x		x						x	x	4
57	Onde fui Roubado		x					x	x	x				x	x	6
58	Onde Votar					x		x	x	x		x		x	x	7
59	Onibus ao vivo					x		x		x		x			x	5
60	OTT (Onde Tem Tiroteio)							x								1
61	Participa BR	x				x		x		x		x		x	x	7
62	Particity					x		x								2
63	Patrimonio PE		x			x		x		x		x		x	x	7
64	Poa Transito		x			x		x		x		x		x	x	7
65	Portal do patrimonio	x				x		x						x	x	5
66	Porto Alegre #EuFaçoPOA				x	x		x						x	x	5

RQ3. What are the technology features of these platforms?

		Communication and engagement				Location		Connectivity		Privacy						
	Code ->	**C&E**				**LOC**		**CON**		**PRI**						
67	Pra Cima	x		x		x		x						x	x	6
68	Proximo Onibus Curitiba					x		x		x		x		x	x	6
69	Radar Cidadao					x		x	x					x	x	5
70	Recicla Retro Recife							x		x						2
71	Reclame Aqui					x		x				x		x	x	5
72	Relix					x		x								2
73	Resultados							x						x	x	3
74	Rota Da Reciclagem					x		x						x	x	4
75	Rua BH					x		x								2
76	Sempre Alerta	x			x	x		x						x	x	6
77	SIC.SP							x								1
78	Sigep					x	x	x						x	x	5
79	Sincov Cidadao				x	x		x		x		x		x	x	7
80	Sinesp Cidadao							x	x					x	x	4
81	SIU Salvador					x		x						x	x	4
82	SOS Infancia					x		x						x	x	4
83	SP Servicos		x			x		x		x		x		x	x	7
84	sp156					x		x	x					x	x	5
85	Sr.cidadao	x				x		x	x					x	x	6
86	Tarifa taxi POA		x			x		x						x	x	5
87	TCMRJ - Visitas as escolas							x						x	x	3
88	Transalvador Noa Cidadao	x	x			x		x		x	x	x		x	x	9
89	Visit Natal					x		x	x					x	x	5

RQ3. What are the technology features of these platforms?

		Communication and engagement				Location		Connectivity		Privacy						
	Code ->	**C&E**				**LOC**		**CON**		**PRI**						
90	Zona Azul Facil		x			x		x	x					x	x	6