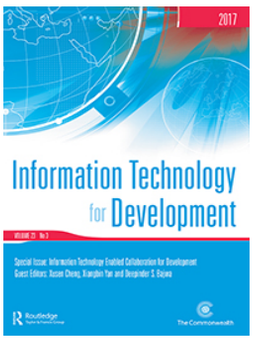

Information Technology for Development

ISSN: 0268-1102 (Print) 1554-0170 (Online) Journal homepage: https://www.tandfonline.com/loi/titd20

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To cite this article: Gabriela Viale Pereira, Maria Alexandra Cunha, Thomas J. Lampoltshammer, Peter Parycek & Maurício Gregianin Testa (2017) Increasing collaboration and participation in smart city governance: a cross-case analysis of smart city initiatives, Information Technology for Development, 23:3, 526-553, DOI: 10.1080/02681102.2017.1353946

To link to this article: https://doi.org/10.1080/02681102.2017.1353946

Published online: 19 Jul 2017.

INFORMATION TECHNOLOGY FOR DEVELOPMENT, 2017
VOL. 23, NO. 3, 526–553
https://doi.org/10.1080/02681102.2017.1353946

Increasing collaboration and participation in smart city governance: a cross-case analysis of smart city initiatives

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ABSTRACT

This study addresses the concept of smart governance in the context of smart cities, with a focus on analyzing the phenomenon of smart collaboration. Relying on the existing collaboration and participation concepts in the smart city domain, an empirical analysis was undertaken of how ICT can promote collaborative governance and increase the participation and engagement in government. The multiple case studies focus on three cities in Brazil that run municipal operations centers in an effort to "become smarter": Rio de Janeiro, Porto Alegre, and Belo Horizonte. Interviews with directors, managers, and technicians shed light on the contribution that ICT makes in promoting an environment of collaboration in the government. The findings have revealed that ICT has an important role in supporting information sharing and integration between government agencies and external stakeholders, including citizens, especially in developing countries.

KEYWORDS

Smart city; smart governance; information sharing; center of operations; collaborative governance

1. Introduction

Creating an environment of collaboration can be considered one of the main differences between electronic government and smart governance concepts. Governance can be defined as interaction and collaboration between different stakeholders in decision-making processes (Alonso & Lippez-De Castro, 2016). As noted by Scholl and Scholl (2014), smart interaction with stakeholders is a broader field of interest in smart governance research that has emanated from traditional electronic government research.

Generally, the main goal of e-government is to optimize services in the urban space, which goes hand-in-hand with actions that are taken to improve the quality of life. In addition to this traditional understanding, Castelnovo, Misuraca, and Savoldelli (2015) emphasize the importance of using ICT-based approaches to achieve a qualitative improvement in the relationship between citizens and their government. Further, they

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Xusen Cheng is the accepting Associate Editor for this article.

stress the utilization of ICT-enabled networks to host electronic public services as a means of establishing contact with the government. However, the communication aspect is not the only one that must be considered. Going one step further, Albino, Berardi, and Dangelico (2015, p. 10) state: "[…] smart governance means various stakeholders are engaged in decision-making and public services." In return, when put into the context of smart city initiatives, governance takes a key position. This is particularly true when engaging citizens in these initiatives and for keeping the associated decision-making processes transparent (Albino et al., 2015; Castelnovo et al., 2015). To increase the total number of participants, ICT-based solutions such as social media can help spread the word, collect feedback, and thus support decision-making based on the public's needs (Castelnovo et al., 2015).

Regarding the previously described background, this paper addresses the concept of smart governance in the context of smart cities, with a focus on analyzing the phenomenon of smart collaboration. According to Alonso and Lippez-De Castro (2016), the contribution of ICT in providing information and increasing the engagement of citizens has not been completely described. Thus, this paper examines the role of ICT in smart city initiatives within municipal operations centers. On a high level of abstraction, this paper aims to answer the following question: How can ICT promote collaborative governance and increase participation and engagement in smart city initiatives?

From the viewpoint of municipal operations centers, the following have specifically been analyzed: (i) the role of ICT in supporting collaborative governance, (ii) the elements of collaborative governance, and (iii) how participation and engagement can be increased through ICT-based solutions. Despite the importance given in the literature to collaboration and ICT-enabled collaboration, there is still a gap in how ICT can leverage collaborative governance in smart cities or, in other words, ICT-enabled collaborative governance.

To explore how the phenomenon of smart collaboration occurs, an exploratory study was conducted based on multiple case studies. This particular research method was chosen due to its key characteristic of holistic investigation, which allows the understanding of the complex and ubiquitous interactions among organizations, technologies, and people (Dubé & Paré, 2003).

Municipal operations centers have emerged in Brazil as a way to mitigate the consequences of rapid urbanization without a specific treatment of quality of life issues and citizen well-being while struggling with the growth of urban problems. In this sense, the empirical setting of this research is determined by the municipal operations centers in Rio de Janeiro, Porto Alegre, and Belo Horizonte. These centers require the interaction of various actors and are a prime location for observing collaboration and participation phenomena.

This paper focuses on three cities in Brazil that run municipal operations centers in an effort to "become smarter": The Centre of Operations Rio (COR) in Rio de Janeiro, the Integrated Centre of Command (CEIC) in Porto Alegre, and the Centre of Operations at Belo Horizonte (COP-BH) in Belo Horizonte. These cities have been recognized as smart cities and represent the three most relevant municipal operation centers in Brazil. The cities vary largely in terms of population, demographics, economy, and location, which allows interesting differences to be addressed.

The findings revealed that ICT has an important role in supporting information sharing and integration between government agencies and external stakeholders, including citizens.

The remainder of this paper is organized as follows. Section 2 provides an overview of collaborative governance, ICT-enabled governance, and collaboration and participation as a way to analyze smart city initiatives. Section 3 describes the data collection method and distinct case studies. Section 4 reports the findings from data analysis, followed by a discussion in Section 5. Finally, the paper closes with the conclusion.

2. Literature review

The concept of a smart city can be considered a utopia and derives from the overlapping assemblage of studies in urbanism and the wave of ICT for development (Allwinkle & Cruickshank, 2011; Bolívar & Meijer, 2016; Hollands, 2008; McFarlane, 2011). In the field of ICT, a rapid development of hardware, software, and networks has been experienced and, combined with a cost reduction, has made ICT for development available for most cities around the world (Pérez-González & Díaz-Díaz, 2015). The different and often complementary perspectives of a smart city encompass an efficient, technologically advanced, sustainable, and socially inclusive city (Vanolo, 2014).

In the context of smart cities, smart governance is a key issue. Smart governance means that various stakeholders are engaged in decision-making and public services (Albino et al., 2015); it also means that new technologies – that is, social media, the internet, open data, citizen sensors, and serious games – are used to strengthen the collaboration between citizens and urban governments (Federici, Braccini, & Sæbø, 2015). From this perspective, one important element of governance is collaboration both across departments and with communities and making operations and services truly citizen-centric (Bătăgan, 2011). For some authors, the development of ICT promises to transform urban governance into "smart governance" because ICT enables city governments to carry out their tasks more effectively and efficiently (Hoon Lee, Phaal, & Lee, 2013; Inayatullah, 2011; Winters, 2011). Moreover, ICT supports relationships among citizens and other organizations and presents new opportunities, particularly for governments, to promote new forms of communication, consultation, and dialogue between public organizations and citizens (Federici et al., 2015).

Gil-Garcia, Pardo, and Nam (2015) present a comprehensive view of the components and elements of a smart city. This view comprises four dimensions: (1) technology and data, (2) government, (3) society, and (4) physical environment. Technology is seen as a dimension that extends across the others and aids in enhancing and interconnecting them. Considering the question that motivated this work, the technology and data dimension was analyzed, along with governance, engagement, and collaboration, as one of the three components of the "Society" dimension. Immersed in the specific context of municipal operation centers, the focus was on collaborative governance and the role of ICT in enabling collaborative governance, participation, and engagement.

2.1. Collaborative governance

From the ideal-typical perspective with the focus on governance, smart cities are defined as cities with smart collaboration (Meijer & Bolívar, 2016). Governments around the world are facing complex problems, and solving them requires government agencies, non-profit and private organizations to work together (Pardo, Gil-Garcia,& Luna-Reyes, 2010).

Collaboration can be defined as "a process or a set of activities in which two or more agents work together to achieve shared goals" (Chun, Luna-Reyes, & Sandoval-Almazán, 2012). Several aspects of collaboration have been studied, such as team collaboration (Cheng, Yin, Azadegan, & Kolfschoten, 2016) and collaborative learning (Cheng, Fu, & Druckenmiller, 2016). In the context of government, Harrison et al. (2012) define collaboration as the sharing of responsibility and authority for decisions on operations, policies or actions of government for more than one set of stakeholders. Collaboration can occur at different levels and can be inter-organizational, cross-sectorial, or through the government-citizen relationship (Nam & Pardo, 2014). Internal collaboration, which can be characterized as inter-departmental or inter-institutional (between public organizations), can be defined as collaborative governance. Thus, it can easily be affirmed that ICT plays an important role in facilitating inter-organizational collaboration (Chun et al., 2012) and that governments around the world have prioritized the enhancement of collaboration and integration across government departments (Alhusban, 2015). External collaboration includes the involvement of governmental and non-governmental parties, such as companies, non-profit organizations, civic groups, or individual citizens.

Considering the organizational changes, smart city initiatives aim to increase the efficiency and effectiveness of public administration as well as aspects that promote smart governance to encourage greater collaboration between stakeholders (Chourabi et al., 2012) and improve the provision of information and services (Angelopoulos, Kitsios, Kofakis, & Papadopoulos, 2010). Other benefits related to collaborative government are better information sharing by agencies, higher resource utilization, and more engaged policy-making (Estevez, Ojo, & Janowski, 2010). Information sharing optimizes and reduces the impediments to improving government performance and promotes situation awareness that supports well-informed, collaborative decision-making, and joint actions (Chun et al., 2012). A collaborative government can apply collective intelligence for innovative solutions to problems; it can also provide shared governance that ultimately fosters the trust and confidence of citizens in governments (Chun et al., 2012). This collaborative environment is one of the distinct characteristics between smart governance and e-government (Scholl & Scholl, 2014).

For Gil-Garcia, Helbig, and Ojo (2014), technology can be a core component of changes and innovation in government, but in other cases, this is only a minor aspect. Other elements of smart governance include coordination between economic and social policy, improvement in intra-governmental coordination, decentralization, increased participation, and renewal of organizational structures. From the literature, six defining elements that cover the various aspects of smart governance have already been identified (Bolívar & Meijer, 2016): (1) the use of ICT (e.g. Giffinger et al., 2007); (2) external collaboration and participation (e.g. Bătăgan, 2011); (3) internal coordination in order to achieve collective goals through collaboration (e.g. Willke, 2007); (4) decision-making processes (e.g. Barrionuevo, Berrone, & Ricart, 2012); (5) administration and the ability of government agencies to interact with the public online in the delivery of services and in fulfilling their predesignated mandates (e.g. Odendaal, 2003); and (6) outcomes, for example, Caragliu, Del Bo, and Nijkamp (2011) note that the overall aim of smart governance could be to achieve the social inclusion of urban residents in public services. Bolívar and Meijer (2016) also stress that most papers in smart governance present a combination of these various defining elements.

2.2. ICT-enabled governance

Data, information, and ICT are crucial components of a smart city. In a smart city initiative, data management capacity, information processing, and information sharing through ICT are key aspects for promoting partnerships and inter-organizational communications in cities in both developed and emerging economies (Odendaal, 2003). Gil-Garcia et al. (2015) note three perspectives that are useful in defining urban smartness in terms of data and information: (1) a smart city is instrumented with data from physical and virtual sensors (Chen, 2013); (2) a smart city has an enterprise computing platform that integrates real-time, real-world data and is responsible for sharing information among city services; and (3) a smart city uses analytics to make better operational decisions. In addition, some authors stress the importance of data and information to improving the decision-making processes of public policies (Charalabidis, Koussouris, Lampathaki, & Misuraca, 2012).

Technology comprises a broad variety of elements that are used to support data and information sharing among urban governments, governmental agencies and departments, citizens and all of the stakeholders involved in a smart urban initiative. Broadband and wireless infrastructure, interconnecting computer networks, ubiquitous systems, virtual technologies, and service-oriented architecture are some of these elements (Anthopoulos & Fitsilis, 2009; Gil-Garcia et al., 2015).

In a broader vision, electronic governance encompasses the strategic use of ICT to support governance processes, including the relationships between government and citizens and other stakeholders (Estevez & Janowski, 2013). In a more specific definition, ICT-enabled city governance consists of the use of ICT to simplify and improve the internal administrative operations of government, facilitate public service interaction between government and all stakeholders, enable citizen participation, and ensure inclusiveness and equal opportunities (Castelnovo et al., 2015). Focusing on improving the quality and effectiveness of policies and governance models, Charalabidis et al. (2012) define ICT for governance and policy modeling as an umbrella term indicating the use of technologies that interact to achieve the target of participative, evidence-based governance and the related organizational and social processes associated with them.

The exchange of data and information between government agencies and between governments and social actors makes interoperability a bigger issue in smart cities. The context is the combination of the use of technologies that are traditionally used by governments and new technologies – social media, the internet, open data, big data analytics tools, citizen sensors, IoT, and games. Interoperability defines the necessary condition for cooperation by exchanging information and communication between organizations. Moreover, measurement processes, performance evaluation, and improvement are expected (Maheshwari & Janssen, 2014). Nam and Pardo (2014) defined some metrics for a smart government initiative evaluation in pursuit of an effective, efficient, transparent, and more collaborative management. The same can be assessed both in operations management within public organizations and in their interaction with the public, stakeholders, and other non-governmental actors.

To perform the role of moderators of collective decision-making processes, governments should be able to establish platforms for policy intelligence in which all

stakeholders can contribute to the policy directions, thereby improving governance and policy-making processes. However, what is still missing is the definition and realization of new ICT-enabled governance models, where the balance of power and the roles and responsibilities of governments, societal actors, and the population will have to adapt to these challenging new possibilities (Misuraca, Broster, & Centeno, 2012).

2.3. Participation and engagement

Harrison et al. (2012) define participation as the intensity of direct involvement of other parties in decision-making regarding governmental actions. In this definition, it is important to observe the way in which forums are organized, aiming to facilitate communication among government, citizens, companies, stakeholders, and concerned groups that face a specific decision or issue (Renn, Webler, & Wiedemann, 1995). One can include public consultations, public meetings, focus groups, surveys, citizen counsels or committees, referenda, initiatives and businesses, among other models.

There is a growing interest, both in academic research and in governmental practice, regarding the new forms of relations between the state and citizens enhanced by ICT, especially in public participation or decision-making with citizens' participation (Cunha, Coelho, & Pozzebon, 2013). ICT-based applications can be used to raise public engagement in public debates about societal needs (Castelnovo et al., 2015). Citizen-centric e-governance is considered a new mechanism for the government to use ICT to enhance citizen engagement with political discourse and decision-making, influencing meaningful change in public policy and governance (Chatfield, Reddick, & Brajawidagda, 2015; Reddick, Chatfield, & Jaramillo, 2015). In general, ICT-based tools can mediate, extend, and transform participation in democratic and consultative societal processes (Sæbø, Rose, & Flak, 2008). These processes involve the use of ICT in political, civil, and administrative spheres of governance (Grönlund & Horan, 2005).

Some governments have proven the potential of ICT to generate value through co-creation and citizen participation (Díaz-Díaz & Pérez-González, 2016). The focal point of applying ICT-based tools for participation is the citizen, and therefore its main purpose is to increase the abilities of citizens to participate in governance, including the processes of providing public services at various stages in the production chain (Pérez-González & Díaz-Díaz, 2015), that is, planning, decision-making, implementation, and evaluation (Grönlund, 2001; Sæbø et al., 2008). Beyond the public services delivery, smart city initiatives usually have inter-sectorial relationships and encourage citizen participation (Alawadhi et al., 2012). Further, the goal is to enable them to have a genuine impact on public policies (Aström, Karlsson, Linde, & Pirannejad, 2012; Pozzebon, Cunha, & Coelho, 2016). In particular, to create responsive governance, social media can have a key role when adopted by the public sector. According to Bekkers, Edwards, and de Kool (2013), social media monitoring can facilitate more responsiveness in policy-making and co-production with citizens, but it can also facilitate governance processes in which citizens participate and public organizations take their ideas and suggestions into account.

There is strong evidence that social media helps the government empower citizens and expand democracy, especially in more open local governments (Bonsón, Royo, & Ratkai, 2015). Citizen engagement relies on connecting government with citizens through ICT and combining ideals of citizen-centricity and community empowerment in values

such as responsiveness, consultation, collaboration, and participation (Rose, Persson, & Heeager, 2015). Furthermore, citizen engagement allows two-way communication and enables collaboration and participation, thereby increasing the quality of the relationship between citizens and governments (Gil-Garcia, Zhang, & Puron-Cid, 2016). Citizens tend to engage more when they see that governments are open to interacting and integrating their point of view when formulating decisions and when they have access to useful, relevant, and a complete set of information from the government (Bonsón et al., 2015; Mellouli, Luna-Reyes, & Zhang, 2014).

As suggested by Nam and Pardo (2014), transparency can be a tool to make government smarter. Harrison et al. (2012) define transparency as the access to data or information on governmental operations, assisting in areas such as responsiveness or influence over government. Considering the internal and external views of smart government, transparency can be seen both in information sharing and in the integration among government organizations, apart from the accessibility of information and decision-making processes related to the provision, monitoring, and delivery of services (Nam & Pardo, 2014).

Table 1 summarizes the concepts presented in the literature review, including their descriptions and references.

3. Method

As stated by Yin (1994), most studies require the analysis of multiple cases, following the logic of literal replication or theoretical replication for case selection. To select case studies in this paper, the logic of literal replication was used, where the conditions of cases led to a prediction of similar results (Yin, 1994). The authors chose the cross-case analysis of multiple cases in which they are not shown separately, seeking more general results (Yin, 2009). Following the matrix of case study types proposed by Yin (2009), this research is characterized as a holistic study of multiple cases in which each case study presents a different context (three different cases so three different contexts). Furthermore, the cases are analyzed by a single unit of analysis (holistic study), which is defined in this study as the role of ICT in municipal operations centers.

The first two cases, Rio de Janeiro and Porto Alegre, were selected because the cities won the World Smart City[1] award in 2013 and 2014, respectively. To maximize the results addressing the totality of municipal operations centers in Brazil, the Belo Horizonte case was also included based on the criteria of typical cases (Yin, 2009).

Primary data were collected through 32 individual and 3 group interviews (2 individuals each) across the three cases between the second half of 2014 and the first half of 2015, resulting in a total of 37 respondents. One supervisor was interviewed twice, as listed in Table 2. The selected individuals are included in different functional teams at different levels and with different professional backgrounds to obtain a wider range of perspectives on the case. Thus, due to the specifics of the cases, the sample includes representatives of senior management, such as directors and coordinators of the centers; administrative managers and administrative staff, such as advisors and managers of centers, technology analysts and other technical and administrative staff; and operating managers and service operators, especially agents of other agencies allocated in the center.

Table 1. Adopted concepts, descriptions, and authors.

Concept	Description	Authors
Collaborative governance	*Collaborative governance* Inter-departmental collaboration or between public organizations for problem-solving. In a broader definition, it involves sharing of responsibility and authority between urban governments and/or governmental departments, citizens, private sector, and stakeholders working together in problem-solving and decision-making.	Meijer and Bolívar (2016) Bătăgan (2011) Inayatullah (2011) Winters (2011) Hoon Lee et al. (2013) Pardo et al. (2010) Chun et al. (2012) Scholl and Scholl (2014) Chourabi et al. (2012) Angelopoulos et al. (2010) Estevez et al. (2010)
	Governance elements The use of ICT; external collaboration and participation; internal coordination in order to achieve collective goals through collaboration; decision-making process; e-administration; and outcomes.	Bolívar and Meijer (2016) Giffinger et al. (2007) Bătăgan (2011) Willke (2007) Barrionuevo et al. (2012) Odendaal (2003) Caragliu et al. (2011) Gil-Garcia et al. (2014)
ICT-enabled governance	*ICT and other technologies* Comprises a broad variety of elements such as broadband and wireless infrastructure, interconnecting computer networks, ubiquitous systems, virtual technologies, and service-oriented architectures.	Gil-Garcia et al. (2015) Anthopoulos and Fitsilis (2009)
	Data and information A city instrumented with data from physical and virtual sensors; a platform integrating real-time, real-world data and responsible for sharing information among city services; analytics to better operational decisions. Data and information being used to improve the decision-making processes of public policies.	Gil-Garcia et al. (2015) Chen (2013) Charalabidis et al. (2012) Harrison et al. (2010)
Participation and engagement	*Participation* Intensity of the direct involvement of other parties in decision-making regarding governmental actions.	Harrison et al. (2010) Cunha et al. (2013) Castelnovo et al. (2015) Chatfield et al. (2015) Reddick et al. (2015) Sæbø et al. (2008) Grönlund and Horan (2005) Díaz-Díaz and Pérez-González (2016) Pérez-González and Díaz-Díaz (2015) Grönlund (2001) Aström et al. (2012) Pozzebon et al. (2016)
	Collaboration and engagement Connecting government with citizens through ICT, combining ideals of citizen-centricity and community empowerment in values such as responsiveness, consultation, collaboration, and participation; allows two-way communication and enables collaboration and participation, increasing the quality of the relationship between citizens and governments.	Rose et al. (2015) Gil-Garcia et al. (2016) Bonsón et al. (2015) Mellouli et al. (2014)
	Transparency Access to data or information on governmental operations, assisting in areas such as responsiveness or influence over the government.	Nam and Pardo (2014) Harrison et al. (2012)

Source: Authors.

To select the participants, we approached an initial point of contact who was the communication advisor of the centers or secretaries for assistance. Thus, the selection of the sample followed the snowball technique, where the interviewees could indicate

Table 2. Profile of interviewees.

City	Level	Technique	Number of interviews
Porto Alegre	Senior management	Individual interview	3 (2 with the same interviewee)
Porto Alegre	Managers and administrative	Individual interview	2
Porto Alegre	Manager and operational	Individual interview	6
Belo Horizonte	Senior management	Individual interview	3
Belo Horizonte	Senior management	Group interview	1 (2 interviewees)
Belo Horizonte	Managers and administrative	Individual interview	4
Belo Horizonte	Managers and administrative	Group interview	1 (2 interviewees)
Belo Horizonte	Manager and operational	Individual interview	7
Belo Horizonte	Manager and operational	Group interview	1 (2 interviewees)
Rio de Janeiro	Senior management	Individual interview	2
Rio de Janeiro	Managers and administrative	Individual interview	5

Source: Authors.

someone to participate in the next meeting. The convergence of responses was used to define the end of the data collection in each case. Table 2 presents a detailed list of respondents.

To increase the qualitative research credibility and validity, this study adopted data triangulation of data, which involved verifying facts from multiple data sources (Cho & Trent, 2006), interviews with different people and different locations, and document analyses. The interviews occurred at the individuals' work sites, and each session lasted approximately one hour. Each interview was recorded digitally to facilitate the process of transcription and analysis of data, preserving the anonymity of participants who authorized the recordings. Moreover, during the interviews, notes were made, and documents were collected to supplement the data and assist in understanding the context in which the interviews were conducted.

In addition to conducting semi-structured interviews, an interview protocol was used to guide the data collection. The interviewers were free to build an appropriate conversation interacting with each interviewee, considering their expertise and function. The protocol was based on the literature review and on the pre-established questionnaire in the field of smart cities (Alawadhi et al., 2012; AlAwadhi & Scholl, 2013; Chourabi et al., 2012; Nam & Pardo, 2012; Gil-Garcia & Aldama-Nalda, 2013; Macadar & Lheureux-De-Freitas, 2013; Nam & Pardo, 2013), featuring both open and topic-related questions. We also considered the integrative framework of smart cities proposed by Gil-Garcia et al. (2015), which is an evolution of the original model of the aforementioned questionnaire and has four dimensions (1) technology and data, (2) government, (3) society, and (4) physical environment. Technology is seen as a component that extends across the others and helps enhance and interconnect them. Considering the objectives of this study, we analyzed the technology and data component along with the governance, engagement (participation), and collaboration components in the specific context of municipal operation centers.

Table 3 presents the selected questions that were used to guide the interviews and address the objectives of the study.

The set of primary data proved to be rich and the content of the transcribed interviews filled 558 pages (Times New Roman, 12 pt font, and 1.5 line spacing). In addition, further highly relevant document sources (such as laws and norms, websites of the municipalities and municipal operations centers, social networks and applications linked to the initiatives, resilience reports officially published by the municipal governments of Rio de

Table 3. Interview protocol.

Objectives	Interview protocol
(i) The role of ICT supporting collaborative governance	• How does this initiative make the city smarter? • What were the motivation and the objectives in implementing this initiative? • How does this initiative differ from others that you have been involved in? • What is the role of ICT in this initiative?
(ii) Elements and mechanisms to support collaborative governance	• What is the governance model of this initiative? • In which way is this initiative governed and structured?
(iii) How participation and collaboration can be increased through ICT-based solutions.	• In which way are other stakeholders, such as citizens and non-governmental organizations involved in this initiative?

Source: Authors.

Janeiro and Porto Alegre, and strategic planning, news and other documents) accessed only during the data collection were incorporated to ensure a greater data triangulation capability (Yin, 2009). This study had the evaluation of data collected from a theoretical perspective as a general analytical strategy (Eisenhardt, 1989; Yin, 2009). The entire qualitative analysis process was performed using the QSR NVivo software.

The literature review provided an overview of collaborative governance, ICT-enabled governance, and collaboration and participation as a lens for analyzing the smart city initiatives, which in this study are the municipal operation centers. Although the codes were generated from the data analysis, the main categories were defined based on the literature review and a discussion of the empirical data.

Thus, the proposed dimensions, (1) Collaborative governance, (2) ICT-enabled governance, and (3) Participation and engagement, were analyzed across the three smart city initiatives. Table 4 presents the dimensions and categories of analysis. These categories feature 26 codes that were derived from the data through 225 codified parts.

4. Findings

In this section, the authors present evidence to answer the main research questions for the three smart city initiatives, considering the ICT and governance dimensions that were coded and analyzed. During the data analysis, the respondents were identified by codes to ensure confidentiality. Representatives of Rio de Janeiro were identified by the letter "R" followed by an identification number (e.g. seven respondents, or seven interviews, are represented by the following codes: R1, R2, R3, R4, R5, R6, and R7). Similarly,

Table 4. Dimensions and categories of analysis.

Dimensions	Categories
Collaborative governance	Collaborative governance
	Governance elements
ICT-enabled governance	ICT and other technologies
	Data and information
Participation and engagement	Communication and participation
	Collaboration and engagement
	Transparency

Source: Authors.

representatives of Porto Alegre were identified by the letter "P" and Belo Horizonte by the letter "B."

4.1. Collaborative governance

The governance model identified in the analyzed initiatives encompasses a hierarchical structure with a collaborative/participative decision process. Depending on the context, the decision-making is authoritative or shared. Table 5 presents the codes and evidences for the identified collaborative governance elements.

Respondents from all three centers consider the organizational structure to be hierarchical (P1, P3, P7, B2, R3), especially because the centers are directly connected to the mayors' offices, which control all of the other municipal agencies. Internally, the

Table 5. Empirical evidences of collaborative governance.

Codes	Quotes	Evidences
1. Collaboration	8	"What is distinct about us is that all subjects are placed under the knowledge of all members, regardless of hierarchy, for suggestions" (B11). "I think it is more collaborative. There are some issues that must be decided by the director, but since I'm here, I am always asked about my thoughts and what my Department could help with, we have had this collaborative view, a win-win relationship, and how we can do better, making a decision together and not in a dictatorial way"(P8). "Each agency has its representative here, and everyone has a collaborative role. It is not such a hierarchical thing, in that order has to be met this way, but it is all discussed" (B4). "Is there anyone who decides? Yes, and it has to be like this, but to reach this decision, there is a collaborative process" (P7).
2. Hierarchical structure	6	"Although this hierarchical structure does exist, there has never been a situation in which we had to use it because there is a sense of co-operation, even between the higher levels"(P1).
3. Participatory decision-making	9	"No, we do not have a formalized structure of committees, but we have a full participation of the whole management together with technicians working in decision-making" (P3). "Decision-making is done in a conjugate way. So, the decision is the one that least affects (in a negative way) everyone" (R3). "The Mayor answered a question once like this: I do make some mistakes sometimes, but only in small things, because for the big things I usually surround myself with a lot of people to give opinions" (R3).
4. Flexibility and autonomy in decision-making	3	"An agency that has the ability to solve everything very fast is very good for the citizens; this is a benefit of the centre, the de-bureaucratization of things" (B5). "The support from other institutions has been faster in a matter of readiness, because it does not have much bureaucracy" (B10). "The centre has flexibility and autonomy in decision-making regarding the operation of the city" (R2). "This dialogue between director and the mayor streamlines the process in many ways" (B1).
5. Decision-making is authoritative and the leader is imperative	3	"The model is collaborative to some extent because there are some decisions that have to be made by the leaders" (B11). "The fact that you systematize processes, delegate authority, and invest in technology does not exempt the competence and responsibility of the decision maker" (R3). "There are events of greater magnitude in that I'm going to call the decision maker, and this is already stated in the protocol, things that might have political implications" (R3).

Source: Research data.

organizational structure of the centers has well-defined management positions, such as directors, managers, and operators. The majority of the respondents noted that although there is a hierarchical structure, the decision-making process is very collaborative/participatory (P1, P3, P6, P7, P8, P10, B3, B4, B11).

During the analysis of cases, some governance mechanisms could be identified, such as the prioritization of processes through action frameworks and operating instructions, crisis management, operating protocols, and operating briefings.

There are different forms for defining the prioritization of demands in the centers. Some of them are the analysis of the impact on the city (B5, P1, P9) and the severity of the situation (R3). According to respondent P9, the situations that negatively impact the city require an urgent response. Respondent B5 emphasizes the need to analyze the entire situation, including the number of agents needed and the potential risk. Then, prioritizing processes by its level of emergency state involves a trade-off between long- and short-term achievements, mainly due to the characteristic of professionals working on initiatives and seeking a balance between personal and professional satisfaction (R4).

One identified mechanism for supporting the prioritization of processes is the definition of an action framework. For each situation, this framework includes the operational impact, the impact on reputation, and the necessary communication actions (B13). According to respondent B13, this framework was created to define the communication plan for the situations, as presented in Table 6.

Operating instructions provide support in prioritizing processes based on the emergency of the situation. According to respondent R3, "when you have multiple datasets and you combine and interpret the data, you obtain information. When you have information and combine it in a space-time matrix, you have the operating instruction, which is what we work with."

Among the identified governance mechanisms, the operating protocols are defined to ensure autonomy for those who are responsible in the center in the absence of the mayor or in situations where there are no risks or adverse effects (R3, P1, B1). The operating

Table 6. Action framework for prioritization of processes.

Action framework	Low	Medium	Crisis
Operational impact	Events that do not significantly affect the lives of citizens in the region where it was recorded	Events that do not significantly affect but do impact other areas of the city.	Events that significantly affect people's lives and impact other areas of the city
Impact on reputation	Citizens post little or no information about the occurrence without any demand or quote in the press	Citizens post a reasonable amount of information without many complaints, few demands or quotes in the press	Citizens publish a lot of information and make many demands of the press
Communication actions	Post on social media or the center replies to the demands that appear in the press, only to the involved institution	Align the central action with other actions in which there are other institutions involved, publish on Twitter, Facebook, post on the center website and on the daily newsletters, notify the press, make special news, possibility of creating a hot alert site and assess the need for a spokesman of City Hall.	In a crisis situation, in addition to aligning all agencies or triggering the press, think of a conference press that allows people to understand the integration and understand how the center is involved in the issue

Source: Research data.

protocol is applied when there is no serious political implication and is, therefore, suitable for most situations.

> The operating protocol is not an integration cake recipe. It means that I can delegate authority to trigger the protocol. That is the goal. I do not need to involve the decision maker for all situations. We only approach the mayor when our protocol has reached its limit. That is, we reach a position where there are no favourable decisions anymore. When a situation has been faced before, the protocol has a pre-consent given by secretaries and operational managers to the staff level so it can act to instantly meet the demands and implement the protocol. (R3)

The situation or crisis room is a mechanism to operationalize coordination and collaborative decision-making processes. According to respondent P1, this room centralizes the information to support decision-making. This information encompasses camera images, georeferenced data, and information about the municipality's infrastructure, building structures, water supply, sewage system, and gas grid. By defining the area where a problem occurs, it is possible to identify the entire infrastructure that will be needed in the region. According to respondent B3, the crisis room brings the representatives together and helps make a decision. This convergence of agencies in a shared environment ensures that decision-making will occur in situations where it is required and involve the center in a participatory and coordinated way, which is one of the main advantages of the initiatives according to respondent P1.

Operating briefings are integrated to the crisis room and have the objective of bringing the same level of information to everyone to make it available to the relevant people in the whole situation and, in particular, to ensure that the resources are available to meet a certain demand (B1). According to respondent R3, such coordination started to become a reality through these operating briefings, in which "three times per day, every agency's representatives get together in a room to share information and define the best strategy for solving the problems without interfering in each other's work."

Table 7 presents a summary of governance elements and their related mechanisms.

4.2. ICT-enabled governance

As suggested by Gil-Garcia et al. (2015), one of the main aspects to make a city smarter is the use of data and information in the government. ICT contributes to creating

Table 7. Governance elements, mechanisms, and functions.

Governance elements	Mechanisms	Functions
Coordination	Operational briefing	Level the information between agencies Creating combined strategies
Prioritizing processes	Action framework	Operational impact analysis, impact on image, communication actions needed
	Operational instruction	Contextualizing information in time and space
	Trade off analysis	Balance long- and short-term projects
Shared decision-making processes	Operation protocol	Sets responsibility for each type of situation in operational terms Activated in situations where there is no serious political implications
Autonomy in decision-making	Operation protocol	Promote agility for the processes Increased flexibility
Collaborative decision-making processes	Crisis room	Operationalize collaboration and coordination

Source: Research data.

Table 8. ITC-enabled governance dimension factors.

Codes (Factors)	Quotes
ICT and other technologies	
6. Adoption of new technologies	17
7. Data sharing and integration	14
8. Monitoring system	12
9. Integrator system	6
10. Lack of interoperability	14
11. Privacy and consistency of information	14
12. Budget constraints	11
13. Technological upgrade	3
Data and information	
14. Geo-location-based data	9
15. Data-based decision-making and planning	9
16. Providing real-time data	7
17. Big data analytics	7
18. Data crossing	6
19. Integration and opening data	3

Source: Research data.

channels in which government can make the knowledge about government operations accessible to people and can foster communication both between the government and stakeholders and among government agencies (Alonso & Lippez-De Castro, 2016). We have analyzed the impact of ICT on collaborative governance and participation by identifying the main elements regarding technology and data use in municipal operation centers. Table 8 presents the codes and evidence for the identified ICT and data elements.

In line with the literature, the results of the data analysis show that ICT has an important role in both enabling information sharing and integration between government agencies and the centers and being part of the initiatives infrastructure. According to respondent R3, "the technology supports a pre-determined environment that has a clear organizational guideline. The role of technology is not organizing contexts, which is harmful when there is no clear structure in which it will be applied." According to respondent P1, "the objective is that the information is available for whoever needs it and has the competence to make better use of it."

Information sharing through ICT is a key aspect for inter-organizational communication (Gil-Garcia et al., 2015). Although incipient in some of the centers, using ICT to operationalize information sharing is on the agenda of the municipal operation centers, as noted by B13: "crossing information between agencies is one of the key aspects of a smart city […] the idea is to integrate systems that will be supplied by everyone, and the databases of each secretary will be available for the others." The same is noted by respondent P6, who states that "despite the advancement in monitoring technologies, geoprocessing systems and automatic stations, what is missing is an integrated system and technologies for supporting management."

In Rio de Janeiro, which is in a more advanced stage of functioning, the integration of systems occurs through the GeoPortal, which encompasses many information layers to support decision-making. According to respondent R2, the GeoPortal "integrates the overlapping layers, processes, information, and data that are created through the centre, and some of them support the decision-making processes." One of the prerequisites for being part of the center is technological compatibility.

Regarding interoperability, respondent P3 believes that a smart city seeks innovation and system integration. Although essential, this integration is still considered a challenge because most of the technicians used to work with individual systems. Systems interoperability is not a reality for the initiatives in Porto Alegre and Belo Horizonte.

Susceptibility to error is a consequence of the lack of systems integration and automatization. According to respondent B11, when it is implemented, it will "definitely increase processes' efficiency and effectiveness." The same is noted by respondent R2 concerning integration updating that will lead to process optimization. The interoperability of systems is seen as the main barrier for the centers, especially the need for personalized solutions that address the reality and specificities of a city (R1).

The use of data and information to support decision-making is perceived by several respondents as a main factor of the initiatives. The use of government data, for instance, allows problems in the city (R1) to be anticipated and the indicators improved (R6). Among the goals of the initiative in this sense is the generation of information for citizens and ensuring that this information reaches them (R2).

According to respondent R5, a characteristic of a smart city is to ensure the best possible use of the available data. The main strands in data use in smart cities are the integration of data from the city, open data, ensuring an improvement in city enforcement, and the use of historical data for new purposes. Thus, data analysis and data mining were identified as relevant, as was the use of historical or real-time data.

In the context of democracy and public participation, disclosing data is perceived as a mechanism to bring an individual out of society and a way to get him or her involved (P1). According to respondent P1, "disclosing the data is very important because it brings the possibility for the citizen to also contribute." In Rio, data transparency is on the center's agenda (R2).

In terms of collaboration, one way to make citizens participate in processes is through tools and applications that have enjoyed widespread use by the population. Waze is one application that allows the individual to report a traffic situation and is considered by respondent P1 to be "a very powerful channel"; an example is an accident that someone has already seen or photographed. For the interviewee, this collaboration will streamline service in terms of information (P1). By receiving information from the existing applications, the government has access to a very important layer, that is, the perception of citizens (R4).

Big data analytics in Rio de Janeiro is helping managers to identify the source of the problems and guide the way they should act (R3, R6). A lack of interconnection between agencies is perceived, especially in the intersection of information (R3, B13, R6, P5). According to respondent P5, the idea is to have a multilayer map with information from several agencies, all aggregated into a single platform. In the same line, respondent R6 affirms that the problem of city halls is that each department has a set of data, which alone and without contextualization does not generate relevant information. Someone must, therefore, connect the data on the intersection of robbery occurrences and lighting conditions in a region, as in the example mentioned by respondent R3. He says that the agency responsible for lighting does not include this information in their priorities, even though this information could help them focus on regions with more robberies.

Decision-making and the definition of preventive measures are also driven by the use of big data analysis. According to respondent R3, big data analysis can generate

visualizations of city dynamics and allow governments to plan structuring works when the issue is not manageable. One example can be found in situations of constant congestion on certain routes, where a need is indicated to improve points by duplicating lanes or inserting mobile public transport lines (R3). In the case of preventive measures, respondent P1 states that data collection is already taking place and is always looking for historical data "because it always has to be based on data." The example that the interviewee presents is related to the mapping of flood points and possible prevention of them: "Look, this point here flooded four times in 2008; in 2009, five times. Well, I already know that it is a chronic problem at that point" (P1).

A second stage of intelligence, according to respondent R3, is the use of data mining to assist in decision-making and the definition of action plans. Respondent R2 states that the center "has a system that integrates all the layers, processes, and information generated here. All the data generated here are via GeoPortal, and we use them for decision-making; it helps us in making decisions." An example is the use of data mining to operate an emergency plan by mapping an area of risk that can be affected by an explosion (R3). Respondent P5 reiterates the importance of geo-referencing, which information to be shared between agencies, such as civil defense, the military brigade, and ambulance service for an injury involving firearms. From these occurrences, the mapping of incidents begins with analytical information, which helps achieve a greater understanding of the city and improve interventions, "I understand the city, and I see where I can intercede" (P5). Respondent P5 contextualizes, affirming as follows:

> For example, we did some geo-referencing work at SAMU (ambulance service), where I can put a filter for firearms, white weapon, or hypoglycaemia, and every time the ambulance arrives at an address for hypoglycaemia, I can include a point on Google Maps. So, we create spots of incidence of certain situations. I have a gunshot wound map, where a shooting takes place in the city, a map of white weapons where stabbings take place, a map of hypoglycaemia, etc. Through this map, I can intelligently enhance safety in the case of firearms and strengthen the consultation of specialists, neurologists or the release of drugs for convulsion in the places where the most convulsions are taking place. (P5)

Respondent R2 adds by stating that the center has a tool that mines data from social networks. An example is the Twitter monitoring of identified urban problems. The potential of monitoring social networks is perceived by respondent B13 as a form of auxiliary communication in the operation.

> So, if someone inside Belo Horizonte (BH) posts the keywords "accident" or "flood," we can pull it through social networks. When we had the collapse of the viaduct last year, I did a search for all the stories, all the news, everything that happened that day, and I discovered that three minutes after the overpass fell, someone had posted on a social network that the viaduct had fallen. We knew seven minutes after the overpass crash, so if we had a social network monitoring, that would work, we'd know right away, we'd know much sooner than the centre personnel. (B13)

Although it is currently seen as a weakness, the potential of using large volumes of data to create indicators is noted by the center's agents. According to respondent R2, "this is a deficit point still here in COR, but we must create a fixed methodology so we can measure the response time" (R2). Along the same line, respondent B13 believes that although improvement results already exist, such as a decreased response time, one must say

> look, we have a 30 percent reduction in response time; if we had an accident before, it took 5 hours to respond. Now, it's taking two hours to answer, and that's a great reduction when it comes to saving lives. (B13)

Interviewee B13 believes that this is a way to get the population to understand what the center does and what the population actually gains.

During the coding of the data, references to the various sources of data entry and information in the centers were identified. According to respondent R2, the center has some sources of information. The main sources of information that the center uses in terms of operation range from core stakeholders to capturing data from applications, social networks, and private companies that are integrated with GeoPortal. Among the sources of information are the population that informs about what occurs in the city, government agents, journalists, state agencies, clusters of people of interest (e.g. sub-secretaries, secretaries, groups of secretaries' advisers), and information from the agencies that work at the center or that is captured online, such as from Waze and Twitter, and then integrated into GeoPortal.

"Waze is an application that tells you the traffic conditions. We measure the traffic of car routes and times of travel. This is information captured online" (R3). The center also obtains information from the concessionaires and integrated agencies on where the ambulances are for instance, and they receive information about where there is heavy traffic, where it is flooded, where it is raining, and where an accident has occurred.

Thus, a geo-referencing system is one of the main sources of data that supports decision-making and monitoring the city's situation. GeoPortal is a geo-referencing system that works through layers of information, such as ambulance position, day-care centers, city hall assets, state assets, municipal guard positions, and siren radars (R3).

4.3. Participation and engagement

The first understanding that emerges from our analysis of the role of ICT in the initiatives is that it allows real-time communication between government and citizens. We have analyzed the impact of ICT participation and engagement by identifying the main tools used to increase the interaction among government and its constituents, how citizens are engaged in the actions of the centers, how they contribute to decision-making process, and how openness and transparency have been used to increase engagement. Table 9 presents the codes and evidence for the identified Participation and engagement factors.

Table 9. Participation and engagement dimension factors.

Codes (Factors)	Quotations
Communication and participation	
20. Interaction through media	19
21. Interaction through social media	15
22. Lack of channels for engaging with citizens	9
Collaboration and engagement	
23. Inter-sectoral partnerships	10
24. Civic engagement	5
Transparency	
25. Access to real-time information	3
26. Supervision of public services	3

Source: Research data.

According to respondent R3, it was assumed that talking to citizens is a key issue for managers of the city. Thus, the center operates 24 hours a day, 7 days a week, and maintains a strengthened relationship with external actors, such as journalists and citizens. "We have created an information channel to ingrain in people the habit of consuming this information" (R3). The information is open and uncensored and allows people to see the image of the cameras or the discussions about what is occurring in the city. "The interaction occurs all the time" (R3). In this sense, it was noted that the centers are creating information and communication channels in real time as a resource for citizens. Respondent P4 corroborates this by stating that through joint actions between the agencies, the center can trigger this information. "As a citizen, the more information I have on my tablet or via radio, the better. This I think is a smart city, being able to know what to do in a particular situation" (P4).

Considering the context of a developing country, it has been noted that there are specific situations that address the needs of vulnerable groups, as suggested by Janowski (2015) in the stage of contextualization of electronic governance. To start interacting with the population, the interviewed B1 states that the center is seeking projects from other departments that involve specific audiences and providing them to the center. "We got here a month ago or so, people related to the environmental agency, people who are involved with social policy, for instance, the threatening homeless situation" (B1). For the respondent, the characterization of the citizens who are involved in projects varies depending on the project and the secretariat involved.

ICT-based applications, such as social media, can be used to raise public engagement in public debates and give information to governments about the population's needs. Citizens can then be seen as one of the main sources for knowledge about what is occurring in the city (Castelnovo et al., 2015). According to respondents R2 and P1, citizens interact with the center through social media in particular. The centers utilize information from social media to build scenarios for addressing unusual situations, such as political manifestations. The same was noted by respondents P3, P4, P6, B13, R1, R2, and R3, who claim that the various social networks are tools that can assist in communication and citizen participation. "Twitter or Facebook are direct channels where citizens talk to the communication department of the centre" (R1).

In addition to the constant use by citizens, the center monitors social media for data intelligence matters. "There is a monitoring of social networking that is done to work in intelligence purpose, and there is a supply of these social networks, mainly through Twitter and the City Hall website" (P5).

The interaction also occurs through the media, in which the press helps in disclosing information that can be used to reduce disorders in citizens' day-to-day lives (P1). Among the various means of dissemination, radio appears to be one of the channels adopted from the center. According to respondent P1, "the radio is a very large channel of communication to citizens who are moving, so we want to provide it, and the radio is also connected to social networks and rapidly spreads information" (P1). According to respondents P4 and P6, some information is only accessible by the public through the press. The importance of the press is also perceived by respondent B1, who states that they have a proposal to bring the press inside the center, which is also a form of partnership and dissemination.

To facilitate this interaction (with the press), as noted by respondent R2, the center has a conference room and a communication department, including several TV stations and city

radios, to ensure aspects such as transparency and participation. In terms of communication, respondent R2 believes that this room strengthens the relationship between the press and the center. He said that although it was present since the start, with time, the press became increasingly confident about the work done by the center and started increasing its membership and presence.

It was identified that the main challenge for the initiatives in this sense is the lack of communication channels with citizens to enable a better understanding of the actions and the existence of the centers. Several respondents (P3, P5, P7, R6, R7, B3, and B4) believe that the population has a very low perception of the center's performance; they realize that the city is getting better, that problems are being solved, and that the media reports timely information, but they do not know that the source of everything is the center of operations. Respondent P5 believes that the challenge is making "people understand what the centre serves and that this initiative can improve your assistance in a crisis situation." In the same view, respondent R6 believes that "citizens do not have this return, and in reality, they know very little about the city." For him, the initiatives reach the citizens without their knowledge (R6).

As identified by Alawadhi et al. (2012), beyond collaboration between government agencies, smart city initiatives usually have inter-sectoral relationships and encourage citizen participation in decision-making, monitoring city services and providing feedback. As suggested by Halchin (2004), an improvement can be noted in external collaboration through partnerships and engagement of stakeholders, such as private companies, universities, representatives of communities or specific groups, and citizens in general.

External collaboration in the analyzed centers is represented by public–private partnerships (inter-sectoral partnership), partnerships with universities, and relations with citizens who are indirectly affected by the operations center and, as discussed above, have an active role in relation to the problems of the city. In addition, relationships were identified with associations and other non-profit organizations.

The cross-sector partnerships are especially represented by technology companies and social networking services, such as Google, Twitter, and Facebook. One example of public–private–people partnership, according to respondent R4, is the Waze application (outsmarting traffic application). For him, it represents an exchange for both sides that affects people in general. The use of government information by regional TV companies (media) is another example of public–private partnership between the centers and radio and television stations.

One challenge for governments in implementing new technologies and smart processes is that the agents should be able to follow this progress, which requires specific skills. However, this is also a major barrier to the government, which addresses limited budget and human resources that limit progress in some areas. One way to overcome this barrier is through interactions among universities, industry, and government. In the center of Belo Horizonte, a partnership is being proposed with a university in the city to offer a discipline or internship in which people are trained to work in an operations center (B1). Respondent B1 states that "people talk about smart city and centre of operations as if it was the future, but this future is actually now, and the cities must have professionals working in this area." The case of Rio de Janeiro is already showing evidence of a public–private–university relationship. According to respondent R3, increasing the amount of collected data increases the need for artificial intelligence that can process

all of the data generated. Artificial intelligence algorithms to select cameras to illustrate various city problems are developed by engineering school laboratories at UFRJ (Federal University of Rio de Janeiro) using Waze data, for example.

Considering public engagement, two ways for citizens to get involved and participate in public affairs could be identified: directly (through citizen service or social media service) and indirectly (through an intermediary actor who interacts and actively participates in the decision-making process).

The direct form includes both the demand side of citizens to get instructions, information, and public services and acting as a source for government to obtain information and new demands through a toll-free number for non-emergency situations or social media. "In terms of social networks, we use this issue a lot, not only to stimulate public engagement but also to develop a kind of counter intelligence" (R2). That is, according to respondent R2, a two-way communication path in which governments receive information from society through social media and transfer the information to the press and general public through social networks. Using social media to communicate with people stimulates public engagement, thus making it possible to align governments with society.

The indirect way depends on an important figure called the "deputy mayor," who acts in connecting citizens and the city. According to respondent R3, "these individuals often gather the comments on everyday life in the region and bring them to the centre." It allows the government to create a risk grade for each district for the better control of the city, and it covers the perception from all angles through contact with sub-prefects or local managers of the unit. In Porto Alegre, there is the city council, regional forums, and a community advisor who participates in the meetings. The community councils are the "community spokesman," who generally discusses safety concerns (P10).

5. Discussion

In this section, we discuss and present a framework of the results that emerged from the findings section as a way to illustrate the main contributions of this research. To answer the main research question of this study – how can ICT promote collaborative governance and increase participation and engagement in smart city initiatives – based on the evidence, we propose that information sharing and the integration of systems and departments are the main elements in framing the use of ICT to enable collaborative governance along with participation and engagement practices. Figure 1 illustrates the proposed framework.

The first research question covered the role of ICT in supporting collaborative governance. In short, it was found that the main objective and achievement in adopting ICT in these smart city initiatives is enabling information sharing and integration between agencies. In the interviews, this aspect could be noted in the emphasis on information sharing and integration but also because of the frequency with which the respondents referred to data and information concepts and technologies (Table 8). From the literature (Charalabidis et al., 2012; Chen, 2013; Gil-Garcia et al., 2015), the urban smartness of a city is defined as data and information: when it is instrumented with data from physical and virtual sensors, when an enterprise uses a computing platform that integrates data and shares information, and when it uses analytics to make better operational decisions. In

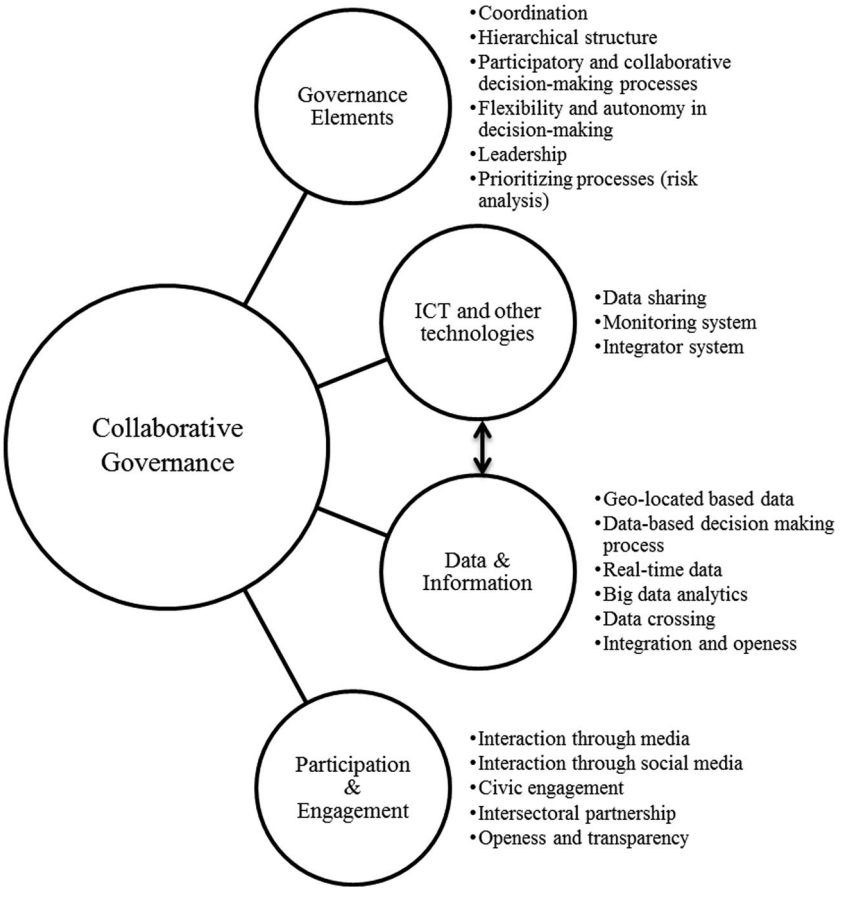

Figure 1. Framework of results on the use of ICT to enable collaborative governance.

this study, aspects such as data collection from a broad number of sources, data mining, big data analytics, data analysis, a common platform that encompasses data processing and geo-referencing systems, and social media for sharing information within the stakeholders were mentioned. One innovative aspect that was also identified in the cases is the use of city sensors to gather information, such as the river levels to mitigate the risks of a flood. Although there is still an absence of city sensors in all sectors and a lack of infrastructure in the context of emerging economies, this issue has been solved by collecting historical information, examining social media, and using private enterprise systems such as Waze.

The integration of systems and processes is another important role, but the interoperability of systems is critical and is the main barrier for enhanced collaboration. These interoperability aspects include the exchange of data as a key asset to provide the basis for information and, as a consequence, knowledge-sharing between departments and organizations (Axelsson & Melin, 2008; Tambouris, Liotas, & Tarabanis, 2007). In this regard, the role of ICT in supporting collaborative governance should not minimize the challenges of privacy and consistency of information, budget constraints, and the continuous need of technological upgrade. Future research must therefore address the inter-operational

aspects of front-and back-offices through a more general/holistic approach (Angelopoulos et al., 2010).

The second research question focused on governance elements. In the smart city context, governments should perform the role of moderators and establish platforms for collective intelligence that can be adapted to the challenging new technologies, processes, and mechanisms that are being built (Misuraca et al., 2012). The definition and realization of these governance models are still missing, but our findings highlight a governance model based on a hierarchical structure, with a collaborative/participative decision process in which decision-making is authoritative or shared, depending on the context, and in which the leadership plays a distinctive role. This governance model has some elements across the cases that seemed to be a pattern and might provide insights for other smart initiatives. Such elements are coordination (operational briefing), prioritization of processes (action framework/operational instruction/trade-off analysis), shared and autonomous decision-making processes (operation protocol), and collaborative decision-making processes (crisis room).

This question is important because according to several existing studies, coordination and cooperation are always important issues in e-government initiatives (Axelsson & Melin, 2008). The elements that we found have been implemented to operationalize internal collaboration or collaborative governance.

The third research question concerned increasing the participation and collaboration through ICT-based solutions. The participation mechanisms and citizen engagement vary, depending on the project and the secretariat that is involved. Without contradicting the literature concepts of collaboration, engagement, and participation, the research results emphasize interacting through media (e.g. communication channels in a resource for journalists and the use of radio or the press by the centers to deliver real-time information to citizens); interacting through social media (e.g. monitoring Twitter or connecting social media with radio broadcast); civic engagement (e.g. directly engaging citizens or through an intermediary actor such as the "deputy mayor"); inter-sectorial partnership (e.g. technology suppliers, universities); and openness and transparency. Regarding the last access to real-time information and the supervision of public services acquired importance during the data analysis. The introduction of information feeds that the general public can tap into can improve transparency and participation in that the public can see what occurs and then communicate feedback in a bi-directional manner through the introduced social media channels.

According to Gorla (2008), sustainable governance proficiently manages the resources and tasks at hand, always on the conditions of openness, accountability, and responsiveness to the needs of the general public. Furthermore, it directs effort towards minimizing corruption and towards protecting minorities and valuing their opinion. It should be noted that transparency is an asset in inter-sectorial work because both the various sectorial actors and government departments benefit from it. Considering the context of the emerging economy it is worth noting the actions that address the needs of vulnerable groups.

6. Conclusion

This study contributes to a better understanding of the role that ICT plays in smart city initiatives within municipal operations centers. Relying on the existing collaboration and

participation concepts and the smart city domain, this study empirically analyzed how ICT can promote collaborative governance and increase the collaboration and participation in government in smart city initiatives. Our findings revealed that ICT has an important role supporting information sharing and integration between government agencies and external stakeholders, including citizens.

Our study makes two primary contributions. The former, from a substantive viewpoint, is that our results reveal data and information sharing as a key asset in municipal operations center initiatives. In addition to the substantive field, the research contributes to the literature gap suggested by Alonso and Lippez-De Castro (2016), in which the role of ICT in increasing the engagement and collaboration of people in public debate was not fully achieved. Data-based decision-making is one of the main results of the analyzed initiatives for increasing the quality of public decisions. Using the definition of governance of Alonso and Lippez-De Castro (2016), that is, that governance has been characterized as multiple stakeholders influencing decision-making processes through increased interaction and collaboration, we may affirm that ICT has been playing a role in initiatives supporting smart governance. From a theoretical perspective, our results illustrate how to apply the framework proposed by Gil-Garcia et al. (2015) to better understand smart city initiatives. By considering two of the components of the proposed framework, it was possible to offer a comprehensive view of ICT-enabled collaborative governance.

This study explored the context of smart city initiatives in the form of municipal operation centers. Interviews with directors, managers, and technicians shed light on the contribution of ICT to promoting an environment of collaboration in government. A limitation of this study may be that the cases are located in an emergent economy, which may limit the results to this specific scenario. Because operation centers have been gaining attention in local governments, future research should focus on similar centers around the world to contextualize the results, especially including countries in different levels of economic development to identify the challenges in each context.

Regarding the limitations of the study, we can note that both the composition and the number of participants in the interviews differ among the three cases. In the cases of Porto Alegre and Belo Horizonte, the composition includes service operators and professionals who work internally in the centers. In contrast, the case of Rio de Janeiro includes members of partner agencies, such as the big data office and the citizen service, whose activities are strongly related to the center. Although there were fewer respondents, the case of Rio de Janeiro presented a convergence of data that allowed the collection to be completed. Because we used the "snowball" technique to select interviewees, different compositions were generated, probably due to differences in the size, time of existence, and organizational structure. One way to minimize this situation in future studies may be through the prior analysis of possible interviewees.

The time of existence of the centers may have led to some limitations, particularly in the case of Belo Horizonte, which had been operating for a year when the data collection was performed. Over time, operations centers present more precise outcome indicators that can provide data to analyze the impact of the center's actions on future research. Moreover, due to constant technological changes, new technologies can emerge, and a longitudinal study can bring new contributions in this sense. One of the aspects to analyze in future studies is the implementation of the integrative system in the cases of Porto Alegre and Belo Horizonte.

It was also noted that the digital divide is a concern when implementing smart city initiatives because everyone should receive and understand government alerts in a critical situation. As shown by Janowski (2015), in a more complex stage of e-government, especially in the specific context stage, governments face pressure for self-governance and using open platforms to democratize the exchange of real-time information and services. Such aspects may, however, result in consequences such as the inquiry of government power and the increase in the level of the demands by the citizens. Thus, understanding the unintended consequences of smart city initiatives is another aspect that should be explored in further research.

Note

1. http://www.smartcityexpo.com/awards

Disclosure statement

No potential conflict of interest was reported by the authors.

Funding

This research was partially supported by the Coordenação de Aperfeiçoamento de Pessoal de Nível Superior; CAPES Foundation, Ministry of Education of Brazil, Brasília – DF 70.040-020, Brazil (Process number 99999.014692/2013-09); Fundação de Amparo à Pesquisa do Estado do Rio Grande do Sul.

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