Hearing the Voice of Citizens in Smart City Design: the CitiVoice Framework

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Abstract

In the last few years, smart cities have attracted considerable attention because they are considered a response to the complex challenges that modern cities face. However, smart cities often do not optimally reach their objectives if the citizens, the end-users, are not involved in their design. The aim of this paper is to provide a framework to structure and evaluate citizen participation in smart cities.

By means of a literature review from different research areas, the relevant enablers of citizen participation are summarized and bundled in the proposed CitiVoice framework. Then, following the design science methodology, the content and the utility of CitiVoice are validated through the application to different smart cities and through in-depth interviews with key Belgian smart city stakeholders. CitiVoice is used as an evaluation tool for several Belgian smart cities allowing drawbacks and flaws in citizens' participation to be discovered and analysed. It is also demonstrated how CitiVoice can act as a governance tool for the ongoing smart city design of Namur (Belgium) to help define the citizen participation strategy. Finally, it is used as a comparison and creativity tool to compare several cities and design new means of participation.

Keywords— Smart cities; Citizen; Participation; Framework; Evaluation

I. INTRODUCTION

In the last few years, smart cities have been more popular than ever because they provide new solutions in the domains of mobility, environment, economy, governance, quality of life, and education, thanks to the innovative use of Information and Communication Technologies (ICT) (Caragliu et al. 2011). Generally, the interest in smart cities is strongly linked with the rise of new information technologies such as mobile devices, semantic web, cloud computing and the Internet of things (Schaffers et al. 2011). The term "smart city" was adopted in 2005 by a number of technology companies as they offered complex information systems to integrate the operations of an urban infrastructure (Harrison and Donnelly 2011). A number of other non-technological factors led to the larger adoption of a smart city strategy: the increasing size of cities, the need to safeguard the environment from pollution and energy consumption, or the higher requirements of citizens regarding the delivery of public services (Cocchia 2014).

Although the technological aspects of smart cities have been well covered by the literature, the essential role of citizens n these cities has often been neglected. Too often, smart cities have not reached their objectives because citizens were not properly involved in their definition or the impact on their daily life was not taken into account (Dameri and Rosenthal-Sabroux 2014). In the smart city research area, many authors have underlined the importance to discuss citizen participation in a smart city. However, so far, no article has attempted to summarize the different enablers of citizen participation in a smart city context. In this article, smart cities are considered as socio-technical systems with citizens as their end-users. In this regard, this article situates itself in the line of research of Vácha et al. (2016) that adapts systems engineering methodologies to collect users' needs, to plan, and to monitor smart

city projects. The goal of this article is to find out how citizens can contribute to transform a city into a "smart" city and to provide a framework to structure and evaluate this participation.

This paper is structured as follows. Section II presents the concept of citizen participation as well as its relevance for designing smart cities. In Section III, we describe the methodology applied to perform the extensive literature review and to build the CitiVoice framework. In section IV, the different enablers of citizen participation are studied in depth and translated into the criteria of the framework. CitiVoice is then applied to three Belgian smart cities in section V to demonstrate its different uses. Section VI details the practical implications of the framework for the interested stakeholders as well as theoretical implications and avenues for further research. Finally, Section VII provides some closing comments and summarizes the contributions of the paper.

II. Background

The concept of citizen participation is not exclusive to smart cities, but smart cities have shed a new light on this concept and provide new means to enable this participation. This section first positions citizen participation and its impact in different research fields. Then, the section outlines the relevance of citizen participation in smart cities and identifies the research gaps this article aims to fill.

A. Positioning Citizen Participation

In public administration literature, citizen participation is a process that gives citizens the opportunity to influence the decision-making and administrative tasks of government (Callahan 2007) and is central in the co-creation and coproduction concepts (Galvagno et al. 2014). The emphasis on citizen participation is also stressed by the Open Government movement, which argues that citizens should be at the center of the public life via the transparency of government, participation, and collaboration among citizens (Lee and Kwak 2012).

In information systems research, the participation of end-users in the design of systems has often been considered as an important factor for system quality (Hartwick and Barki 1994). This paper considers the distinction between the notions of participation and involvement that comes from the well-researched field of user participation in information systems (Schuler and Namioka 1993): participation relates to the activities that the citizens perform whereas involvement relates to a psychological state of personal relevance that the citizens feel (Hartwick and Barki 1994). The remaining of the paper will focus on participation.

The e-government literature has already researched the participation of citizens (Følstad et al. 2004; Axelsson and Melin 2008). It has long shown a tension between two conceptions for the citizens: citizens as customers that need to be satisfied by the service delivery and citizens as participants capable of adding value in public processes (Linders 2012). In their attempt to suggest a research agenda for smarter government, Scholl and Scholl (2014) underline the need for the e-government paradigm to evolve and integrate participation in order to tackle the challenges that modern cities aim to face.

B. Relevance of Citizen Participation in Smart Cities

Smart cities are currently benefiting from a positive buzz from supporting organizations and thus from a lot of economic support. Taking advantage of this support and the multitude of technological possibilities, cities must devise smart city projects, decide how they will use and advance their ICT infrastructure, and optimally exploit their assets. A key challenge is to carry out these actions in coordination with the citizens, since the ultimate goal of building a smart city is to improve their quality of life. Hollands (2008)[MS1] underlines the importance of citizens and critiques the technological focus of smart cities. He also claims that smart cities must be based on something more than the use of ICT if they want to enable social, environmental, economic, and cultural development. The real smart city, according to Hollands, should start from the people and human capital of the city and use IT to favor democratic debates about the kind of city people want to live in. This radical critique led to a new stream in the scientific literature. A new definition of a smart city integrated the various dimensions of a smart city as well as the critique (Caragliu et al. 2011): *A city can be defined as 'smart' when investments in human and social capital and traditional (transport) and modern (ICT) communication infrastructure fuel sustainable economic development and a high quality of life, with a wise management of natural resources, through participatory governance.* This definition is widely accepted and used in scientific literature and in practice (e.g. smart cities such as Amsterdam used this definition as a basis for their strategy).

Even though the traditional definitions of smart cities take the specific role of citizens in a smart city into account through the "participatory governance" or the "human capital" dimension (Albino et al. 2015), the input they can provide and how it can be gathered need further research. In their integrative framework, (Gil-Garcia et al.) attempt to conceptualize smartness in government. They state that fostering collaboration between citizens and governments is an essential dimension of smart government. Scientific literature acknowledges the essential role of citizens in smart cities and argues that the notion of empowerment of citizens and "democratization" of innovation should be added to this definition (Schaffers et al. 2011; Perera et al. 2014). The citizens must be able to identify priorities, strategies and goals for the smart city strategy and should be considered as actors at the center of the implementation and benefits of smart city projects (Nam and Pardo 2011; Albino et al. 2015).

However, despite this crucial role for citizens, no paper has yet tried to take a holistic view on the different participation methods (research gap 1). Furthermore, the need for appropriate evaluation tools and metrics is emerging but there is still a gap in scientific

literature regarding the evaluation of citizen participation (research gap 2) (Lombardi 2011). Based on our observation in practical cases, this leads to the risk that "citizen participation" remains an abstract buzzword instead of an essential element of the strategy of a city aiming for the label "smart".

This article tackles these two research gaps by trying to answer the following research question: *How can a city enable the participation of its citizens to become a smart city?* To answer this question, we will tackle the following research sub-questions: What are the different means of citizen participation in a smart city? And: How can citizen participation in a smart city be evaluated? Building on the formalization of citizen participation by Berntzen and Johannessen (2016), (Simonofski et al. 2017a) suggested a framework to evaluate citizen participation in smart cities that will be further detailed, refined and validated here.

III. Methodology

The methodology we applied to design the CitiVoice framework is represented visually in Figure 1 and further described in this section. In order to design the framework and its criteria, we followed the guidance of the design-science paradigm, consisting of three research cycles: Relevance Cycle, Design Cycle and Rigor Cycle (Hevner et al. 2004).

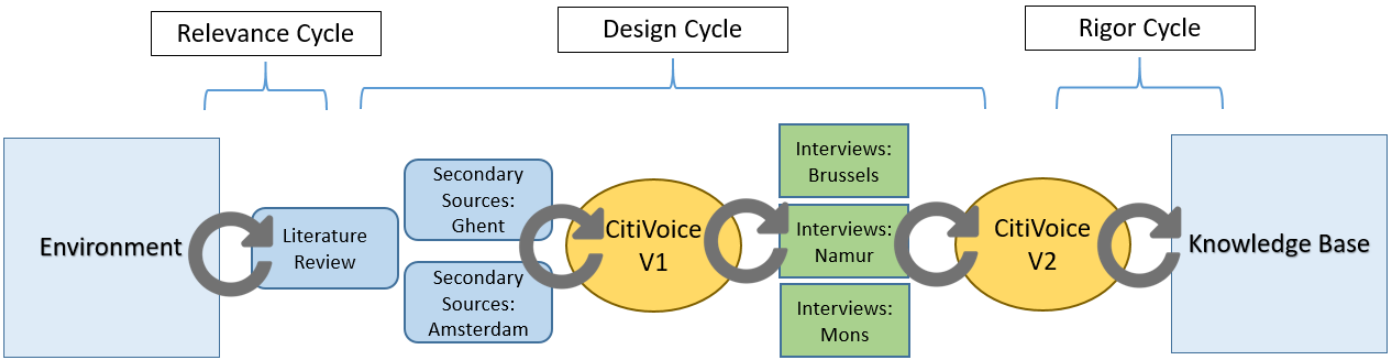

Figure 1: Design Science Methodology

In the *Relevance Cycle*, the smart city literature was analyzed through an extensive review of papers found in well-regarded scientific electronic databases (Google Scholar, Scopus, ScienceDirect, Web of Science) (Falagas et al. 2008). In order to be considered for reviewing, the articles had to include at least one of the following terms in their title and/or abstract: "citizen", "participation", "involvement", "engagement", "empowerment", "e-inclusion" and "e-participation". In order to obtain input from other fields of research, these search terms were used with and without combination with "smart city". This intellectual core was then extended through backward and forward snowballing. To be considered for the review, articles had to discuss insights about the implementation or evaluation of citizen participation. In total, the authors reviewed 62 papers. This review allowed us to ensure that the design of the framework will add value to the environment and application domain.

In the *Design Cycle*, this review allowed us to identify relevant criteria to construct an initial version of the framework to structure citizen participation in smart cities. Thus, the criteria were considered as artifacts and refined in two validation steps. The validation methods were observational in order to study the criteria in a real-life environment. In the first validation step, the framework was applied to the evaluation of Ghent and Amsterdam. The input data for these cities originate from secondary sources: the official websites of the cities (Gent City 2014; Amsterdam City 2015), official documents of the city council, newspaper articles, and scientific literature (Baccarne et al. 2014; Dameri 2014). Based on this first validation step, the framework was improved: the categories were modified to better reflect reality and criteria were modified to be more easily usable. For instance, thanks to the example of the "Ghent Living Lab", the Living Lab category was refined as it is not only its presence but also the activities it organizes that really enables citizen participation.

As it was observed that for some criteria, no public information is available in secondary sources, we opted for the in-depth study of three Belgian smart cities in the second validation step. For these cities, all required information was collected through in-depth interviews with relevant stakeholders in charge of the implementation of the smart city strategy. These stakeholders were selected from different functions to have different perspectives (see Table 1). After understanding the current actions that they implement regarding citizen participation, the framework was also presented to these stakeholders for validation. In that regard, the 12 interviews also constituted an improvement phase where the different elements of the framework were refined. Indeed, the interviewees pinpointed key points out of their experience that could not have been as extensively identified in literature, e.g. the essential presence of group facilitator to support participation. These interviews were performed in a semi-structured manner following literature's best practices (Drever 1995). Some questions were predefined and grouped in general themes about the main categories of citizen participation and the concrete implementation of the smart city strategies of the different cities. However, the interviews remained open in order to explore new ideas and to be able to discover other relevant themes. On average, the interviews lasted between one and two hours each and were performed face to face for the majority. Thanks to the validation steps of the design cycle, we reached a saturation of findings, as interviews did not lead to further modification of CitiVoice in the last iteration (cases of

Brussels and Mons). We made sure that the studied smart cities are heterogeneous enough to limit the threats to validity (see Table 2). Through the *Rigor Cycle*, we ensure that CitiVoice contributed to the knowledge base. However, these theoretical contributions, as well as potential threats to validity and reliability will be discussed in Section VI.

N°	City	Function	Relevancy for Citizen Participation
1	Namur	Academic	Living Lab responsible
2	Namur	Political Representative	Supporter of Smart City Strategy
3	Namur	Political Representative	Supporter of Smart City Strategy
4	Namur	Public Servant	Smart City Manager
5	Namur	Public Servant	Expert on Smart Governance
6	Mons	Public Servant	Living Lab Responsible
7	Mons	Public Servant	Communication Manager
8	Mons	Private Sector	Digital Platform Developer
9	Mons	Political Representative	Supporter of Smart City Strategy
10	Brussels	Public Servant	Smart City Manager
11	Brussels	Public Servant	Citizen Participation Manager
12	Brussels	Political Adviser	Citizen Participation Expert and Entrepreneur

Table 1: List of Interviewees

City	Size	Maturity Smart City	Country
Namur	Small	Low	Belgium
Mons	Medium	Low	Belgium
Brussels	Medium	Medium	Belgium
Amsterdam	Medium	Advanced	Netherlands
Ghent	High	Advanced	Belgium

Table 2: Selected Cities to Design CitiVoice

IV. Results: CitiVoice framework

The section presents all the elements of the CitiVoice framework extensively. CitiVoice consists of three main categories of citizen participation. In order to make sure that this categorization is as complete and without bias as possible, we heavily rely on previous works on the matter to design these three categories(Callahan 2007; Berntzen and Johannessen 2016; Simonofski et al. 2017b)

- Firstly, citizens can be democratic participants in the decision-making process of the city. The concept of participation has been theorized by Arnstein (1969) who suggests that participation is a spectrum that consists of three main steps: non-participation, consultation (gathering of ideas but no impact on decision-making) and co-decision (with decision making shared between officials and citizens). The criteria in this category aim at verifying that citizens' opinions indeed have an impact in decision-making.
- Secondly, citizens can be co-creators in order to propose better solutions and ideas and to decrease the risk of failure early in the process. Thanks to previous studies presented about inventory of co-creation methods, we were able to collect and analyze the main co-creation methods dedicated to ensure that citizens' ideas and expertise are collected in an effective way.
- Finally, in the post-implementation phase, the citizens can also participate as ICT users by proactively using the smart city infrastructure to make them feel surrounded by technology and to enable them to participate more easily. As stated before, ICT was considered as the main element in smart cities for several years. The profusion of literature allowed us to compare smart city infrastructures and analyze how they could support participation (Anthopoulos et al. 2016).

Figure 2 summarizes the suggested framework, with the proposed criteria organized hierarchically into categories and sub-categories. The different elements of CitiVoice are detailed in the following sub-sections.

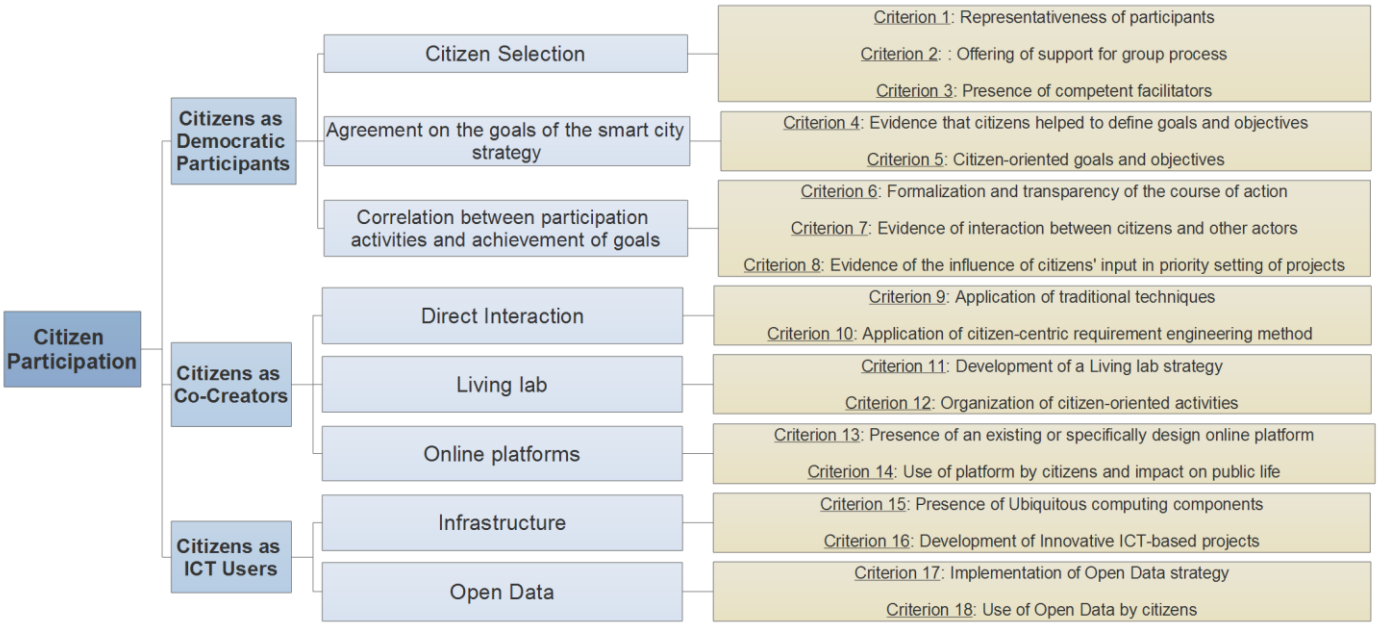

Figure 2: CitiVoice framework

A. Citizens as Democratic Participants

Seeing citizens as direct democratic participants in a smart city has several advantages (Irvin and Stansbury 2004). By being involved in the decision process, the citizens can learn about difficult technical problems and become experts in matters of public relevancy. Moreover, the public servants are also learning from the citizens about the reasons why a policy might be unpopular and how to avoid this. Democratic participation of citizens is also cost effective as it reduces the chance for litigation or, in a smart city, useless investments that will not be helpful or used by the public. This section introduces how citizens can have an impact on the decision-making process of smart cities.

1) Citizen Selection

In practice, the implementation of democratic participation of citizens faces numerous challenges. Firstly, the group of citizens involved in the process must be sufficiently representative for the population. For instance, the selected group could be biased towards people whose life is more heavily influenced by the decisions about the smart city strategy. The criterion "*Representativeness of participants*" checks the number of citizens involved and the description of their profiles in order to avoid overrepresentation of a certain class, gender, neighborhood, and so on. This representation could be obtained through basic statistics about the population to ensure the representativeness of each sub-group.

Secondly, the participation process can be costly in terms of resources, money, and time (Irvin and Stansbury 2004). These challenges can lead to an overrepresentation of a certain social group having the time and money to participate (Weber 2000). In order to reduce the time and money consuming nature of the decision-making process, the criterion "*Offering of support for group process*" is also added. This support can reward the citizens through financial but also other kinds of social benefits ("Citizen of the week" awards, free training courses, …). The time consuming nature of the decision making process and, thus, the challenge of underrepresentation of people lacking time can also be tackled through to the introduction of e-voting systems (Zissis and Lekkas 2011).

The criterion "*Presence of competent facilitators*" is added to check that the participation activities are handled by competent and unbiased group facilitators who will ensure the objectivity and relevancy of debates. Since citizens may not be used to participate in this kind of meetings, these facilitators should also ensure each voice is heard through the use of facilitating techniques such as described in (Mahaux and Maiden 2008)

2) Agreement on the goals of the smart city strategy

The main pitfall when including citizens in the decision process is to perform this in a purely instrumental manner. Governments might include citizens in the process only in order to obtain a more cooperative public hoping to face less resistance when the discussed project is implemented (Irvin and Stansbury 2004). Similarly, administrations may revert to democratic participation to take decisions that they could never have taken unilaterally. This conception may lead to "routinized" democratic participation that serves only marketing purposes. This risk is considerable for smart cities because citizen participation is considered a matter on which cities want to capitalize to be labelled as "smart".

Some strategies attempt to minimize this risk and aim to enable efficient democratic participation, e.g. through the evaluation of citizen participation (Rosener 1978). When participation is a means to a specific end, counting the number of people involved does not suffice to evaluate participation. Proper evaluation then requires having an agreement on the goals of the specific participation program, like "select the best ideas from a specific online participation platform" or to "develop smart lighting in a city in order to meet at best the citizens' expectations". The criterion "*Evidence that citizens helped to define goals and objectives*" checks that the citizens contributed to the definition of the goals. Furthermore, the criterion "*Citizen-oriented goals and objectives*" checks that the goals of the smart city are citizen-oriented and take the human capital of the city into account. This step is essential because it will ensure that CitiVoice is not used in an instrumental way, as a simple check-list of initiatives.

3) Correlation between participation activities and achievement of goals

In order to avoid the instrumental participation of citizens, there must be an established cause/effect relationship between the activities of the participation program and the achievement of the agreed-upon goals (Rosener 1978). The criterion "*Formalization and transparency of the course of action*" checks if the course of action has been formalized and is transparent so that the decision-making process is clear to all actors involved. Secondly, the criterion "*Evidence of interaction between citizens and other actors*" checks if the smart city actors decided to include citizens in the decision-making process of their strategy. Lastly, the criterion "*Evidence of the influence of citizens' input in priority setting of the projects*" checks that the citizens were not only passive actors. By prioritizing the smart city projects according to the citizens' input, the decision-makers ensure that the citizens, their quality of life, and their participation are at the core of the smart city strategy.

B. Citizens as Co-Creators

The traditional approach to innovation in cities consisted in urban planners making centralized decisions based on their own ideas, but in recent years, and in the smart city context, a new model that takes advantage of the citizens' input and ideas has emerged (Schaffers et al. 2011). Hence, citizens should not be considered as passive consumers but as crucial stakeholders that can generate valuable ideas that can meet social needs. This section explores how this co-creation can be applied in a smart city context.

1) Direct interaction

There exist some general techniques to collect citizens' ideas such as conducting focus groups or interviews with experts and users, town hall meetings, testing usability, functionality, and accessibility, encouraging real-time comments and suggestions, and developing and adhering to measures and standards of service quality (Johannessen 2010). The criterion "*Application of traditional techniques"* checks that these techniques are used by the smart city to gather input from the citizens.

Other means to gather citizens' ideas and needs for the smart city can be found in the area of requirements engineering for e-government services. Requirements engineering increasingly tries to reflect as accurately as possible the goals, needs and expectations of the users who are, in this case, the citizens. A citizen-oriented approach (van Velsen et al. 2009) advises to conduct semi-directive interviews to explore the critical needs of the citizens for the potential system. Other approaches such as the application of the agile paradigm (Schön et al. 2016) and the crowdsourcing paradigm (Adepetu et al. 2012) to the traditional requirements engineering method also provide new methods to collect citizens' needs in a more optimal way. The criterion "*Application of citizen-centric requirement engineering method*" checks the involvement of citizens in the requirement engineering method used by the city when developing e-government services or applications labelled as "smart".

2) Living labs

Another popular technique resides in the living labs, defined as "user-driven open innovation ecosystem based on business-citizens-government partnership which enables users to take active part in the research, development and innovation process" (European Commission 2009). The living lab methodology implies that the user is involved early in the development process when analyzing the needs and brainstorming about solutions. The panel of users can also be involved in the concrete development of ideas and finally in testing of prototypes. The goal is to get as close as possible to the citizens to connect with their expectations and to test how this innovation relates to the everyday environment of the users. The applications of the living lab methodology are very diverse and often relevant in the smart city domain: eHealth, ambient assisted living, e-governance, ICT for energy or environment (Pallot et al. 2010), and so on.

The motivation to engage in a living lab methodology not only originates from the willingness to improve user participation. It also ensures market evaluation, the exploration of a large range of ideas, and the reduction of business risks for companies (Pallot et al. 2010). However, the application of the living lab methodology for the public sector drives away these market-related motivations and increases the potential for citizen participation. Thanks to these labs, the needs, expectations and ideas of citizens about the smart city projects can be explored.

The criterion "*Development of a Living lab strategy*" checks whether the living lab strategy aims at putting the citizen at the center of its implementation. The description of strategy and planning does not suffice: this framework entry needs also to consider the citizen-oriented activities the living lab potentially organizes such as the exploration of ideas for smart cities, the vulgarization of technology, collaboration workshops, etc. Thus, the criterion "*Organization of citizen-oriented activities*" is added, which verifies that the living lab was built to enhance citizen participation in the smart city.

3) Online platforms

In the presence of time or space constraints, citizen participation can be enhanced by two means: centralized platforms and social media analysis (Berntzen and Johannessen 2016). As centralized platforms can be expensive to develop and hard to maintain, social media can be used to reach a larger number of citizens in different contexts: crowdsourcing platforms, collaboration tools, social networking, questioning tools,… (Criado et al. 2013). However, the gathering and analysis of social media data might require the support of proprietary platforms. Solutions to this challenge are hybrid systems where a social media interface is included in the proprietary platforms to favor the interaction between citizens and government (Dolson and Young 2012). This kind of system could be applied in a smart city context to stimulate the citizen input.

The criterion "*Presence of an existing or specifically designed online platform*" checks that the Online Platform(s) used by the smart city is (are) described. These platforms can be of any type (hybrid systems, social media, centralized platform, application…). Furthermore, the smart city can use an existing or specifically designed one. The criterion "*Use of platform by citizens and impact on public life*" checks that the platform has a real-life setting. This can be ensured by monitoring the number of citizens involved in the platform and its impact on the public life (how many discussions led to a concrete project? How many ideas or complaints were considered?).

C. Citizens as ICT users

The presence of ICT as "the" defining element in smart cities does not suffice and the excessive emphasis on ICT has even been reported as the principal defect of a number of smart cities (Merli and Bonollo 2014). The integration of ICT in a city can nevertheless offer a new range of opportunities and can change the landscape of the city. This section describes how the participation of citizens can be stimulated under the umbrella of the *ICT* term.

1) Infrastructure

Technological advances enable an "ubiquitous computing" infrastructure (Friedewald and Raabe 2011), a term that is closely related to the concepts of sensors and internet of things. It refers to the embeddedness of wireless, intercommunicating microprocessors, etc. in objects of the everyday life such that these objects can record and modify the environment. The criterion "*Presence of ubiquitous computing components*" lists all computing elements that could effectively lead to an increased participation of citizens.

The critical factor is to put these technological developments at the service of the citizens. These developments still remain too abstract for most citizens who are most interested in applicable solutions (Schaffers et al. 2011). The criterion "*Development of innovative ICT-based projects*" is a criterion that is added to check that innovative, or new citizen-oriented applications can be mapped to the framework. These applications range from Augmented Reality systems (Gutierrez et al. 2013), through Citizen Science platforms (Khan and Kiani 2012) and Public Displays (Du et al. 2017) to any innovative application that makes the citizens feel surrounded and supported by technology as well as motivated to engage in other applications.

2) Open Data

Open Data refers to all publicly produced data that is diffused without restrictions (Janssen et al. 2012). It stimulates the government to act as an open system and interact with its environment and thus, to welcome opposite views and ask for feedback. Open data focuses on several domains such as traffic, weather, public sector budgeting, tourist information, etc. The criterion "*Implementation of Open Data strategy*" checks the policy of the city concerning the availability of public data.

However, the publication of open data will not automatically lead to citizen participation because it demands considerable transformations of the public sector and skills for the citizens to use this data. Even so, more active citizens can create open source platforms or applications to make use of Open Data, to ease collaboration among citizens in order to solve issues at any scale (neighborhood, city, or even country). The criterion "*Use of Open Data by citizens*" checks the different uses of the available datasets by the citizens.

V. APPLYING CITIVOICE

We improved CitiVoice by applying it to the smart city designs of three Belgian smart cities (Mons, Namur and Brussels). For reasons of brevity, we will focus on the case of Namur to demonstrate the three uses of the framework:

- It can be used ex-post as an evaluation tool to assess a smart city strategy. This evaluation refers to the analysis of one city along all the criteria of the framework.
- It can be used ex-ante as a governance tool for government officials that want to invest in a citizen-oriented smart city strategy. In that respect, the criteria can be considered as guidelines for implementation.
- It can be used as a comparison and creativity tool by enabling comparative analyses of best practices for one criterion or category across different smart cities. These comparisons allow differentiating by which means different smart city strategies can ensure citizens' participation and to design new means based on this comparison.

A. Evaluation tool

CitiVoice takes as input all information that demonstrates the fulfilment of a criterion. For example, the text describing the construction of a living lab does not suffice but it is its usage by the city and the citizen-oriented activities organized in the context of

the living lab that will define it as a participation enabler. The evidence for criteria can be gathered through, e.g., reviewing textual materials, interviews, excerpt from minutes, etc. For each criterion, a score of 0/0,5/1 can be attributed in order to quantify the state of advancement for each smart city. This scoring is not criterion-specific and is generic enough to be applied to all criteria. The general scoring rules are as follows. "0" means that the city has not considered this criterion or has rejected it. This criterion has no effect on the participation of citizens. "0,5" means that the city has considered this dimension but has not fully implemented it yet (for example, a project is budgeted and planned or at the beginning of its lifecycle without concrete effects yet). In this state of implementation, the criterion holds the possibility of improving the participation of citizens or already influence it at a minor level. "1" means that the criterion is fully implemented and has a clear effect on citizen participation. Table 3 shows the evaluation of citizen participation in "Smart Namur" according to CitiVoice.

	Evaluation Criterion	Namur	Score
Citizens as Democratic Participants	**Citizen Selection**		
	Representativeness of participants	No assurance for representativeness of citizens	0
	Offering of support for group process	No support	0
	Presence of competent facilitators	No group facilitators	0
	Agreement on the goals of the smart city strategy		
	Evidence that citizens helped to define goals and objectives	The goals were not defined by the citizens.	0
	Citizen-oriented goals and objectives	The political will to transform Namur into a smart city aims to include the population in public life through digital means.	0,5
	Correlation between participation activities and achievement of goals		
	Formalization and transparency of the course of action	The course of action is not made available to the citizens.	0
	Evidence of interaction between citizens and other actors	"One-way" interaction: citizens are informed of the advancement of the smart city but have no opportunity to influence it.	0
	Evidence of the influence of citizens' input in priority setting of the projects	No opportunity for the citizens to influence projects.	0
Citizens as Co-Creators	**Direct Interaction**		
	Application of traditional techniques	"Smart Namur" is promoted via conferences. Direct interviews and focus groups are planned in the context of applied research by the University of Namur.	0,5
	Application of citizen-centric requirement engineering method	The e-government services are only developed internally.	0
	Living lab		
	Development of a Living lab strategy	The TRAKK is a multidisciplinary and co-creation space that aims to promote creative projects in the Na-	1

		mur region (TRAKK 2014).	
	Organization of citizen-oriented activities	The TRAKK is at the beginning of his lifecycle and is used by companies in the digital industry, developers and the creative class.	0,5
	Online platforms		
	Presence of an existing or specifically designed online platform	An online platform will be launched by the BEP and another one will be deployed by the city of Namur.	0,5
	Use of platform by citizens and impact on public life	/	0
Citizen as ICT users	**Infrastructure**		
	Presence of ubiquitous computing components	A budget has been assigned by the European Regional Development Funds to set sensors in the city (L'avenir 2015). Projects in the area of mobility are targeted.	0,5
	Development of Innovative ICT-based projects	The city of Namur plans to develop intelligent "bus stops" using "augmented reality".	0,5
	Open Data		
	Implementation of Open Data Strategy	Namur is about to launch a portal that will provide relevant information to all citizens, even the non-developers.	0,5
	Use of Open Data by citizens	/	0

Table 3: Evaluation of Namur with CitiVoice

B. Governance Tool

In order to make smart cities as citizen-oriented as possible, the guidance of CitiVoice allows to issue more concrete recommendations for a specific city. In this case, the recommendations are made after an evaluation of Namur with the framework. However, the different criteria could also be used as a checklist beforehand by any interested stakeholder (e.g. the smart city manager) to guide his actions about citizen participation.

Firstly, Namur should formalize its course of action to stimulate the democratic impact of citizens. This formalization will summarize for all ongoing or future projects the people are involved in, the clear authority in the decision-making process, and the relevance to include citizens depending on the technicity of the project. Then, a reflection must be carried out to include citizens so that they can contribute to the priority setting of future projects and give ideas about the implementation of the ongoing projects. Secondly, Namur should design an online portal to include the formalization of the future course of actions in order to be transparent. Each step might include a link for the interested citizens so that they can offer their perspective or ideas. It should also make a clear statement of the goals and objectives of the city and include structured information about its ongoing and future projects. At last, it should include or redirect to an online participation platform. Thirdly, the city of Namur should use its living lab as a hub for citizen participation. The co-creation space of Namur (the TRAKK) currently does not reach all the citizens of Namur yet. However, the TRAKK could explore citizens' ideas about the smart city, make them aware of new technologies and make them engage in digital activities such as educational activities (facilitation of the use of Open Data for citizens, introduction to programming), brainstorming activities (workshops to build concrete proposal for issues of the city), or competitions (hackathon, serious gaming, neighborhood games). Finally, the city of Namur should reflect about the use of ubiquitous computing. Questions about the placement, applications and potential value of "smart furniture" for the citizens need to be considered and can be answered through direct interaction with the citizens and through the testing of applications in the TRAKK. This research might lead to the conclusion that an investment in "smart furniture" will be irrelevant and too costly for the potential usage.

C. Comparison and Creativity Tool

For facilitating the visualization of citizen participation in smart cities, we have made use of a radar graph (see fig. 3). This form allows comparing in a straightforward manner in which forms of citizen participation the smart cities have decided to invest. The framework provides the dimensions to establish a "Dashboard" to monitor citizen participation strategies within smart cities. This

Dashboard would allow to monitor in which directions (Democratic, Co-Creation or ICT) investments are made to stimulate participation.

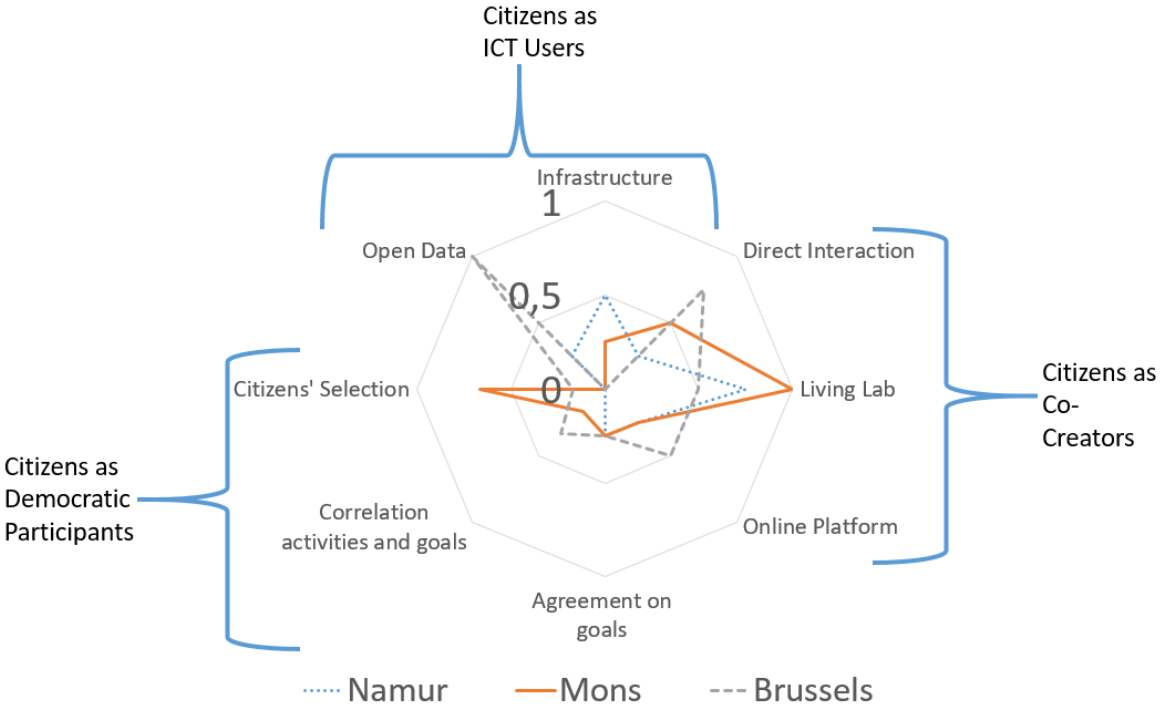

Figure 3: Participation Dashboard for Namur, Mons and Brussels using CitiVoice

The comparative analysis of different cities could also help generating new methods for citizen participation thanks to the identification of different best practices within one specific category. In this paper, we will not reflect extensively on that potential use as it would require the analysis of a higher number of smart cities in order to truly generate value. However, the comparison of three cities along one particular dimension is already promising. For instance, the specific case of the use of Online Platforms by the researched smart cities yielded interesting insights.

In the three cities reviewed, two categories of online participation platforms were present: large scope participation platforms that enables to collect an important number of ideas from citizens on the one hand, and more focused platforms that only enable participation on a specific issue (e.g. mobility, culture) on the other hand. Next to this difference in scope, there was also a difference in the degree of influence that the citizens truly have in the decision-making process. With focused-scope platforms, the administration will thoroughly process the ideas of the citizens and even provide some additional participation opportunities (such as Crowdfunding to invest in the projects). However, with the large-scope platforms, this processing will be more challenging depending on the resources of the administration. Furthermore, no real mechanism of feedback or additional participation opportunities are provided by the city.

Thanks to the analysis of three different cities, the framework allowed us to describe two relevant dimensions to consider when investing in an online platform: the scope of participation and the degree of influence in decision making. In that regard, cities must find a balance between the scope of the "Citizens as Co-Creators" and the impact of "Citizens as Democratic Participants". Currently, the citizens are generating ideas that do not always have a concrete impact on the city's strategy.

VI. Discussion and Further Work

During the design of the CitiVoice Framework, we have reduced the potential threats to validity and reliability of the framework. Regarding the **validity**, we ensured the **content validity** of the framework by extracting the framework categorization from 3 different sources: an exhaustive study of the literature, an analysis of secondary sources, and in-depth interviews with relevant stakeholders of Belgian Smart Cities. As such, the three main categories of CitiVoice (described in Section IV) provide an holistic view on citizen participation. In addition, the structure of the framework is flexible enough to be extended with new criteria and dimensions as the smart city domain is innovative and still developing. Note that citizen participation strategies can be implemented in several ways from different perspectives. Therefore CitiVoice's categories are complementary in order to reflects this diversity of choices and the different participatory opportunities that a city can invest in. Furthermore, the three categories of CitiVoice should also be considered as independent as one city could invest in one category and without influencing the two other ones. Of course, certain correlations could be determined but this will be discussed in the theoretical implications. This strategic look at citizen par-

ticipation investments opportunities (or "Dashboard" view) represents a theoretical novelty of this paper and will be further discussed in this Section. In order to ensure the **construct validity** of the framework, we ensured that each criteria indeed measures one of the three participation categories. Therefore, as described in the Section IV, we heavily relied on previous studies to formulate criteria that measure the category.

Regarding the **reliability** of the framework, we ensure that CitiVoice measures citizen participation consistently and precisely thanks to the refinement through the different validation steps of the design cycle. We applied the framework to 5 different cities with high heterogeneity regarding their smart city strategy maturity (see Table 2) and we reached saturation in the final step., i.e. through the application to Brussels and Mons. Furthermore, the interviews were conducted with stakeholders from different backgrounds and thus different perspectives on citizen participation (see Table 1). Finally, we limited subjective perception of data by validating with the stakeholders themselves the evaluation of their city.

After discussing the validity and reliability of CitiVoice, we will now reflect on its theoretical an practical implications.

A. Theoretical Implications

The first theoretical implication resides in the theory-building of metrics to evaluate participation. Indeed, the application of the CitiVoice framework to smart cities uses a very simple evaluation metric, uniform to all criteria. This application enables the evaluation and comparison of several smart cities. Although this simplicity facilitates the use of CitiVoice, it may be needed to have individual and more precise metrics for each criterion to provide a more specific evaluation in order to limit threats to validity. This implies the further elaboration of theories on citizen participation, as no ready-made set of metrics is available today. The metrics could furthermore be scaffolded according to a maturity model for evaluating each criterion. For example, the evaluation of the "Implementation of Open Data Strategy" or "Use of Open Data by Citizens" criteria could build on the work performed by (Lee and Kwak 2012). As future work, mechanisms to automate the measurement of the suggested criteria will require further theory-building. Some citizen data, e.g. the number of projects submitted to online platforms, could be gathered automatically in the process to complete information about some criteria (e.g. "*Use of platform by citizens and impact on public life*").

The second implication of the framework resides in making the term citizen participation for smart cities more explicit and tangible. Indeed, we were able to identify and validate three main participation categories. The theoretical novelty of this identification is that we consider citizen participation as a policy area in which investments can be made in different directions. The "dashboard" way to look at citizen participation (especially demonstrated in the comparison use of CitiVoice) differs from "sequential" ways to look at citizen participation. In a sequential process of participation, the first step would be to install an ideal setting for participation, then to consult citizens for ideas and finally to take their ideas into account during decision-making. In that way, we differ to the sequential process of participation often depicted in literature by looking at the phenomenon as a Dashboard with different investments to be performed. Indeed, some cities would prefer to invest in co-creation projects whereas other would prefer ICT infrastructure projects. The possible correlations between the participation categories would constitute a very interesting avenue for further research. The analysis of the three Belgian cities reveal that democratic participation seem to be under-investigated. This finding should also be validated and further explored in future research. However, this theoretical novelty also introduces an inherent limitation as CitiVoice does not capture the pre-conditions of participation. However, this first step is important as well for the participation of citizens to be effective: the citizens must be informed and have the capacity to participate, the administration must be ready to integrate this new stakeholder and the citizens must be motivated to participate. Each of these pre-conditions might require further research as it will probably influence the participation activities that the city will implement.

Finally, CitiVoice also constitutes a theoretical contribution for helping to find gaps in the literature, e.g. by finding that some criteria are under-investigated in current research. As numerous smart cities exist and this field is continuously and rapidly evolving, future research is needed determinate if are other perspectives from different research fields or other smart cities that are relevant to refine and improve each category.

B. Practical Implications

CitiVoice also provides practical implications as it allows stakeholders to make better decisions about participation. As shown in the diversity of profiles of the interviewees, citizen participation is in fact not only about citizens but also impacts a multi-stakeholders ecosystem that includes:

- Public Servants: The integration of citizens' input is a challenge that has to be integrated by the public servants in order to rethink their internal processes. Administrations tend to have a hierarchical functioning which can be incompatible with the networking approach of working with citizens. Therefore, it is not surprising to see failure of participatory projects if the internal functioning of the cities is not ready to integrate this additional layer of complexity.
- Political Representatives: The political representatives show two contradictory attitudes regarding citizen participation in smart cities. On the one hand, they sometimes push the administration to engage in such projects due to the visibility of smart city projects. On the other hand, they are sometimes not completely committed to take the voice of the citizens into account because they fear that the participation of citizens will be limited to negative complaints and personal comments. There is thus a need to convince representatives about the usefulness of citizens' comments.

- ICT Managers: A strong tendency in Belgian smart cities is to assign the responsibility to implement the smart city strategy to the ICT Managers of the administration. This constitutes an opportunity and a threat. The opportunity exists that it allows re-using the best practices from e-government strategies and not to disconnect the two areas. The threat exists in falling back on the technology-oriented conception of smart cities.

With CitiVoice, we also intend to provide some practical implications for all the pre-cited stakeholders. After the interviews conducted for this study, stakeholders from two cities (Brussels and Namur) have underlined the usefulness of the framework to guide them in their strategy (for Brussels, for a participatory budgeting project and for Namur, for a Living Lab project). By establishing a "dashboard" overview of citizen participation categories, we help stakeholders to think about their participatory strategies in an holistic way. For instance, the Democratic Participation category leads the interested stakeholder to think about the ideal organization of participation activities (representativeness, facilitators,…) and to truly implement activities that will have an impact on decision-making in order to avoid manipulation or simple consultation. As far as Co-Creation goes, CitiVoice provides an inventory of co-creation methods to guide the interested stakeholder. This inventory enablers the stakeholders to develop a multi-channel strategy to reach the whole population. Finally, for ICT Use, the framework enablers stakeholders to invest or redirect ICT infrastructure investments to really think about the potential value they have for citizens.

The three uses of the framework also have practical implications in line with the three applications of CitiVoice described in Section V. When used as an evaluation tool, stakeholders can use the framework as lens to analyze the strategy ex-post. Such analysis will reveal missing elements (for instance, no facilitators in group discussion), and provide stakeholders with a clear view on the orientation of participation of their current smart city. Furthermore, thanks to the potential automation of the criteria, it will provide practitioners with easy-to-read status reports of their participation strategy. Using CitiVoice as a governance tool ex-ante allows to guide stakeholders for specific projects. For instance, the city of Brussels used this framework in a participatory budget activity: they used the guidelines of the democratic participation category (presence of facilitator, impact in decision-making, representativeness of participants) to improve their strategy. Ultimately, they decided to use a multi-channel approach to enable the co-creation of projects with citizens (by using online platform and workshops). Finally, the comparison of several Belgian smart cities with CitiVoice led to the formulation of consolidated guidelines for the formulation of the smart city strategy of Namur. Furthermore, especially with the automation of data collection, a dashboard summarizing this comparison (depicted in Figure 3) will allow stakeholders to take empirically-grounded decisions with this information.

VII. Conclusion

To answer the research question *"How can a city enable the participation of its citizens to become a smart city",* this article contributes on several levels. Firstly, a critical state-of-the-art evaluation was performed in order to summarize enablers of citizen participation in the smart city. New means of participation were also provided through the study of other fields of research. Three main means of participation were identified: citizens as democratic participants, citizens as co-creators and citizens as ICT users. This state-of-the-art will provide a solid theoretical basis stimulate research to determine new means for participation. Secondly, a framework to structure and evaluate citizen participation in smart cities was designed based on the aforementioned state-of-the-art: the CitiVoice framework. This framework can be helpful in different ways. For instance, CitiVoice was applied as evaluation tool to the case of three Belgian smart cities: Namur, Mons and Brussels. Furthermore, structuring the participation in Namur allowed providing some governance recommendations to make "Smart Namur" more citizen-oriented, and also provided some general recommendations for smart cities. A last interesting that has been demonstrated was the comparison of several smart cities according to the main categories of the framework. Thanks to the guidance of the framework, a structured comparative tool was suggested to compare best practices among different smart cities. Finally, we expect this paper to have relevant implications for research as it provides a structuring tool to analyze citizen participation in smart cities. Both the findings of the literature review and the CitiVoice itself are expected to help future interested researchers to tackle other aspects of citizen participation in smart cities. We also expect the paper to have implication for practices as the framework constitutes an interesting evaluation, governance, and creativity tool that could influence ongoing and future smart city strategies as it is currently done for the case of Namur.

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