Empowered Cities? An Analysis of the Structure and Generated Value of the Smart City Ghent

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Abstract Smart cities have gained momentum as a conceptual model which embodies a fresh wave of techno-optimism and emphasizes the positive effects of ICT and other innovative technologies in a city, often in combination with multidisciplinary collaborative partnerships. This article assesses a series of six smart city initiatives within one local city ecosystem by proposing a conceptual framework which is then used to analyze the architecture, value flows and contextual dimensions of the smart city Ghent. The results of our analysis show the multi-level collaborative value creation potential in a smart city and shed light on the complexity of these processes. The main conclusion is that current smart city initiatives face the challenge of evolving from demonstrators towards real sustainable value. Smart cities often have a technological deterministic, project-based approach, which forecloses a sustainable, permanent and growing future for the project outcomes.

Keywords Smart city • Multi-stakeholder network • Collaborative value creation • Living labs • Innovation ecosystems

1 Introduction

Cities are becoming the main locus of society. Worldwide, population has been steadily concentrating in cities. In Europe, more than 70 % of the population now lives in urban areas [1]. These demographic changes have an impact on the way society is being organized. On the policy level, cities are increasingly positioned as the main center of political action. To quote New York's major Bloomberg: "while nations talk, cities act" [2]. Cities indeed play an increasingly important role in the lives of the vast majority of people and are becoming a central platform for

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knowledge exchange and value generation. At the same time, we are facing grand societal challenges such as global warming, congested traffic, ecological challenges, aging populations, economic challenges, etc. Although these challenges transcend regions, nations and continents, cities are often seen as the main driver for change and most relevant when it comes to tackle these challenges.

In this article, cities are approached as organic ecosystems, which strive to become 'greener' (with smart energy, smart environments and smart mobility), and more 'liveable' (with smart health, smart education and smart living/working), increasing the overall quality of life for city inhabitants [3, 4]. Recent technological evolutions have also fostered a fresh belief in the positive effects of ICT and other innovative technologies in a city. The combination of smart (technology enabled) solutions to meet the grand societal challenges and the focus on the city as the main driver of change led to the concept of the 'smart city'. Although its definition is still subject of debate, it has been increasingly stimulated by (trans)national governments (e.g. the European Commission) and international networks (e.g. EuroCities) over the past years. The availability of funding and emerging enthusiasm about the first smart city success stories has led to a boost in smart city initiatives worldwide. Despite the support for these initiatives, however, only little research exists on the actual value creation and value creation potential of smart cities.

This article assesses a series of six smart city initiatives in Ghent (Flanders, Belgium) to determine in which way and to what extent public and economic value is being created. First, the article provides a brief overview of the evolution towards a smart city and the different definitions of the concept. Next, we analyze some of the main dimensions which appear in smart city (related) literature and propose a conceptual framework, mapping the different actors and the setup of smart city initiatives. This enables us to assess six smart city projects within the city of Ghent with a focus on how value is being generated and processed.

2 The Journey Towards a Smart City

In the second half of the 1990s, Internet caused huge optimism regarding the possibilities of ICT for the improvement of everyday life. For the relation between the citizens and the city, the most prominent example of this uncurbed techno-optimism was the 'e-government' hype [5]. Although the concept of e-government is steadily fading away on the academic and public agenda, most of the promises related to this concept were not realized. The emergence of the next generation web platforms [6] fostered a new era of promises, this time focusing on the democratic potential (e.g. transparency and participation) rather than on governmental services [7]. Democratization of data, for example, allows increased transparency and stimulates participation and interaction between governments and their citizens. Also important in the evolution towards a smart city is the emergence of new technologies to measure and interconnect different dimensions of everyday life, the so-called internet of things.

Besides changing demographics, politics, technological evolutions and societal challenges, economic reality is changing as well. Especially in the domain of

Table 1 Main catalysts for the emergence of smart cities

Changing demographics	A strong rise of people living in urban areas
Changing politics	Cities becoming central actors for social, economic and political change
Grand societal challenges	Climate, mobility, ecological challenges, aging populations, economic challenges, etc.
Techno-optimism	Internet, e-government, web 2.0, internet of things, (linked) Open Data, etc.
Pressure to innovate	Open innovation, increased competition, innovation spiral, etc.
Policy support	The importance of funding and governmental support
City marketing	'Smart' as an appealing attribute for the city as a brand

new media & ICT, rapid technological evolutions, shorter product life cycles, globalization and increased competition have put high pressure on companies, forcing them to innovate in order to survive. This has led to an 'innovation spiral', which means that ever more innovations come to the market, although this also implies an increasing amount of failures [8]. Frissen and van Lieshout [9] refer to this phenomenon as an 'interesting mix' between massive market failures and groundbreaking innovations. In this context, smart cities are trying to stimulate innovation and tailor innovations to the needs of their citizens by stimulating collaborative development of innovations with multiple stakeholders.

Another catalyst in the emergence of smart cities is policy support. Smart city projects are most often relying on funding (see later). Also, and finally, the notion 'smart' is becoming a popular attribute which a lot of cities want to identify themselves with, relating the phrase 'smart city' to city marketing as well (see Table 1).

3 Defining Smart Cities

Literature on urban development shows various concepts for labeling the integration of ICT in civic planning and management, such as 'intelligent cities', 'digital cities', 'ubiquitous cities' or 'smart cities'. This section elaborates on these closely interconnected concepts.

The concept '*smart cities*', although often used as a marketing concept by both cities and businesses to envision a city of the 'future', emphasizes the growing importance of digital technologies in the city to make it more 'green', more 'accessible' and more 'liveable'. Caragliu et al. [3, p. 50], state that a city is smart when "investments in human and social capital and traditional (transport) and modern (ICT) communication infrastructure fuel sustainable economic growth and a high quality of life, with a wise management of natural resources, through participatory governance". In other contexts 'smartness' refers to context-aware systems, ubiquitous computing and Internet-of-Things technologies [10].

Other authors use the concepts '*ubiquitous cities*' or '*U-cities*' to refer to "a next generation urban space that includes an integrated set of ubiquitous services: a convergent form of both physical and online spaces" [11, p. 143], emphasizing

the importance of involving the citizens in development of U-City services (e.g. Helsinki's Virtual Village, U-Seoul and the Lower Manhattan project) [12]. Finding a match between the needs of the citizens of U-cities and the right ubiquitous services is put forward as a critical success factor [11, 13].

'*Digital cities*' are "extensive information systems (including network infrastructures and applications running on them) that collect and organize the digital information of the corresponding 'physical cities' and provide a public information space for people living in and visiting them" [14, p. 144]. Ergazakis and Ergazakis [15] state that these 'digital cities' should offer innovative services targeting various stakeholders that are inherent to a city environment (administrations, citizens and businesses), focusing on interactions between different city stakeholders [15, 16]. Similar to the notion of digital cities is the idea of '*intelligent cities*', which aims at uniting, promoting, acquiring and stimulating diffusion of information. In order realize this, an 'intelligent city' should develop and implement electronic and digital technologies in the city [17].

In smart cities, these collaborative digital environments facilitate the development of innovative applications, starting from the human capital of the city, rather than believing that technology as such can transform and improve cities. Another important dimension is the collection of all sorts of data and information through sensors and sensor networks. Under the moniker 'Open Data', this information is made public and put to use in 'smart city' applications and technologies that visualize, transform and utilize this data [18]. Smart cities focus on the involvement of all relevant stakeholders, whereas 'digital cities', 'wired cities' or 'ubiquitous cities' stress the presence of technological infrastructure. In other words, a city needs to be 'digital', 'wired' and 'intelligent' in order to become 'smart', although being 'digital', 'wired' and 'intelligent' does not automatically imply that the city will become 'smart' by itself.

While both research and policy often promise disruptive solutions, improvement of life in the city and economic growth, there is a vast lack of evidence concerning the actual value that is being created in a smart city and the processes that allow the exchange of value and knowledge. In this article, a smart city is considered as a collaborative ecosystem allowing for the co-creation of sustainable, future proof innovations that improve life in the city and boost the economy, in which technology plays an enabling role. Because it is often difficult to assess or define this concept in actionable, tangible elements, we will make this assessment based on six smart city projects in the city of Ghent.

4 A Framework for Analyzing the Structure and Generated Value of a Smart City

4.1 Smart Cities as an Ecosystem

The collaborative nature of smart cities is related to the Living Lab-concept and the quadruple helix-models for innovation. Triple and quadruple helix-models, deal with collaboration between universities, government, industry, and end-users, in

this context citizens [19]. Co-operations like these have been claimed to facilitate exchange of ideas and technologies, with fewer barriers between academia, end-users, policy and industry [20]. This approach is very similar to Living Lab literature. Living Labs are ecosystems in which end-users and other relevant stakeholders are involved in the development of an innovation over a longer period of time using a combination of different research methods, following an iterative process [21]. Living Labs facilitate university–industry relationships, but also relationships between large companies and SME's, start-ups, entrepreneurs, and, most importantly, involve the end-users themselves, commonly referred to as public–private–people partnerships (4P's) [22]. Various Living Lab authors stress the importance of collaboration and knowledge support activities as cardinal to a successful Living Lab [23, 24]. These collaborative ecosystems promise to contribute to the facilitation of knowledge exchange among the ecosystem actors. In line with the above collaborative ecosystem literature, this chapter conceptualizes knowledge as both information (e.g. data), expertise (latent) and skills (e.g. coding).

Cosgrave et al. [25] connect the multi-stakeholder aspect of Living Labs to the concept of '*innovation districts*', small regions which cluster innovative actors such as start-ups, creative industries and venture capitalists. These "pockets of growth" are characterized by inter-firm collaboration and governmental support. In EU programs such as i2010 and Europe 2020, the importance of smart cities is highlighted, and the Living Lab-approach is considered a best practice in this context as it enables structuring user interaction by keeping users continuously involved in making better products and services while their expectations are continuously monitored and reflected upon in a systematic process [26]. Consequently, collaboration between all smart city stakeholders requires a user-driven and user-centric research approach to replace a more technology-centric approach. Based on these concepts, the proposed smart city framework includes four types of actors (1) *policy*, (2) *citizens*, (3) *research* and (4) *private partners* (see Fig. 1).

4.2 Policy

The policy actor is present at several levels. The most active policy level is the city government, but smart cities are also being supported on a regional level and on the (inter)national level as well. Smart city initiatives help these governmental levels to reach policy goals. An important actor is the European Commission, which put the idea that European cities should become 'empowered' or 'smarter' forward as one of the core inspirations of the European Digital Agenda, "which seeks to recognize the power of urban planning and the role of ICTs in managing infrastructures" [27]. Horizon 2020, the EU's new research program for 2014–2020 encompasses a €80 billion package for research and innovation funding. Horizon 2020 will support the development of ICT in Science (in future and emerging technologies or e-Infrastructures); in industrial leadership (such as smart systems, robotics, photonics, etc.) and in societal challenges (such as eHealth, eGovernment and eSkills.) Also, international organizations such as the OECD (Organization for

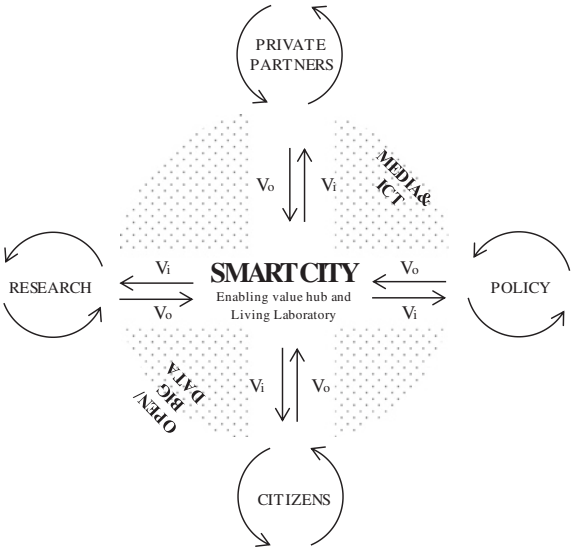

Fig. 1 Conceptual model of a smart city

Economic Co-operation and Development) [28], and UNESCO [29] have started to promote open access to information and knowledge, thus stimulating open innovation and smart city initiatives.

4.3 Citizens

End-users and citizens have been increasingly emancipated on different levels. In the domain of new product development, R&D departments rely increasingly on user input and collaboration (e.g. the use of *Lead Users* [30]). Innovations are no longer (solely) developed top-down, but are increasingly shaped and molded bottom-up [31]. End-users and citizens have also become emancipated when it comes to the creation and distribution of products, services and media themselves, indicating a power shift from traditional industries towards the people [32]. Another evolution that supports more citizen or user-centric paradigms and projects is the criticism on technological-deterministic discourses [33]. In smart city projects, one of the challenges is to transcend the technological-deterministic discourse by actively involving all stakeholders that can provide substantial input for developing a more accessible, information based, interactive and participatory urban environment.

In this context, *Web 2.0* is an important medium that creates a new degree of agency in constructing engagement with online resources, with other internet users, with open innovation [34] and with 'collective creativity' [35]. Web 2.0 also demolishes the idea that innovation is a proprietary activity conducted inside organizations in series of managed steps and entails ceding control over decisions

about the content of products or services to networks of (online) citizens who interact with one another. Web 2.0 is "characterized by new forms of interaction with users who now play a key role in the content-creation and innovation processes" [36, p. 43], and consists out of a set of tools and a collection of social processes originating out of online communities and networks [37].

4.4 Research

At the academic level, smart cities have been looked at from different domains and backgrounds. It is a cross-disciplinary concept which covers urban studies, economics, political studies, city planning, engineering, sociology, communications as well as user research. This is one of the main reasons why it is difficult to find consensus on the actual definition of the concept. When it comes to the role of the research actor in the smart city ecosystem, [38] consider academic researchers as a necessary actor because they provide expertise in user research and knowledge. The triple and quadruple helix concepts also stress the importance of universities as a distinct actor in the innovation ecosystem [19, 20, 25, 39]. Moreover, the contribution of academia is not limited to user research; it can also include research on technical topics or policy and business related issues.

4.5 Private Partners

Innovation is becoming increasingly important for companies to remain competitive. However, high flop-rates still illustrate the need for an adequate management of innovation, which includes selecting the right tools and methods in order to structure and optimize innovation processes [40]. Traditionally, innovation was viewed as an inherently closed process with most operations running inside the boundaries of the company and R&D processes taking place in secretive in-house laboratories. More recently, this closed, vertically integrated model has been challenged and replaced by a distributed view on innovation and innovation management [41]. Smart cities serve as an innovation broker, connecting different stakeholders, allowing for real-life validation, ideation and co-creation. They create a framework for open innovation [34] continuous innovation [42] and systemic innovation [23].

In the smart city as an ecosystem, value and affordances flow between the different actors (see Fig. 1, indicated as V_i and V_o). In our conceptual framework value consist out of two dimensions: *socio-economic value* and *affordances*. Affordances can be conceptualized as 'what one system provides to another system', in the case of this article, as what a city system provides to its users, its citizens or other smart city actors. An affordance also encompasses the perceived functional significance of that system for an individual. For our purposes, we use

the definition of affordances by Norman [43], describing them as: "the perceived and actual properties of the thing, primarily those fundamental properties that determine just how the thing could possibly be used" (p. 9). An illustration in a smart city context could be the online co-creation of a city service, which enables citizens to interact with their city (affordance 1), opening this process to local entrepreneurs, which enables them to generate business out of this (affordance 2). In our analysis, these affordances are approached as 'enabling dimensions'.

A relevant conceptual model for '*value*' can be found in literature on business modeling. For example, [44] proposes a tool to model the relationship between the value of new ICT products or services and the control over new ICT products or services. In our analysis, a distinction is made between the generation of public value (e.g. safer streets) and economic value (e.g. generation of revenue). The concept of '*public value*' refers to the value that is generated through the creation and implementation of services and technologies that adequately harness opportunities within the city, tackle societal challenges and/or realize policy goals [33]. It refers to, for example, reducing traffic jams, emancipating citizens, increasing neighborhood cohesion, etc. '*Economic value*' on the other hand covers economic metrics such as the annual economic growth of cities and companies within the city, a decrease in unemployment, the extent to which new businesses (start-ups) are being generated and able to survive, a reduction of bankruptcies, an increased competitive advantage, attracting existing businesses to the city, etc.

As discussed in the introduction, two other frequently occurring smart city attributes are the use of technology (ICT, internet of things, etc.) and the integration of Open/Big Data. Therefore we also take these contextual dimensions into account when analyzing smart city ecosystems.

5 Methodology

In the next section, we will apply this conceptual framework on the city of Ghent as a smart city ecosystem. Because of the long-term nature of smart city projects, the exploratory nature of our research a multidimensional comparative case-study analysis seems the most suitable approach to make the assessment [45]. Case study research excels at bringing an understanding of a complex issue and can extend knowledge or add strength to what is already known through previous research. On top of that, case studies are most suited for processes which are poorly understood and lack a (solid) theoretical foundation [46], allow to analyze the process open-ended and on multiple levels [45] and gain deeper qualitative insights. Yin defines the case study research method as an empirical inquiry that investigates a contemporary phenomenon within its real-life context; when the boundaries between phenomenon and context are not clearly evident; and in which multiple sources of evidence are used. Given the complexity of the studied phenomenon, the multiple levels of analysis and the participation of the author team

in the studied smart city projects, the multidimensional comparative case-study design seems most appropriate.

For our case study analysis, six smart city projects were selected using three criteria, the project had to (a) take place in the city of Ghent; (b) be referred to as a 'smart city project' in the project documents and (c) have a collaborative nature. Both finished projects and running projects were taken into account. As research partners in the selected projects, we were able to use both research results (documents) as well as our own experiences (participatory observation/action research) and lessons learned (soft data). The following hard data sources were used for our analysis: (a) meeting reports of steering committees, (b) the initial project proposal and project reports and (c) deliverables from the projects.

The presented conceptual model is applied in three ways. First, the ecosystem architecture (actors) is studied for each of the six smart city projects. Next, the incoming and outgoing value is studied. Finally, the six cases are analyzed on eleven parameters;

- involvement of the full smart city ecosystem
- intensity of the network collaboration
- reuse of knowledge
- importance of Big Data
- importance of Open Data
- importance of technology
- generated economic value
- generated public value
- potential for civic engagement
- knowledge valorization
- sustainability.

5.1 Research Context

The City of Ghent has developed a long-term strategy until 2020, comprising five strategic goals. Knowledge and innovation is one of these goals. In the light of the development of smart cities and the empowerment of smart citizens, a long-term strategic program 'Digitaal.Talent@Gent' has been set up. This program supports the strategic mission of the administration and the city council: "Ghent, a creating city in the development of a sustainable, solidarity and open society by uniting all creative forces" [47, p. 1] . In this regard, different objectives have been formulated around 'knowledge, innovation and creativity', 'social sustainability', 'economic sustainability' and 'ecological sustainability'. In specific, Ghent is involved in setting up open platforms to help develop innovation ecosystems (for and by active user involvement) accelerating the move towards smart cities and providing a wide range of opportunities for sustainable services that are developed, implemented and used for and by citizens and businesses as co-producers.

5.2 Selected Smart City Projects

Citadel.[1] Citadel (on the Move), is a European project that aims to make it easier for citizens and application developers to use Open Data to create innovative mobile applications they want and need. Currently, open governmental data is often difficult to access and use, even by the developer community. Citadel aims to lower this barrier by (a) creating formats that make it easier for local governments to release data in useable, interoperable formats and by (b) providing templates that simplify creating mobile applications. These templates should provide a simplified route to smart service development for non-developers who have great service ideas.

Ghent Living Lab.[2] Ghent Living Lab (GLL) is an open collaborative network led by the City of Ghent. Key partners include the local government and its service partners, iMinds (Flemish organization that supports innovation in media and ICT), all major colleges and universities in the city and local (developer) networks and community organizations. GLL acts as a facilitator between the different parts of the collaborative network that has been established between the research community, businesses, the public sector, citizens and the wider community. Its primary focus is on smart cities and the development of Future Internet related services to support the further development of smart cities. GLL serves as a learning platform and as a test and development environment in a real-life environment. In this way, GLL becomes a tool to work with researchers, entrepreneurs, citizens, digital creative forces and the City of Ghent on joint trajectories in function of product development, research, service delivery and policy strategy. GLL is also an effective member of the European Network of Living Labs.[3]

Zwerm.[4] Zwerm was part of the European project SMARTiP.[5] This city intervention/game took place in two neighborhoods in Ghent. It wanted to support 'smart engagement' and establish a meaningful and stimulating contact between citizens and their neighborhood. Zwerm had two overarching objectives: (a) activate citizens around urban places of interest and motivate them to carry out assignments that are beneficial to the community, meanwhile emphasizing neighborhoods as the place where citizens can meet each other, and (b) encourage a better take-up and use of ICT while helping to develop the information society.

Mijn digitaal idee voor Gent[6] **(MDIVG)**. In the same SMARTiP project, a crowdsourcing platform was launched to gather and generate 'wild' ideas on smart engagement, but also on mobility and environmental solutions for cities. MDIVG

[1] http://www.citadelonthemove.eu/

[2] http://www.ghentlivinglab.be/en

[3] http://www.openlivinglabs.eu/

[4] https://www.zwermgent.be/

[5] http://www.smart-ip.eu/

[6] For academic research on this project see [65, 66].

involved about 5,500 citizens, the city of Ghent and iMinds (looking to benefit from the crowd input). The intermediation platform or 'crowdsourcing enabler': Mijndigitaalideevoorgent.be enabled selective and creative crowdsourcing (see [48]) based on the proprietary software of UserVoice (http://www.uservoice.com). The platform was open to answers on the question 'How can ICT make it even more pleasant to live in Ghent?' between April 1st and May 15th 2011. In this period the website was visited by 5,451 unique visitors and counted 17,873 page views. More than 1,400 people registered their e-mail on the platform, enabling them to submit an idea or cast votes on already submitted ideas. A total of 128 ideas were submitted, which received more than 4800 votes.

Apps for Ghent.[7] This hackaton event, organized by the City of Ghent, iMinds Multimedialab (Ghent University) and OKFN[8] wanted to stimulate the use of Open Governmental Data provided by the City of Ghent. By doing so, the city wanted to increase governmental transparency and stimulate citizen entrepreneurship. The idea is that by providing both professional and amateur developers with data, it will fuel the creation of innovative applications. The event was a 'hackaton' where developers are challenged to create the best application. Participating teams were brought together and allotted a fixed timeframe to develop a prototype or mock-up of an innovative application within a city context. The winning team of the 2012 edition created an application which connects neighborhoods to cultural activities.

Future legends.[9] Future Legends was a Living Lab project, instigated by the City of Ghent, which capitalizes on the lifestyle of Flemish young people from urban areas and the outskirts of the city. These young people are often low skilled and mostly, but not exclusively, of immigrant origin. Research of the REC Radio Centre and the VRT Radio showed that these 'urbans' show limited engagement with the mainstream media landscape. In other words, their own rhythm of life requires an own media pattern and offerings. The bottom up 'Future Legends'-project resulted in a media platform called 'Chase—Music From Scratch' (www.chase.be). This online radio station offers youngsters a platform to express their creativity by participating in the show. Together with professional artists they can compose a playlist and air their own creations.

6 Application of the Framework, Case Study Ghent

In this section, we apply the proposed smart city framework on the different actors for each of the projects (Table 2). We then analyze the different flows of value and affordances between these actors (Table 3). Finally, we compare the selected smart city projects on the different dimensions described before (Table 4).

[7] http://appsforghent.be/

[8] http://www.okfn.be/

[9] http://www.mediatuin.be/projecten/future-legends

Table 2 Application of the framework: actors

	Policy	Citizens	Private partners	Research
Citadel	City government + EU (funding & collaboration)	Low involvement, mainly citizen developers	Providing programming services	Social sciences
Ghent living lab	City government + EU (funding) + ENoLL (EU network)	Focus on citizen participation and empowerment	Involved as project partners (mainly ICT)	Multidisciplinary (technical, creative and social)
Zwerm	City government + EU (funding)	Citizen as a topic of research and co-creator (two neighborhoods)	Providers of technology	Social sciences
Mijn digitaal idee voor Gent	City government + EU (funding)	Citizen as an external source of information	No involvement	Social sciences
Apps for Ghent	City government	Citizen developers	Invited to participate, sponsor and scout talent	Engineering (organizational support)
Future legends	City government + public organizations	Urban youngsters	No involvement	Social sciences

The policy level plays a central role in all six cases, especially the city government, which is part of every project in our selection. The policy actor uses funding schemes and collaborative partnerships to meet its policy goals. Besides the city government, smart city projects are supported by the regional government (Flemish government, through IWT and IWT funded organizations) and the transnational government (European Commission, through special project funding) as well.

Smart city projects do not always approach citizens in the same way. This difference exists on two levels. First, the selected projects *target* different populations. In only two projects, all city inhabitants are being targeted. The other projects target specific niche groups in the city. This subset of citizens can be determined by geographical parameters (such as Zwerm, which was targeted on two neighborhoods), by skills (such as citizen developers) or by sociodemographic profile (such as the Future legends project). Second, *citizen involvement* can be of a different nature. Citizens can be approached as a source of information (GLL, MDIVG), as a provider of services (Apps for Ghent, Citadel) or as a research subject (Zwerm, Future Legends).

Private partners are not always involved in smart city projects (MDIVG, Future Legends). If commercial enterprises are involved, they are providing technological *infrastructure* (Zwerm), *services* (Citadel) or they function as a *partner* that can potentially benefit from the project (GLL, Apps For Ghent). In some of the projects, research actors are *part of the project* and have their own work packages, central in the project (Citadel, Zwerm). In other projects, research activities should

rather be considered as a *side track* of the project (GLL, MDIVG, Apps For Ghent, Future Legends). For the latter, research partners only use the data which is generated within the project for academic analysis, but the research results are not being processed within the project.

Table 3 provides an overview of the incoming (Vi) and outgoing (Vo) value flows between actors in a smart city ecosystem. Most of the flows enable other actors to perform certain tasks and can therefore be considered as *affordances*. These enabling flows or affordances differ in nature. Within the studied projects, we distinguish enabling *funding* (financial support), enabling *environments* (an ecosystem or working space), enabling *services* (activities), enabling *knowledge,* (data and expertise), enabling *networks* (brokerage) and enabling *policy* (stimulation by policymakers). Different scenarios exist in which the four smart city actors play a different role in transforming one affordance to another.

Each 'chain of affordances' starts with the instigation of the policy actor (city), which seeks for enabling funding at the European level (except Future Legends, which was supported by city resources), brings together relevant smart city actors (enabling network or environment) and sometimes provides enabling information (e.g. open governmental data). Next, each case follows a distinct chain of affordances, depending on the goals and configuration of the project. *Cities* pursue creation of public and economic value but only generate public value themselves (implementing city improvements). C*itizens* pursue creation of public value and also generate public value themselves (creating apps or services). *Private partners* pursue creation of economic value but generate public value instead (creating free apps and services). R*esearchers*, finally, pursue creation of public value, but generate no value directly, since this actor only plays an enabling role. Overall, the potential generation of economic value is not (yet) realized.

Besides the different roles in a smart city and the flows of affordances between them, some higher level units of analysis remain to be tackled. Table 4 shows the results of our multidimensional comparative case study analysis. We distinguish four main clusters (a) the collaborative nature of a smart city, (b) the role of knowledge and technology, (c) the overall creation of value, and (d) the future of smart city initiatives after the project ends. The performance levels were coded by the author team, based on project documents and insights gathered through project participation.

6.1 The Smart City Ecosystem

The first dimension assesses whether the full smart city ecosystem is involved in the project or not. As was discussed above, an important element in smart cities is the way research, policy, private partners and citizens collaborate and share knowledge and services in order to optimally develop future products and services with a high sustainability. Nevertheless, only three out of six projects involve all four smart city actors. On top of that, one of these two (GLL) has only set up this collaboration on paper and has not yet rolled out full collaborative projects. The role most often

Table 3 Application of the framework: flows

		Policy (city government)	Citizens	Private partners	Research
Citadel	Vi	Applications for an improved city environment (public value and potential economic value) and policy advise (enabling knowledge)	Opportunity to create own applications (enabling environment, enabling knowledge and enabling policy)	EU funding (enabling funding) and research insights (enabling knowledge)	EU funding (enabling funding)
	Vo	Open governmental data (enabling knowledge)	Applications for an improved city environment (public value and potential economic value)	Creation (enabling service) of an empowering platform (enabling environment)	User research (enabling service) + policy and development advise (enabling knowledge)
Ghent living lab	Vi	Ideas of citizens and SME's towards policy (enabling knowledge) + potential economic and public value creation	Potential to transform ideas into reality (enabling network)	Easy access collaboration with policy, citizens, other SME's and research (enabling network) + ideas & user insights (enabling knowledge)	Potential use cases (enabling network and enabling knowledge)
	Vo	Brokerage/networking ideas with creators (enabling network)	Ideas, feedback, suggestions, opinions, willingness to collaborate (enabling knowledge)	Economic growth/entrepreneurship, (potential economic value) products & services (potential public value)	Enabling user research and product development for non-academic projects (enabling service and enabling knowledge)
Zwerm	Vi	Policy advise (enabling knowledge)	Experimental socio-technical environment (enabling environment)	EU funding (enabling funding) + Information on economic potential for enabling technology (enabling knowledge)	EU funding (enabling funding) + Raw data on citizen behavior (enabling knowledge)
	Vo	Facilitating the city as a laboratory (enabling environment)	Participation and behavioral data (enabling knowledge)	Provision of technical components (enabling environment)	Knowledge on human behavior and policy advice (enabling knowledge)

(continued)

Table 3 (continued)

		Policy (city government)	Citizens	Private partners	Research
Mijn digitaal idee voor Gent	Vi	Ideas of citizens (enabling knowledge)	Empowerment platform (enabling environment)	–	Reuse of citizen input for academic analysis (enabling knowledge)
	Vo	City improvements (enabling policy) + city improvement (public value)	Ideas (enabling knowledge)	–	Insights on citizen participation (enabling knowledge)
Apps for Ghent	Vi	Applications for an improved city environment (public value and potential economic value)	Open governmental data (enabling knowledge)	Open governmental data (enabling knowledge)	Low
	Vo	Open governmental data (enabling knowledge) and stimulate app development (enabling policy)	Apps based on governmental Open Data (public value and potential economic value)	Apps based on governmental Open Data (public, and potential economic value)	Low
Future legends	Vi	Policy advise (enabling knowledge)	Experimental environment (enabling environment)	–	Raw data on citizen behavior (enabling knowledge)
	Vo	Project funding (enabling funding)	Project participation (feedback + behavioral data) (enabling knowledge) and creation of their own radio service (public value)	–	Knowledge on human behavior and policy advice (enabling knowledge)

Table 4 Multidimensional comparative analysis of six smart city projects

	Citadel	Ghent living lab	Zwerm	Mijn digitaal idee voor Gent	Apps for Ghent	Future legends
Involves total smart city ecosystem	Yes	Yes	Yes	No	No	No
Network collaboration	Medium	t.b.d.	Medium	Medium	Medium	High
Reuse of knowledge	Yes	No	Yes	No	No	No
Importance of big data	Medium	Low	Low	Low	Medium	Low
Importance of open data	High	Medium	Low	Low	High	Low
Importance of technology	High	Medium	High	High	High	Low
Created economic value	t.b.d.	Low	Low	Low	Low	Low
Created public value	t.b.d.	Medium	High	Medium	Medium	High
Potential for civic engagement	High	High	High	High	High	High
Knowledge valorization	t.b.d.	Medium	Medium	Medium	Medium	High
Sustainability	t.b.d.	Medium	Low	Medium/high	Medium/ low	High
Potential for economic growth	High	High	Low	Low	High	Low
Importance of funding	High	Medium	High	Medium	Low	Medium

neglected is that of the private partner. This is challenging when the aim is to create economic value and forecloses the sustainability of the developed products and services. Without a private partner, smart city projects have to rely on 'citizen entrepreneurs' or continuous project support by the city government.

6.2 Collaborations

Besides the involvement of all four smart city actors, it is also interesting to elaborate on the intensity of the collaboration between smart city project partners. The downside of involving the full ecosystem is that collaboration between partners

becomes much more difficult and more likely to be less intense. In the selected projects, the city government always acts as the main project coordinator, determining the degree of interaction with the other three actors. Overall, the intensity of collaboration is rather high, which can be explained by the policy goals, which focus more on the collaborative dimension of smart cities than on the technology dimension. For Apps For Ghent, GLL and MDIVG, the main reason for a medium rating on collaboration is the lower interaction with research partners, which are either only using the generated data for academic purposes (MDIVG), only involved for the promotion of the research group (Apps For Ghent) or, as is the case for GLL, have not yet had the chance to collaborate in one of the projects.

6.3 Reuse of Knowledge

This observation brings us to another interesting dimension: the reuse of knowledge. While an increasing amount of smart city projects are being set up, all focusing on efficiency and sustainability, the question rises whether each of these projects generates new knowledge. From this perspective it is important to build upon previous projects and related knowledge. Reuse processes are considered increasingly important for developing high-quality software and ICT projects. As explained by [49], reuse processes can play a crucial role in the success of private entrepreneurial initiatives as well public projects.

Reuse is critical, as it allows working on existing artifacts instead of starting from scratch, thereby enabling the development and deployment of software and services with greater ease. Consequently, time and human effort required to develop software product and pilots can also be effectively reduced. Given the financial crisis across Europe, reuse of ICT-based pilots and products can effectively add to the cost-cutting measures proposed by the public and private bodies. In addition to this, iterative reuse can also have a relevant, verifiable impact on product productivity and quality, as reusing existing artifacts can iteratively improve the quality of the software or pilot. Nevertheless, our analysis shows that only two of the selected smart city projects incorporate reuse of knowledge. Citadel and Zwerm are both part of collaborative European projects in which the reuse of the infrastructure and system logics in other cities is one of the main goals.

6.4 Importance of Big Data

As our society becomes more digital, with key drivers such as social media, mobile devices and sensor networks, we notice a tremendous growth of generated data. This trend is often defined with the phrase ‘Big Data’. There are numerous definitions for the term ‘Big Data’. However, most authors agree that Big Data is a loosely defined term to describe data that has become so large and so complex that they are difficult to process using standard (statistical) software and databases [50]. The analysis

of Big Data can help people interact in a more flexible and adaptive way with their environment [51, 52]. Big Data can be a source of competitive advantage presenting new opportunities to create new business models to monetize data or to customize services to individuals. However, Mantelero [53] also points out that these huge amounts of data represent a strategic and economically relevant asset resulting in a centralized power held only by a few subjects. In the context of smart cities, Big Data can be approached as a valuable resource connecting the dimension 'reuse of knowledge' and 'Open Data'. Smart cities often produce huge amounts of data, be it by opening up (governmental) datasets, sharing research results or capturing data by sensors placed throughout the city. In order to optimally tap into this source of raw information, smart city projects must find a way to cope with Big Data. In our analysis, only two out of six smart city projects take this challenge more or less into account (Citadel and Apps For Ghent). Both projects focus on transforming raw data into actionable services and understandable visualizations. Given the increasing importance of this dimension, there are various opportunities for future smart city projects to focus on harnessing this largely untapped potential.

6.5 Importance of Open Data

Open Data is related to the idea that certain data should be freely available to everyone to use and republish as they wish, without restrictions from copyright, patents or other mechanisms of control. The goals of the Open Data movement are similar to those of other 'Open' movements such as Open Source, Open Content, or Open Access. The term 'Open Data' itself is recently gaining popularity with the rise of the Internet and World Wide Web and, especially, with the launch of open-data government initiatives such as Data.gov. In order to become more innovative and transparent, Public Administrations worldwide are starting up Open Data Portals stimulated by the idea that open government data (OGD) can open up economic opportunities, can promote transparency and accountability or can support the reform of public services and innovation [54]. Similarly, the EU's 'Open Data Strategy for Europe' emphasizes the fact that public administrations are sitting on a goldmine of unrealized economic potential. Therefore, it is not surprising that Open Data is a central dimension in two out of six smart city projects (Citadel and Apps For Ghent). Open Data is increasingly becoming important for smart cities. The market value of the reuse of public governmental data in the European Union is estimated at €27 billion, each year [55]. Similar to Big Data, this potential is nevertheless largely untapped and the actual economic valorization of this estimation still remains to be proven. We should also be vigilant of privacy and security issues concerning open data since these data sources can also be used for malicious purposes. More specifically, triangulating different data sources can pose a threat for the privacy of the individual and revealing governmental data might help to find weak spots in security systems.

6.6 Importance of Technology

A lot of smart city projects have a technological-deterministic nature. They build upon the belief that (new) media and ICT solutions can improve life in the city and that technology is the main driver to solve the complex societal challenges we face in contemporary cities. New technologies allow for rapid, distributed, contextual and personalized information exchange. It connects information from public organizations and becomes remixed, annotated and redistributed by the citizens (an informal network of people). These socio-technological evolutions fostered a strong belief in the possibilities for smart cities. The central position of technology is also present in all selected smart city projects except one (Future legends). Whereas technology certainly enables a lot of new opportunities, it is dangerous to believe that technology as such is sufficient to create a smarter city. This potential can only be harnessed if it is embedded in a social context. Technology can support city innovations, but to think of it as the main driver of social change is only a one-dimensional point of view. In order to overcome the short-term nature of smart city projects and have impact over a longer period of time, the social context should be central in smart city projects. Of our selected cases, Future Legends is the only project which became autonomous after the project ended. Not surprisingly, this project was the only one which used technology merely to serve social innovation.

6.7 Economic Value

In the end, smart city projects aim to generate economic and/or public value. While this is often part of the project legitimations when applying for funding, especially for the European Union, none of the selected cases was so far able to generate any substantial economic value. Although the value of Open Data and open collaborative innovation ecosystems is often put forward as a huge source of untapped potential, reality has not yet provided any substantial proof for this. This is one of the biggest challenges for smart city projects. If these projects are not able to boost economy or even be economically successful to be able to become autonomous, smart city projects will always have to rely on governmental support and funding.

6.8 Public Value

Besides monetary value, the generated value can have a public nature as well. Especially when supported by public resources, this might also be a valid project legitimation. Although the concept of public value is much harder to assess, the selected smart cities projects tend to generate at least some public value. For Zwerm, this value was validated trough academic research, confirming that the project had improved social cohesion in both neighborhoods [56]. The Future

Legends project resulted in both policy advise on the stimulation of culture participation for urban youngsters as well as a community driven crowd sourced radio station [57]. For the other smart city projects, the generated public value is more 'fuzzy' or still needs to be proven. Although the promises and project goals contain the creation of public value for all of the selected cases, it is unclear whether the creation of public value was actually achieved or not. In order to legitimize smart city projects, it is important for these projects to validate the creation of public value by measuring its impact.

6.9 Potential for Civic Engagement

Civic or community engagement is typically defined along a continuum of participation but it goes further than participation and involvement. It also involves capturing people's attention and focusing their efforts [58, p. 5]. Thus, one can distinguish many forms of community engagement, with varying levels of communication, such as providing knowledge to the public, consulting the public, involving the community, collaborating with the community or empowering the community to make decisions and to implement and manage change [59, p. 8]. Scearce [60] distinguishes five dimensions or processes in engagement:

- Listening to and consulting the crowds: e.g. online conversations and openly asking for advice
- Designing for serendipity: Creating collaborative environments, in person and online
- Bridging differences: Connecting people with different perspectives
- Catalyzing mutual support: Helping people help each other
- Providing handrails for collective action: Giving enough direction for individuals to take effective and coordinated action.

Based on these dimensions, she formulates best-practices related to the social potential of ICT on (a) a 'macro-level', creating a 'public sphere' that enables people in a society to communicate with each other about their positions as citizens and that helps them to act as a political entity; (b) an 'intermediate-level', creating more or less institutionalized and sustainable, but not necessarily formalized, interaction networks of individuals having the same or a similar social position, interests or desires; and (c) a 'micro-level' where ICT has become an important source for the development and acquisition of social capital [61–63].

Because smart cities aim to stimulate 'smart citizenship', they often focus on the empowerment of citizens and improving civic participation, interaction and engagement. All six smart city projects have a high potential for civic engagement. This proves that the above dimensions play a central role in smart cities and that these projects are fully incorporating the stimulation of civic engagement.

6.10 Knowledge Valorization

This dimension assesses the overall valorization of knowledge and surrounding affordances. Although the goals of smart city projects are often very promising, for most of the cases, evidence of solid, sustainable and meaningful valorization of knowledge and enabling processes within the smarty city ecosystem, is sparse. For the selected smart city projects, valorization is mostly of an academic nature (publishing) or serves the purpose of branding a city as an innovative city. Nevertheless, there certainly is ambition to overcome this problem and to stimulate an increased valorization of smart city projects. Through the European projects for example, local developments will be able to be applied in other European cities as well and the Gent Living Lab project aims at bringing together different smart city initiatives in order to optimally make use of the generated knowledge from different projects.

6.11 Sustainability

Sustainability is the main bottleneck of all selected smart city initiatives, with the exception of Future Legends. Smart city projects are often instigated and fuelled by (European) project funding. Once these projects finish, the generated technology, service and/or knowledge disappears. A second threat for the sustainability of smart city projects is technological-determinism. When technology has a central position in the project, the social dimension and the supporting context surrounding the technology are of often neglected. Therefore, most smart city projects have a hard time crossing the chasm from demonstrator towards an autonomous, sustainable product or service which can service without funding.

6.12 Potential for Economic Growth

In the analysis, a distinction is made between the actual generated economic value and the potential for economic growth. This assessment is hypothetical and analyses the potential value of the generated knowledge within the project over a longer period of time, if challenges such as sustainability would be overcome. This allows a comparison between the potential of the project and the actual valorization. In the selected smart city projects two distinct project goals can be distinguished: (a) projects aimed at the creation of public and economic value (Citadel, GLL, Apps For Ghent) and (b) projects aimed exclusively at the creation of public value (Zwerm, MDIVG, Future Legends). Notably, none of the cases merely has economic objectives. The potential for economic growth can be found in the use of Open Data for the development of innovative services (Apps For Ghent, Citadel)

or the collaboration between different stakeholders to co-develop innovative services (GLL). The cases that do have potential for economic growth, however, still have to find a way to realize that potential.

6.13 Importance of Funding

All of the cases with the exception of Apps For Ghent, relied on funding for the kick-start of the project. For the European projects (Citadel and Zwerm) this dependency remains very strong even after the project launched. Without funding these projects (would) seize to exist. The local projects on the other hand rely less on European funding, but the downside of this is that this makes it hard for them to realize their full potential. These projects are governed by the city government, but the officials that are working on these projects have only little or no resources (especially time) to do so. In the case of Apps For Ghent, and especially GLL, promises and opportunities are very high but both projects lack the resources to harness these opportunities to their full potential. The Future Legends project is somehow exceptional in the sense that this project is fully supported by the community and no longer needs external support.

7 Conclusion and Discussion

The concept of a 'smart city' is a container of promises. It holds the belief that cities can and should act as smart collaborative ecosystems, enabled by state-of-the art technology. It envisions cities as laboratories and drivers for social change. In reality, however, a lot of the promises and the potential of a smart city still remain to be proven on multiple levels. In this chapter, a conceptual framework is proposed which enables the analysis of the architecture, collaboration and different dimensions of smart city projects. When this framework is applied to a set of smart city projects in one local ecosystem, different lessons concerning the current state of smart cities can be learned. By making an overarching analysis of six smart city projects in the city of Ghent, the analysis affords an assessment of the overall 'smartness' of a city.

Although smart cities claim to go beyond technology and to have a citizen centric nature, reality shows that a lot of smart city projects still have a rather technocentric nature (e.g. placing sensors). While collaboration is central in smart cities, not all projects involve all the actors, policy, research, citizens and private partners, in the city. Especially the lack of involvement of private partners and possible business models forecloses the long-term sustainability and economic value creation of smart city projects. Smart cities do have the potential to enable multi-stakeholder collaborative value creation, but therefore they need central governance which stimulates this collaboration, serves as a container for the reuse of

knowledge, potentially through Open Data and thus enhancing the sustainability of the generated knowledge. In this context, [64] put forward the concept of *knowledge retention* as an important process in the context of open innovation, indicating the storage and maintenance of knowledge over time. For the city of Ghent, the goals of GLL are most in line with this governance role. This platform, governed by the city government should act as a central actor in the smart city, allowing for an optimal valorization of public and economic value. But for this, sufficient resources are needed, which is the main bottleneck of current smart city initiatives. Most smart city projects rely heavily on public funding, but this funding only has a temporary nature and therefore forecloses long-term planning and strategies, beyond the projects themselves. So far, smart cities have not (or only little) been able to produce long-term creation of value. Most projects are showcases that prove what might be possible, without actual implementation or long-term integration in the everyday life of the city.

In order to move beyond promises and demonstrators, it is important to keep measuring the actual impact of smart city projects. The proposed framework in this chapter highlights and analyses some smart city dimensions, but actual impact measuring remains challenging. Nevertheless, lots of public funding is being consumed by smart city projects, so continuous monitoring and critical analysis is needed in order to force smart cities to prove their added value.

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