Citizen Participation in Smart Government: A Conceptual Model and Two IoT Case Studies

Ali A. Guenduez, Tobias Mettler, and Kuno Schedler

Abstract In its simplest form, *smart government* can be understood as the combination of new technologies and organizational innovation strategies to further modernize the public sector. Within this development, the Internet of Things (IoT) often forms a key technological foundation, offering government authorities new possibilities for interaction with citizens and local communities. On the one hand, citizens can indirectly participate in governmental services' value creation by using public infrastructure or (un)knowingly sharing their data with the community. On the other hand, smart government initiatives may rely more intensively on citizens' active participation to improve public service delivery, increase trust in government actions, and strengthen community sentiment. In this chapter, we discuss active and passive participation scenarios of smart government initiatives and explain how sensor-based systems may enhance citizens' opportunities to participate in local governance. We present two practical cases from Switzerland demonstrating these two citizen involvement modes. We argue that active and passive participation of citizens and other stakeholders play a key role in generating necessary data for algorithmic decision-making to enable personalized interaction and real-time control of infrastructure in the future. We close with a discussion of the possibilities and boundaries of the IoT in the public sector and their possible influences on citizens' privacy and policy-making.

Keywords Participation · Smart government · Internet of things · IoT · Sensors · Big data · Algorithmic decision-making

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Abbreviations

e-government	Electronic government
IoT	Internet of Things
IT	Information technology
LoRaWAN	Long-range wide area network
m-government	Mobile government

Introduction

Since the mid-1990s, efforts have been made to harness the Internet's potential for public administration (Caudle 1994; Lent 1995). Under the phrase *electronic government* (e-government), public administration digitalization has increased (Jaeger 2002). The main objectives of this first digitization stage included improving customer service, enhancing the efficiency and effectiveness of government actions, government accountability, transparency, and administrative management, and promoting citizen participation (Schedler et al. 2003; Yildiz 2007). This first e-government wave sought to create a digital environment in which public authorities provided services to their citizens electronically. However, since e-government has been introduced into public administration, it has been used primarily as a support tool for analogous and internal processes (Davison et al. 2005). There has been no fundamental change in the ways public administrations process their work, which has been particularly disappointing for citizens; their experiences when contacting governmental authorities have not fundamentally improved (Cohen 2006).

With the emergence of portable devices and the widespread availability of broadband wireless networks, the era of mobile government (*m-government*) sought to reduce this frustration and to address the growing demand for easy, effective, and convenient interaction with government agencies (Rossel et al. 2006). However, the paradigm shift from desktop to mobile has not always been successful, given that adjustments in attitudes, aspirations, skills, and behaviors were required from public administrators and citizens (Shareef et al. 2016). In many cases, m-government became synonymous with simply adapting the resolution of existing e-government websites to the smaller mobile device screens, without changing any other process parameters or service logics. Accordingly, the full potential of mobile technology was not used, rendering many m-government initiatives toothless. Positive effects on civic engagement and participation, as desired by government agencies, were seldom achieved (Albesher and Stone 2016).

However, in the past few years, we have seen some innovative, promising developments. Unlike previous e-government initiatives, many digital initiatives are now launched under the umbrella term *smart government,* with the purpose of establishing novel service delivery models by connecting physical, digital, public, and private environments (Scholl and Scholl 2014; Bhatti et al. 2015; Rochet and Correa 2016). These new approaches take an important step further than past digitalization endeavors, asking how the relationship between administration and its stakeholders could be implemented in more efficient, effective, and/or unexpected ways using sensors, big data, and personalized algorithms (Bright and Margetts 2016). Fundamentally rethinking the ways governments operate is not only desirable but mandatory for smart government initiatives to be impactful and effective in establishing seamless information flows and collaborative decision-making (Chun et al. 2010) and, ultimately, more civic engagement and participation in community life (Sean et al. 2012).

Several authors have stressed the reinvigoration of government's use of new technological possibilities (Scholl and Scholl 2014; Anthopoulos 2017), particularly the Internet of Things (IoT) and related technologies, in order *"to interconnect and integrate information, processes, institutions, and physical infrastructure to better serve citizens and communities"* (Gil-Garcia 2012). Simply put, IT-induced change by public organizations based on emerging and advanced information technologies could lead to smarter and more engaged communities (Coe et al. 2001).

Similarly, Gil-Garcia (2012) defined smart government as the interplay of forward-looking technologies and organizational innovation in the public sector to improve interorganizational collaboration, information-sharing, and integration, with the goal of ultimately achieving a *smart state*. Mellouli et al. (2014) see smart government as an attempt to introduce new technologies for addressing innovative organizational usage cases, fulfilling e-government and m-government potential in openness, transparency, organizational renewal, and citizen participation. In this context, Harsh and Ichalkaranje (2015) emphasized the key role of data generated through new technologies and applications and a (machine-based and/or automatic) analysis for improving service delivery. According to them, the merging of new technological and organizational considerations would enable governments to transform e-government into smart government.

In our view, the IoT plays a vital role in the realization of smart government. Data obtained from everyday objects, such as smartphones, wearables, sensor-enabled devices, home appliances, surveillance cameras, or even vehicles (Zanella et al. 2014) provide unprecedented possibilities for government agencies to interact and build relationships with citizens and businesses (Janssen et al. 2017). The enormous amount and variety of data generated and autonomously distributed by such IoT objects could lead to *new services* for citizens, companies, and public administrations in numerous domains, such as public transportation and logistics, healthcare, urbanization, and/or the environment (Atzori et al. 2010).

However, in practice, many smart government initiatives often concentrate almost exclusively on technological aspects (Saunders and Baeck 2015), that is, the development of high-performance information and communication infrastructures. Examples include intelligent power grids for measuring and regulating the energy consumption of individual houses or entire localities, or intelligent parking space systems for managing the utilization of different parking facilities in a region or municipality. A fundamental rethinking of government services and interaction patterns to become more citizen-centric is often missing. *Smartness* in such applications often means linking physical objects, such as waste containers, traffic lights, parking restrictions, and electricity meters, with public information infrastructure. This provides the foundation for automated data collection, data integration, and triggering simple tasks of control, regulation, or alerting, such as primitive, event-driven *if A, then B* procedures.

Certainly, smart government is more than just the introduction of a smarter IoT infrastructure to establish real-time control usage cases. If planned and managed carefully, it could foster more active citizens' participation in the value creation of governmental services. It could create an environment in which involvement and participation of the population in the public sphere (e.g., healthcare, security, transport) is deliberately encouraged so as to significantly enhance public service delivery, increase trust in government actions, and strengthen community sentiment. In this context, IoT would be indispensable for public administrations receiving sufficient detailed and contextualized information; this could serve as feedback for their planned and realized actions and could improve civic engagement. Several studies have shown that IoT applications could trigger and increase citizens' motivation to participate (Salim and Haque 2015; Nam and Pardo 2014).

We also focus on the *participation* aspect and enabling role of IoT in realizing the vision of smart government, since we consider it is a key success factor in democracies and modern public administrations. We start by discussing a conceptual model that illustrates different modes of participation in current smart government initiatives. Based on this description, we will then describe two case studies.

With the first case study, Smart City St. Gallen (a medium-sized municipality in the northeast of Switzerland), we delineate the *passive participation* mode, which is probably dominant in today's IoT implementations. As we will explain, *passive* in this scenario means that citizens are idle and take no deliberate actions to share data generated by IoT objects.

In the second case study, we showcase the DeSearch project, a joint effort by the Baden-Wuerttemberg Cooperative State University Ravensburg-Friedrichshafen (Germany) and the University of Lausanne (Switzerland) to develop a privacy-aware, patient-tracking solution based on *active participation* by concerned and/or affected citizens. In this scenario, *active* means that citizens must consciously decide whether or not to disclose IoT generated data. A high level of civic engagement is imperative to unlock the full potential of this smart government initiative.

Both case studies demonstrate a different logic that public administration must master so as to ensure that a smart government initiative is successful. This chapter closes with a discussion on smart government possibilities and boundaries in current practice, and their prospects to change citizens' privacy and public policy-making in the future.

Research Approach and Conceptualization of Citizen Participation in Smart Government Initiatives

The findings we presented are based on case study research. According to Robson (1993), this is a suitable empirical method for real-world research, enabling scientists to investigate a particular contemporary phenomenon in its real-life context using multiple sources of evidence, especially when the boundaries between a phenomenon and its context are not clear. Case studies involve an in-depth and close examination of one or multiple persons, organizations, communities, artifacts, or contemporary set of events (Stake 2006) to provide rich descriptions and develop (Eisenhardt 1989) or even test theories (Darke et al. 1998). One can differentiate between exploratory, descriptive, and explanatory research designs.

Case studies have proven to be an excellent method for exploring the duality of technology and social relationships (Myers 1997). In this context, they typically seek to answer *how* or *why* type questions, and are usually applied when a scientist has little or no control over a phenomenon, or when an inquiry addresses a situation in which there are many more variables of interest than data points (Yin 2009). To overcome this problem, scientists must rely on multiple sources of evidence; data must be triangulated.

Our research is an exploratory case study. To obtain the necessary data for this inquiry, we conducted participant observation and multiple expert interviews. Personal notes from field visits, communication material, technical documentation, and prototypes received from parties involved were additional sources for conclusions on the nature of participation in IoT-reliant smart government initiatives. We chose the selected cases according to the availability of technical experts as well as to represent the two extreme positions of active and passive participation.

Our starting point was a literature review on what is perceived as smart government. The broad consensus was that smart government initiatives can contribute significantly to the solution of a wide variety of current and future societal challenges (Gil-Garcia et al. 2014; Scholl and Scholl 2014). While such intelligent infrastructures can already address a multitude of everyday practical problems, such as saving electricity or optimizing traffic (Stankovic 2014), there is still a long way to go until we see the use of smart technologies in complex decision-making and context-aware reasoning (De Matos et al. 2017), such as the preparation of political mandates or the evaluation of state interventions.

Unfortunately, we found little evidence regarding the roles and conceptualizations of participation in the literature. Most papers on IoT in combination with smart government initiatives emphasized technical and operational aspects. However, many articles cited different buzzwords such as wiki government (Noveck 2009), crowdsourcing (Brabham 2010), open government (McDermott 2010), Government 2.0 (Nam 2012b, 2012a), or we-government (Linders 2012) to describe ways of cultivating open dialogue with and creating interest among citizens. While the literature suggests that active, involved citizens are better than passive, disinterested ones in democratic state governance (Putnam 1993), it offers little evidence on how IoT could stimulate participation and lead to the purported effects. Analyzing and condensing the findings of our two case studies, we differentiated two perspectives—or modes—of participation, which we will briefly describe.

Mode I: Passive Participation

Most smart government initiatives underway today seek to use IoT for large-scale data collection to establish real-time control over dedicated aspects of public welfare. As we will detail in the subsequent case study of St. Gallen, citizens' roles in such a scenario are relatively passive. There is no need to take deliberate action or make decisions regarding data-sharing, and benefiting from these project types. They simply contribute to the overall data life cycle by using, or being surveyed, by those in public infrastructure. However, these "passively" generated data provide insights into the uses and effectiveness of services in key policy areas, such as transport, health, safety, and agriculture. The great advantage of this data type is that it represents real-time information, generating minimal costs. It provides a new basis for government and administrative decisions: simple, needs-based, and cost-effective regulation and control can be achieved.

Mode II: Active Participation

In contrast to the previous example—where IoT is used for large-scale data collection and automatizing simple control, regulation, or alerting tasks—there are also scenarios requiring a more interactive, joint creation of value between public agencies and citizens. Such smart government initiatives often seek to develop context-based decision-making tools and envision co-creation of public services that are supported by involved citizens. A major challenge in such scenarios is that active participation is quickly halted if the population is only seen as a data supplier (without providing personalized feedback or sensemaking about the real purpose of data-sharing), and the data flow necessary for the development of meaningful forecasts will diminish over time (Yassaee et al. 2016). Thus, it is important to inform and engage with citizens to ensure that the aims and data needs for an active smart government initiative are transparent. As we will show in the DeSearch case study, personal affection, concern, and solidarity could be reasons why citizens share their data.

Conceptual Model

Both modes of participation justify their existence, since they address dissimilar usage cases and fulfill very different public needs. Active and passive participation are not mutually exclusive; both can be combined in smart government initiatives, allowing more complex relationships to become visible. More precise knowledge about the efficiency and effectiveness of state measures can be gained by analyzing and evaluating such data that provides information about the public's behavior, as well as other trends (Mergel et al. 2016).

Accordingly, so that IoT-enabled smart government initiatives can reach their full potential, different elements must be considered and aligned. As shown in Fig. 1, we propose a conceptual model to approach smart government initiatives by applying a data life cycle perspective and concentrating on different modes of engaging with citizens.

To understand participation in IoT-reliant smart government initiatives, we must closely examine and understand the quality and origin of data sources. Smart government initiatives can use not only of public infrastructure (e.g., a city's camera surveillance system, weather and pollution sensors, and traffic light systems), but also private infrastructure for data collection and citizen participation; this is often forgotten. A large number of private data sources (e.g., smartphones, smartwatches, and micro-computers) can be systematically tapped (with citizens' unknowing consent) to obtain extremely detailed data about the habits, routines, and wishes of the

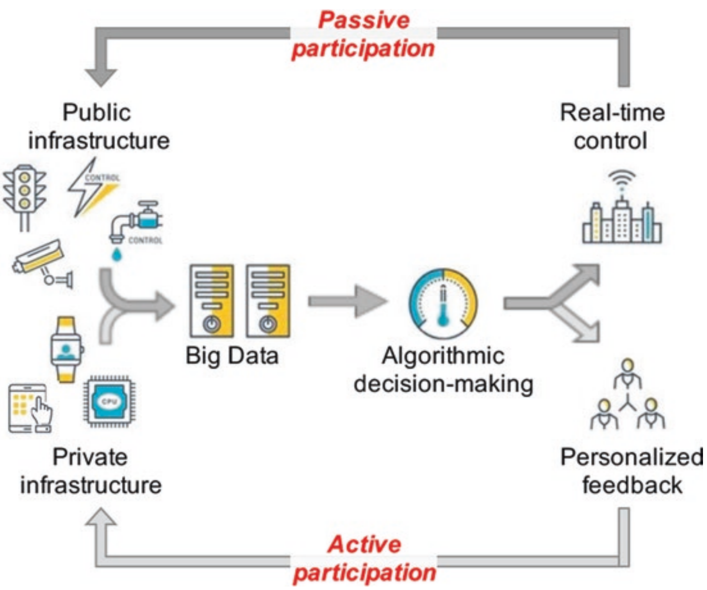

Fig. 1 Conceptual model describing active and passive citizen participation in smart government initiatives (translated from Guenduez et al. 2017)

population. Notably, smartness does not derive from data collection per se, or what many refer to as big data. In such applications, smartness lies in the context-related analysis and combination of a large amount of structured and unstructured data, which allows for self-learning algorithms to make increasingly precise statements about certain facts, groups, or even single individuals, enabling the automation or execution of certain tasks in much more efficient and citizen-friendly ways.

However, smart government initiatives should not end with data analysis and the prediction of events. To prevent the data life cycle from halting, government authorities must engage with citizens and must somehow pass the outcomes of algorithmic decision-making on to them.

We will now use two case studies to explain the differences between active and passive participation.

Passive Citizen Participation: The Smart City St. Gallen Case

To illustrate the passive participation mode in an IoT-enabled smart government initiative, we present the Smart City St. Gallen case.

St. Gallen in Switzerland is close to the borders of Germany, Austria, and Lichtenstein, and maintains close relationships with cities in these countries. St. Gallen is a suitable case for German-speaking countries to illustrate passive participation. From 2000 on, triggered by the Internet, the integration of citizens in the political process became increasingly articulated in public and political debate. As in many cities around the world, many of these e-government ideas have remained theoretical in St. Gallen and have still not become a reality (Baccarne et al. 2014).

The city made another attempt in 2015. The new initiative runs under the name Smart City St. Gallen and has reached significantly further than previous digitalization initiatives, recognizing the huge potential of IoT. The city does not limit the smart city concept to the application of current technologies, but pursues a holistic approach. St. Gallen's smart city strategy seeks to establish an ecologically sustainable and energy-efficient city. The city also seeks to enhance services for citizens, businesses, and other stakeholders through the use of IoT, sensors and data collection (St. Gallen 2016a).

St. Gallen is experimenting with a broad range of IoT technologies, such as smart metering, streetlights, parking, transportation, and waste management. Further, with the area-wide construction of a fiber-optic network, the city has established a "nervous system," enabling high-performance data networking. Having successfully accomplished the first pilot project in IoT applications, St. Gallen plans to extend the Long Range Wide Area Network (LoRaWAN) technology to the entire city. LoRaWAN is a wireless, low-power communication technology for IoT applications. St. Gallen is building on this infrastructure to exploit IoT technologies' potential: automatic collection of context-related data, integration into the overall system, and processing for real-time control. All these technologies are building the technological foundation of Smart City St. Gallen. Figure 2 illustrates how

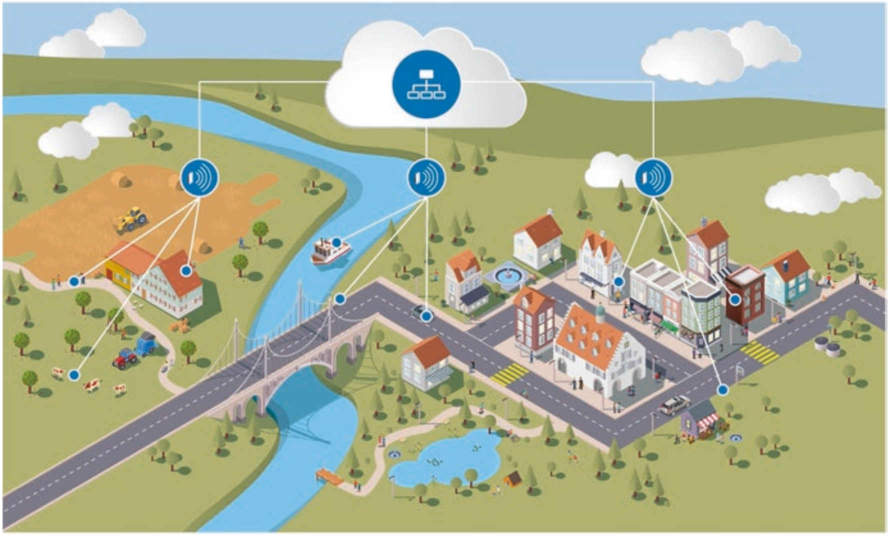

Fig. 2 The technological foundation of smart city St. Gallen (St. Gallen 2016a)

context-related data are automatically collected, integrated into the overall system, and processed for intelligent real-time control.

IoT located in the public infrastructure can create a participative environment (Kortuem et al. 2013). It offers a new opportunity for citizens to get involved in public services' governance. Citizen participation is not based on active expression of political will, but on their social participation in city life. We call this *passive participation*. By driving on a lit road, leaving a car in a parking space, using water, electricity or gas, or disposing waste, citizens communicate their needs to a certain extent through sensor systems. Real-time generated data from autonomous sources spread out through the public infrastructure illuminate a previously unknown volume, variety, and volatility of data about the use, efficiency, and effectiveness of services. Information gained from these data results in evidence-based governance in the truest sense of the word. Thus, citizens' passive involvement results in more citizen-centered governance of services. St. Gallen's IoT architecture is still under development. The experience gained in its smart city project is very promising. With this project's increasing maturity, government services will be better adapted to citizens' needs.

A concrete example of the passive participation cycle is the settlement project Sturzenegg. The city conducts the project to gain empirical civic experience with IoT technology. Sturzenegg has been in operation since mid-2017, installing gas, water, heat, and electricity sensors in the city. The sensors measure occupant consumption and transmit data via a fiber-optic network and LoRaWAN to central data centers, where they are linked, processed, and visualized by software. These data offer many benefits for the city and its citizens, allowing for an exact calculation of consumption. The city can react to bottlenecks in close to real-time. Linking the data to an invoice system also allows for more efficient invoicing, which saves administrative costs. The data are fed back to the residents on an app provided by the city, so that each apartment can see its own current consumption and can adapt accordingly.

IoT enables St. Gallen to include everyone living and working in the city in the policy-making process. Foreigners, minors, and non-voters, who cannot or do not participate in the opinion-forming and decision-making processes, are becoming relevant actors. Sensors connected to parking spaces, street lighting, waste bins or water, gas, and electricity meters also collect data. With the integration of data, these sensors generate political opinion-forming and decision-making processes, and become part of value creation in government services. Thus, IoT not only enhances the quality of the public services, but also fosters a new form of interaction between politically unrepresented people and government. These people represent a large part of the population. Integration of this group into the political process via IoT infrastructure is a new way to promote democracy in cities.

IoT in public infrastructure has huge future potential; many applications are only beginning. The smart city strategy, in this first instance, seeks to modernize the city's infrastructure (water, gas, electricity, waste, traffic) via sensor systems, but needs to be developed further. A comprehensive implementation of IoT in the city is planned (St. Gallen 2016b). Today, St. Gallen is experimenting with the possibilities of IoT technology, knowing that smart IoT technologies alone do not guarantee smartness. Using the technologies to enhance government services is still in the concept stage. Once comprehensive IoT implementation in the city is complete, most data necessary to govern the city will be available via the sensor systems. Utilizing this information enables citizen-centered governance of government services and representation of all social groups in the political process.

Active Citizen Participation: The DeSearch Case

We present the DeSearch case as an example of active participation mode in an IoT-enabled smart government initiative.

For many years, local governments and the EC invested considerable financial resources into the development of assistive technologies for elderly people and others in need of increased care (Bächle et al. 2018), to improve their autonomy and wellbeing (Kubitschke et al. 2010). This is motivated by the fact that senior citizens living in homecare settings are much more independent and active (Sun et al. 2009; Mageroski et al. 2016) and generate a fraction of the costs of older people in long-term care facilities (Wimo et al. 2010). However, this has a downside; they are much more at risk of patient safety incidents (Tudor Car et al. 2017), which makes it crucial to research remote monitoring.

Sensor-based systems for patient monitoring have recently attracted much attention (Pantelopoulos and Bourbakis 2010). Via sensors and actuators integrated into clothing, shoes, bracelets, phones, watches, or integrated in smart home appliances, it is possible to constantly track and accumulate significant biological, physical, behavioral, or environmental information (Swan 2013), which—if deliberately combined and designed with foresight—can be used to improve elderly persons' quality of life by enabling them to stay longer and more safely at home (Mileo et al. 2008).

DeSearch, a smart government project currently underway at the Baden-Wuerttemberg Cooperative State University Ravensburg-Friedrichshafen (Germany) and the University of Lausanne (Switzerland), seeks to develop privacy-aware means to track elderly persons and others in care without unnecessary surveillance and intervention in their daily lives (Bächle et al. 2016). Unlike existing GPS-based systems that record every step a person takes, DeSearch seeks to provide a much less intrusive solution that reduces stigmatization (Dahl and Holb 2012) and increases *adoption willingness*, particularly for persons with mild cognitive impairments, or those who only occasionally experience behavioral difficulties.

The DeSearch solution has several components (cf. Figure 3): (a) a button-sized Bluetooth transmitter that can easily be sewed into an elderly person's clothes or shoes, (b) a small receiver, and (c) a web application, all of which are used to help locate a missing person. Since DeSearch relies on Bluetooth technology, the system is also able to locate a person inside a building. This can be particularly handy in larger health institutions, such as metropolitan hospitals or care institutions, where there are countless spots to hide. However, a major downside compared to GPS-based solutions is its limited range of coverage, which led the research team to consider active participation of engaged citizens to counteract this issue. Figure 4 illustrates the basic functioning of DeSearch.

As noted, DeSearch does not permanently track a person's location. It can be activated when the individual passes a sensor barrier (e.g., a building's exits) or at

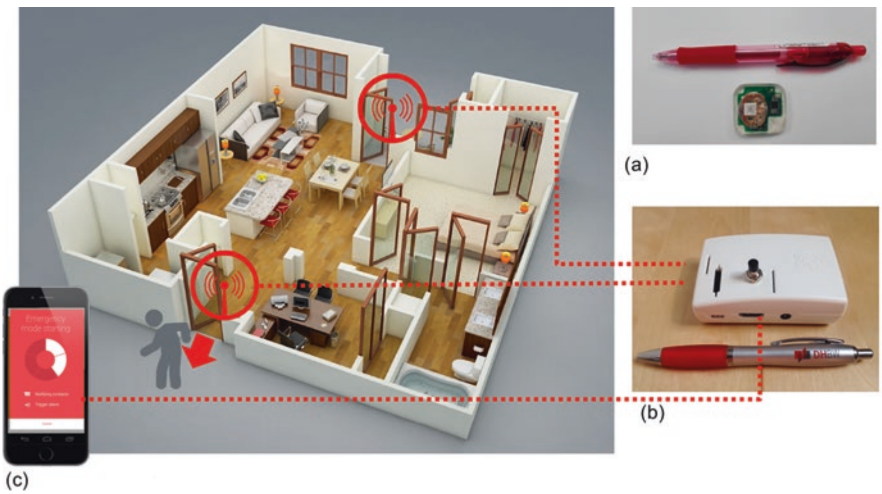

Fig. 3 The technological foundations of DeSearch. (**a**) DeSearch bluetooth-button. (**b**) DeSearch receiver. (**c**) DeSearch app

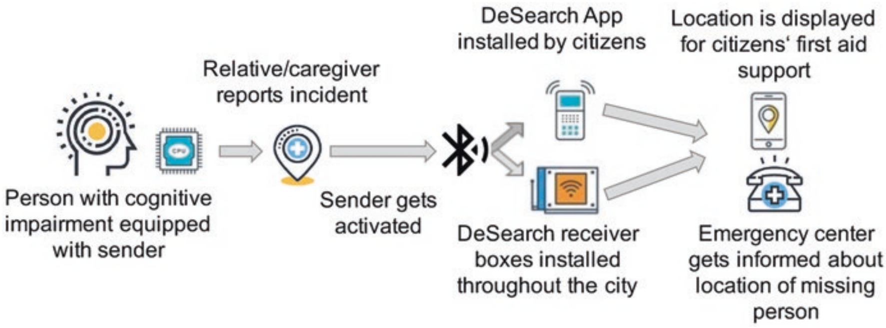

Fig. 4 Active citizen participation on DeSearch

the request of a relative or caregiver (e.g., if the subject is not immediately found in a designated room). To locate a person, DeSearch relies on two approaches.

Given that dementia patients' long-term memory is often good, they tend to go to certain locations (e.g., train stations, marketplaces, or bus stops) they remember. Thus, DeSearch intends to equip cities with a small number of low-cost receiver boxes (based on Raspberry Pi mini-computers) at possible locations, along with constantly moving receivers installed in public transportation vehicles or taxis. When a specific person is near a DeSearch receiver, the local emergency center is informed of their exact position.

An extension of coverage could come from actively involving concerned citizens. Many people know certain individuals or have family members with cognitive impairments. By installing the DeSearch app on their smartphones, the community can assist in locating missing persons. When turned on, a smartphone becomes a mobile receiving station, sharing private infrastructure to locate a missing person. The phone can also display a missing person's location to facilitate first-aid support. In sum, we define the deliberate and intentional participation in a smart government initiative—for example, sharing personal data and providing privately owned resources—as *active participation*.

Overall, active involvement could enhance public responsibility and could significantly minimize search costs for missing persons. In this case study, a network of engaged citizens is established (by running the DeSearch app in the background)—positive smart government.

Active participation creates new challenges for designers beyond the technical realization of IoT, because citizens must be convinced of a project's value. As with any surveillance and tracking technology, privacy concerns are key. Particularly in countries where there is a general distrust of government, there is a widespread conviction that government agencies repurpose one's personal infrastructure and information for objectives other than those initially promoted (Regan 2004; Mutimukwe et al. 2017). Many studies of privacy and information disclosure suggest that citizens perform a kind of cost-benefit analysis or *privacy calculus* (Dinev et al. 2016) to see whether the advantages of IoT-reliant government services are worth the potential privacy risks of using these services. This is fundamentally different from the St. Gallen project, where usage is not a conscious decision, or where there is no real choice on how to access and receive a particular government service. Thus, a transparent and precise communication of costs and constraints of an IoT-reliant government service is needed, and could be a reasonable way to clarify the debate about winners and losers in data-based societies (Loebbecke and Picot 2015).

Key Learnings from these Two IoT Case Studies

Smart government is driven by the use of a new generation of ICT in the public sector. In contrast to previous digitization initiatives that focused on providing services via websites (Zakareya and Zahir 2005), smart government initiatives focus on the unprecedented possibilities and opportunities that new generation IoT technologies offer in collecting, connecting, analyzing, and sharing data—all in real-time, bridging digital and physical boundaries. The IoT will play a key role in the success of the smart government initiatives. Most importantly, IoT could raise the value creation process of government services by actively or passively including the entire population. In this sense, smart technologies are also social technologies, enabling the participation of large groups of people (Cardone et al. 2013). Participation in the value creation process is one a main principle of democracy, affording citizens opportunities to communicate information to government officials about their concerns and preferences (Verba et al. 1995).

We have discussed two modes of the inclusion of citizens in smart government: active and passive participation. Both modes depend on IoT-reliant scenarios. Through active and/or passive participation, citizens contribute to the provision of public services, as illustrated by these two practical cases.

The Smart City St. Gallen case study illustrates the potentials of IoT in public infrastructure, showing that smart infrastructures empower citizens by enabling them to influence government service provisions. As a driver on a smart lit road or a user of a public parking space with sensors, citizens become part of value creation in government services. Greater citizen involvement results in more citizen-centered governance of public services (Cooper et al. 2006), representing a service dimension of passive participation. It could embody a democratic dimension; public infrastructure not only integrates active citizens, but also foreigners, minors, and non-voters, who cannot or do not participate in political opinion-forming and decision-making processes.

The DeSearch case study illustrates how private infrastructures (smartphones) can be used for public tasks, such as for locating missing persons. This opens new possibilities, including privatization of public tasks. However, citizens' *participation motivation* cannot be taken for granted. Through positive stimuli (e.g., monetary incentives, public interest), citizens can be moved to augment or maximize their infrastructure. St. Gallen and DeSearch show that, by using private and public infrastructure, individuals or groups can actively and/or passively influence the provision and governance of public services. Active and passive participation allow them to be part of the policy-making process and to enhance the quality of the public services they receive.

Active and passive participation have major consequences for public administration, enabling interaction with service providers, and influencing the provision and outcomes of public policies. Citizens are no longer only consumers, but become co-designers of and contributors to government services (Bertot et al. 2016; Uppström and Lönn 2017). Through the use of the public and/or private IoT infrastructure, citizens coproduce public services. Coproduction, as the process "through which inputs used to produce a good or service are contributed by individuals who are not 'in' the same organization" (Ostrom 1996). This means that it is not only government agencies who are providers of education, health, security, or infrastructure services, but also citizens and other stakeholders. Coproduction is not new to public administration; it has been at the heart of many previous attempts to include citizens in the policy cycle (Bovaird 2007; Bovaird et al. 2015; Fledderus et al. 2014). However, with IoT technologies, coproduction has a better chance to succeed under smart government (Van Waart et al. 2015). IoT creates an environment that strengthens citizens' roles as coproducers of public services (Schaffers et al. 2011), making it important to foster participative environments. Thus, constructing an open, public IoT infrastructure and encouraging citizens to use their private IoT infrastructure to cooperate with service providers are key to empowering citizens (Millard 2018).

Active and passive participation, as bottom-up approaches, counter the traditional, hierarchical relationship between a government (as service provider or guarantor) and the citizens (as users). A new conception of public service delivery is needed. The traditional, hierarchical model of government service delivery must be revised to account for IoT, sensor systems, and related developments, such as big data and algorithmic decision-making. Despite the potential of IoT, concerns about adverse effects abound. The growing skepticism regarding vanishing boundaries between what is private and what is public is a significant challenge. Trepidation about unauthorized access to private data, use of this data by government agencies for more than policy issues and it being another step toward government surveillance, is deeply rooted. *Smartness* in *smart government* means addressing these challenges while pursuing the benefits of the IoT.

Boundaries and Limitations of Smart Government

So far, we have emphasized numerous benefits of smart government. However, the concept also has limitations.

First, it is not easy to manage IoT-enabled smart government initiatives that connect physical, digital, public, and private environments. Smart governments place high demands on public decision makers, since they need to understand and control the new technologies, implement them successfully in public administration, and add value to citizens. This requires technical, organizational, and managerial skills. Public administrations must acquire these capabilities.

Second, as noted, smart government has huge potential for democratic self-governance. However, this is not without risk. Public services in smart government rely on the collection and analysis of data derived from public and private infrastructures. Collecting and recording (personal) data raise a series of questions concerning privacy, which is fundamental to modern democracies. A lack of appropriate privacy norms poses a significant threat to democracy (Schwartz 1999). Smart governments need to empower citizens to control the collection, analysis, and dissemination of their personal data (Lessig 1999). Smart governments with inadequate personal data protection will have difficulties distancing themselves from a Big Brother reputation.

Third, smart technologies are at the core of smart government, enabling governments to become smart. Despite numerous benefits, there are big risks when governments rely exclusively on technology. Delegating routine administrative tasks to self-learning algorithms and the displacement of human control may have unintended consequences. As Bohn et al. (2004) note,

> Under "normal" circumstances, automated control processes increase system stability—machines are certainly much better than humans if they have to devote their whole attention to a particularly boring task. But situations that have not been anticipated in the software can easily have disastrous consequences if they are not directly controlled by humans.

Thus, smart governments need to develop control mechanisms for autonomous systems. Further, legal guidelines must be established in order to clarify accountability when things go wrong.

Fourth, by emphasizing active and passive participation in smart government, we have outlined the importance of a bottom-up approach. However, citizens often do not have the resources or are unwilling to participate without government intervention. To get citizens involved, governments need to incentivize the use of new technologies; it is hard for citizens to understand the possibilities of new technologies (Capdevila and Zarlenga 2015). As noted, through participation, citizens become co-designers of and contributors to government services. In case of a lack of participation, complementary top-down approaches in smart governments may be useful in order to provide services.

Fifth, our model, which demonstrates active and passive participation in smart government, is a strong simplification of realities. The advantage of our model is that it can be used in different contexts, but it does not reveal all the details to be found in smart government initiatives. Our model is descriptive; it does not allow for statements about causalities. It does not explain how and why citizens participate. However, this simplicity allows for a wide range of applications. The elements of the model point to relevant aspects of smart government, enabling a structured analysis and discourse, which has merits.

Practical Implications

We conclude by pointing out some practical implications. First, merely providing public infrastructure with sensors is not enough. For municipalities to generate added value, they must be linked to citizens' private infrastructures. Citizens should be able to access city services at any time with their smart devices; only then do they become coproducers of services.

Second, a smart city is a connected city; the same is true for any other smart government initiative (Dais et al. 2008). The individual data generated by sensors must be linked, so that government services that use these data can achieve remarkable public value for citizens. For instance, this would mean linking movement data collected by street lighting with data from car park sensors (or even from parked cars themselves), to reduce a city's energy consumption, thereby minimizing costs for the public, as well as lowering the light pollution that affects animals in city surroundings. This could also have practical benefits, such as estimating parking space occupancy. In the St. Gallen case, a link between sensors and smart services is not yet in place. St. Gallen is not alone in this regard. In many smart government initiatives, data collection and use still take place in silos. Public managers must understand that such projects are in most instances coproduction initiatives (Paskaleva et al. 2018). Collaboration with a multitude of stakeholders is needed, whether with other government authorities, private companies, or as we have highlighted, with citizens themselves.

Third, smart government initiatives only work if citizens participate (Anttiroiko et al. 2014). They do this when they understand how smart services, sensors, and data generated from IoT devices are collected, stored, and analyzed, as well as what public value may be achieved by these measures. A concrete, open information policy can encourage more active citizen participation. Collecting data for the sake of collecting, as often happens, will lead to resistance from citizens. Because coproduction is key for the presented participation data life cycle to continue, we advise public managers to carefully consider this.

Fourth, public administration must be aware that the sample from which they draw their conclusions could be biased (Ignacio et al. 2017). Data from active and passive participation are not necessarily representative of the entire population; biased participation leads to biased data and therefore to biased services. For instance, if only certain neighborhoods are equipped with sensors, the collected data do not allow for extrapolation to the entire city population. This is the same for active participation, since disadvantaged groups of the population participate less than others (Warren 2007). As a result, public policies formed by these data may be biased and may favor those who leave digital footprints, excluding those who do not participate. Thus, smart governments are advised to also focus on persons who leave no digital footprint.

Finally, with such a wealth of possible data sources, it becomes important for smart governments to distance themselves from any Big Brother or *uberveillance* mentality (Michael et al. 2014). Quality should come before quantity. Collecting as much data as possible does not necessarily mean providing better services. Only data that are needed to improve services to citizens should be collected. Sensors and IoT are not an end but a means to an end.

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