Smart Urban Governance: Governing Cities in the “Smart” Era

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The last four years have gone by so unbelievably fast. The next thing I know, I'll be finishing my PhD study. Looking back at those four years, many things have happened. When I recall past moments, the first thing that comes to mind is that dark morning when I dragged my two big suitcases on to the train from Schiphol Airport to Utrecht. I sat down and could feel the unfamiliar environment both inside and outside the carriage. The darkness imbued me with a sense of mystery. What is going on outside the train? Is this country going to be how I'd imagined it? Will everything be unknown and different? Are the people going to be easy-going? As the train continued on its way, a soft glowing light began to appear in the east and the true face of the Netherlands started to slowly unfold, as though a curtain were gradually being pulled back to reveal a theatre stage. Farms, peaked roofs, lush fields, medieval towns built alongside canals, orchards, smallholdings and hobby farms, modern cities filled with skyscrapers, and cows, cows, cows flashed across my eyes along with the slowly strengthening sunshine. Novelty and familiarity, joy and sadness, confidence and anxiety, ease and nervousness, determination and concern, purposefulness and disorientation, approachability and remoteness—all these complex feelings were triggered by the scene. The way ahead of me was long.

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Chapter 1

Introduction

1.1 Background

Over the past decade, cities, planners, developers, and governments around the world have embraced the concept of the "smart city"—which is predominantly composed of big data (accrued through sensors) and associated information and communication technologies (ICTs)—as a way to help achieve sustainable development goals and improve the management of cities (see Young et al., 2020; Kitchin, 2014, 2019; Benevolo et al., 2016; Meijer, 2016; Batty et al., 2012; Caragliu et al., 2011). It has been argued that advancements in smart city technologies such as big data, ICT, and connected devices not only upgrade the existing, aging infrastructure of a city, but also enable cities to access data and information that was not previously available (Kim et al., 2017; Hashem et al., 2016; Geertman et al., 2015). Moreover, with the help of effective smart city strategies, governments can identify trends in citizens' demands, concerns, needs, and interests and plan for population growth and urbanization (Batty et al., 2012). It is said that by connecting a wide range of electronic and digital technologies to government systems, communities, and city operations, a smart city can bring together technology, government, and society to realize urban sustainability in the following forms: smart people, smart governance, smart economy, smart living, smart mobility, and smart environment (Giffinger et al., 2007; Anthopoulos, 2017; Caragliu et al., 2011).

However, the development of smart cities in practice is not as satisfactory as it is in theory. It has been criticized that smart cities follow a business-oriented model: The creation of smart cities has largely be driven by the profit motive of global high-tech companies (Hollands, 2015). An example of this corporate-led, technology-driven smart city development is the Songdo Ubiquitous-Eco-City, in South Korea. Initiated as part of Incheon Free Economic Zone, the Songdo project is intended to be a new large-scale urban hub that will enable South Korea's economy to compete with economies such as those of Hongkong, Taiwan, and Singapore. According to Mullins (2017), what is unusual about Songdo Ubiquitous-Eco-City is that it is 100% privately owned and funded rather than being controlled and managed by governmental authorities, like other Korean cities. Sixty-one percent of the project is owned by Gale International; the remainder is owned by POSCO (a large Korean steel company) (30%) and Morgan Stanley Real Estate (9%). The project comes under the green technologies and ubiquitous ICT growth strategies. In this process, new technologies are treated as ideal tools for showcasing the green way of managing cities' facilities (e.g., transportation, electricity grid, and water supply). For instance, there are various ubiquitous ("U") infrastructures and services provided by the public and private sectors to local people, such as "U-traffic, U-crime control, U-facilities, U-disaster control, U-environment, and information provision to citizens" (Joo and Lee, 2015). It is expected that by utilizing advanced ICT to integrate ubiquitous environments in urban areas, Songdo Ubiquitous-Eco-City will largely improve the efficiency of city operations and reduce carbon emissions. Nevertheless, it has been shown that a technology-driven approach to improving efficiency and handling environmental issues in the Songdo project is less sustainable in its ability to cope with complex urban issues such as unemployment, poverty among the elderly, social inequality, and increased house prices (Mullins, 2017; Shin, 2016). The highly closed urban system approach does not allow for the kind of bottom-up approach that allows citizens to play a role in shaping the urban fabrics. Shwayri (2013) argues that knowledge generation and policy content in the Songdo project mainly reflect the agreed interests of the representatives of market and government bodies. Furthermore, the high level of big data and urban data analytics has raised concern about surveillance and predictive policing. As a result, authors like Hollands (2015: 62) claim that Songdo Ubiquitous-Eco-City "symbolizes a new kind of technology-led urban utopia."

According to many scholars, building a smart city requires "smart" governance approaches, including new government structures, new relationships, and new processes (Webster and Leleux, 2018; Meijer, 2016; Testoni and Boeri, 2015). Here, smart governance can be generally understood as the capacity to apply digital technologies and intelligent activities in the processing of information and in decision-making and creating innovative institutional arrangements (Scholl and Alawadhi, 2016; Meijer, 2016). It requires reshaping the role of governments, citizens, and other social actors, innovating organizational and decision-making processes, and improving the use of existing and emerging information technologies to conceptualize and frame a new generation of e-participation (Kleinhans et al., 2015; Sandoval-Almazan and Gil-Garcia, 2014; Gil-Garcia, 2012; Sandoval-Almazan and Gil-Garcia, 2012). In this process, governments are strongly urged to rethink the role they can play in a knowledge-based society.

Nevertheless, current smart governance is, in practice, primarily policy-driven, focused on making the right policies to implement technologies in an efficient way (Barns, 2018). In this process, governments treat the smart governance of cities merely as a management issue that can be dealt with through technological and technocratic approaches (Shelton et al., 2015; Stratigea et al., 2015; Ferro et al., 2013). Then, the design, development, implementation, and evaluation of technologies in augmenting governance processes are mainly delivered by high-tech companies. As a result, many artificial intelligence and data analytics tools are simply used to update the current physical infrastructure (e.g., power grids, transportation networks, sewerage and waste disposal systems, the built environment, and other physical assets) and support private interests and a strong economic development (Kitchin, 2019; Datta, 2015; Shelton et al., 2015; Söderström et al., 2014).

A criticism voiced by Verrest and Pfeffer (2019) is that the technocratic way of governing cities and the entrepreneurial form of urban governance lead to an underestimation of the possible negative effects. For instance, citizens' demands and interests have received far less attention than those of the service and technological providers in smart governance development. In some developing countries—for example, India, Bangladesh, and Kenya—urban governance through a high level of big data gathering and analytics is hardly used to deal with social and inequality problems, such as slums and squatter settlements, unemployment, urban sprawl, urban crimes, and urban pollution (Datta, 2015). Furthermore, the use of facial recognition and surveillance in managing traffic flows (e.g., camera security systems and video surveillance solutions in the UK, and "City Brain" in China) have raised privacy concerns and led to a strong sense of control that is condemned by civil liberties organizations.

As a result, studies stress that alternative approaches are needed to transform technocratic city governance and make cities smarter (Verrest and Pfeffer, 2019). For instance, the long experience of planning support ICT studies in handling technological innovations has recently been argued to offer potential insights into the innovative development and application of new ICTs in the field of the smart city and its subfield of smart governance (Geertman and Stillwell, 2020; Pettit et al., 2018). The key statement is that planning support systems (PSS) innovations and applications in urban planning should be closely related to the needs of users and planning practices. According to Vonk and Ligtenberg (2010), there is an urgent need to shift from the traditional systems engineering approach to developing technologies (one objective optimal technical system with optimized functionality), to a sociotechnical approach to developing an optimal system for a particular situation.

Besides focusing on improving the innovation process of technology, authors claim that there is a need to link smart city governance to the "urban issue," since knowledge cannot be simply gained through data-mining and ICT-based urban analytics (Verrest and Pfeffer, 2019; McFarlane and Söderström, 2017; Stratigea et al., 2015). In accordance with

Lefebvre (1991), the urban issue is understood as a set of social relationships, that is, the social production of urban space. "Needless to say, a city is more than its physical form. It is a historical and cultural artifact, a social and political network, and an economy" (Deuskar, 2015). For urban governance to become smart, the development of functionalities, applications, and ICTs in augmenting urban governance should be closely linked to urban issues (e.g., political, social, cultural, historical, and spatial issues) and support a smart urban governance in the service of local communities and ordinary people, rather than a small group of highly skilled experts (Allam, 2018). In other words, "a redefined [smart governance] should be grounded in places—actually existing cities—with their specific populations, resources and problems, rather than start with technology" (McFarlane and Söderström, 2017: 313). For instance, Bolívar (2016) highlights that new and innovative forms of governance should go beyond the traditional institutions and the classical processes of governing, and build new theories based on interactive decision-making, network management, and coproduction theories. Meijer and Bolívar (2016) state that we should analyze these complex interactions between technology and social structure and conceptualize smart urban governance as an emergent sociotechnical practice.

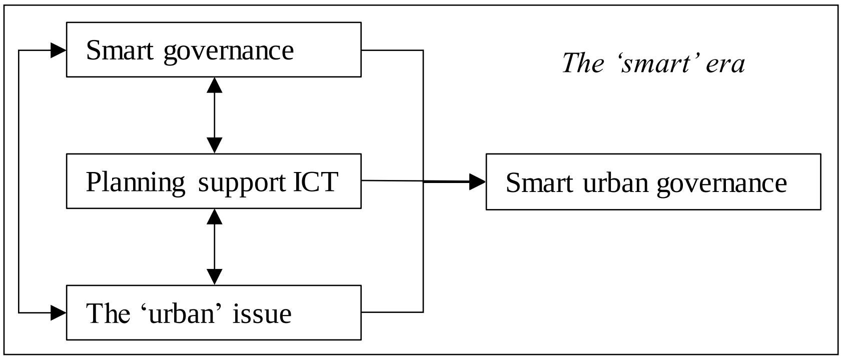

Figure 1.1 The interconnection between smart governance, planning support ICT, the "urban" issue, and smart urban governance.

As a result, two objectives for the research underlying this dissertation were identified:

- To conceptualize smart urban governance that can achieve better governance processes and outcomes in the "smart" era, and
- To investigate the role that ICT can play in smart urban governance.

These two major aims were addressed by answering the following main research question:

How can smart urban governance be conceptualized and what role can ICT play in smart urban governance?

Before answering this question, I first review earlier work in the field of urban governance and ICT-enabled ("smart") governance. Based on that, I look at the work in the planning support field to provide insights into the role of ICT in smart urban governance.

1.2 Theoretical foundations

This section first reviews the multiple perspectives on urban governance. This provides a broader view on the challenges and opportunities faced by cities and city governance. The focus is then put on the smart city and smart governance debate and the question how technologies can be used to develop innovative governance arrangements. Furthermore, a planning support view on the role of ICT in smart cities is given.

1.2.1 Urban governance

The process of national, regional, and local governments and stakeholders deciding on how to govern and manage urban areas is known as urban governance (Devas, 2014; Pierre, 1999). By engaging a range of actors and institutions and the relationships among them, urban governance is expected to open up new ways of thinking about processes of government and urban politics, and promote active citizenship, multiagency partnership working, participation, community empowerment, and urban collaboration (Pierre, 2011). The state is increasingly expected to withdraw from some public activities and share power with other stakeholders in the private sector and civil society. However, in situations such as governing urban transformations, governments at certain levels are still expected to play a strategic role in forging partnerships with and among key stakeholders (Devas, 2004). According to Driessen (2012), by considering the roles of and relations between the state, the market, and civil society, one can identify five ideal–typical urban governance modes, namely centralized, decentralized, public–private, interactive, and self-governance. One example is the governance of city megaprojects through public–private partnerships, in which local governments work together with the private sector and move toward the market, competitiveness, and profit (Hodge and Greve, 2013). A second example is the participatory governance of city–regional environmental challenges, highlighting the importance of democratic engagement and deliberative practices in advancing environmental sustainability (Newig and Fritsch, 2009). From this, it can be seen that urban governance focuses on innovating and reshaping the governance structure and process.

Other authors argue that rather than focusing on the process of governing, more attention should be paid to existing urgent urban challenges (e.g., rapid urbanization, the provision of basic resources, inequalities) in cities and communities (Bulkeley et al., 2016; Loorbach et al., 2016). For these authors, urban issues constitute the "what"—in this case, the content and goal of urban governance—that calls for different political actors to take effective actions to deal with it (Bulkeley and Betsill, 2005). For instance, tackling insufficient housing and traffic congestion caused by intensive urban growth and multiple health hazards created by large volumes of uncollected waste, requires involving the local community in local government and/or building public–private partnerships to create solutions. From this perspective, urban governance is defined as building effective decision-making processes or institutions of information exchange and knowledge enhancement to deal with sustainable urban challenges; in other words, as exploring the outcomes of different institutional arrangements for dealing with sustainable urban challenges (Smedby and Neij, 2013; Holt-Jensen and Pollock, 2009). Instead of taking an analytical or normal view, urban governance shows greater sensitivity to its embedded urban issues and to handling those issues with possible, expedient, or effective governance modes. In practice, an increasing number of empirical case studies consequently focus more on how urban issues get on to the political agendas of cities and local government, when and how they act, and with what effects (Broto, 2017; Certomà et al., 2015, 2020).

On this basis, this dissertation argues that urban governance should bring together these two main strands of discussions, and emphasizes both the "what" (urban issues) and the "how" (the social organization of knowledge and action from different stakeholders) that are central to the challenges of urban governance.

1.2.2 Smart cities and smart governance

1.2.2.1 Smart cities

In the past decade, due to the impacts of rapid ICT developments, the concept of smart cities has been an important policy instrument to enhance the flow of people, goods, and data, augment urban governance, facilitate civic exchange, and promote smarter and greener ways of city development (Batty et al., 2012; Lin, 2018; Lombardi et al., 2012; Kourtit et al., 2012). It is argued that through the implementation of ICTs, smart cities bring together the different dimensions of a city—such as the economy, people, and mobility—and update the conditions of all of its important infrastructures in order to reduce operational costs, optimize the use of resources, and achieve urban sustainability (Neirotti et al., 2014; Lombardi et al., 2012; Komninos, 2011). However, the meaning of smart city varies significantly in the literature.

A technological perspective on smart city stresses the use of traditional infrastructure and new ICTs to leverage the collective intelligence of cities. For instance, Odendaal (2016) posits that a smart city is one that capitalizes on the opportunities presented by ICT in promoting its prosperity and influence. Harrison et al. (2010:1) contend that smarter cities are urban areas that intend to optimize operation of city services by using operational data collected from energy consumption statistics, traffic flow, public security, emergency management, and environmental monitoring. For them, technology is the defining characteristic of a smart city. Examples of this technology-driven smart city are Tianjin Eco-city (China), Masdar City (United Arab Emirates), and Bhubaneswar Smart City (India). However, as stated by its critics, the technology-centered smart city does not consider the extent to which the integration of ICTs into cities can enhance citizens' capabilities, social services, and quality of life (Ruhlandt et al., 2020; Monachesi, 2020; Desdemoustier et al., 2019; Alizadeh, 2017). For instance, Hollands (2008) questions the "self-proclaiming and self-congratulatory notions of such cities." He warns that a smart city should not over-rely on the deployment of ICT or technological infrastructure, since little room would be left for ordinary people (Hollands, 2015). Grossi and Pianezzi (2017) highlight that the development of smart cities is dominated by a market-led and neoliberal restructuring process of the urban space, characterized by the exposure of municipalities to global competition, privatization, and public–private partnerships, and the mobilization of an entrepreneurial ethos and discourse. Using the case of Dholera, the first Indian smart city, Datta (2015:3) puts forward the criticism that that "Dholera's fault lines are built into its utopian imaginings, which prioritizes urbanization as a business model rather than a model of social justice."

Other authors assert that the development of smart cities inevitably increases social inequality (Monahan, 2018). For instance, the discriminatory tendencies of ICTs are aggravated by the uneven distribution in the access to, use of, or impact of ICTs among different groups of persons. A criticism raised is that although there is no doubt that ICTs can help create new knowledge and discover improved ways of governing cities, ICTs are just an enabler of, not a panacea for, all the problems and issues faced by cities and humankind (Kummitha and Crutzen, 2017). Various services can be offered to citizens via ICT-augmented government systems, but not everyone in a city can benefit from such services, especially people with a low socioeconomic status (Leydesdorff and Deakin, 2011).

Also proposed is a human perspective on smart cities, one that emphasizes that smart cities should be closely connected to investments in human capital (e.g., knowledge and skills), since that helps cultivate the knowledge required for a knowledge-based economy. As some authors claim, smart cities are about taking advantage of the opportunities offered by ICT to involve multi-actor, multi-sector, and multi-level perspectives and promote community-based smart city building; that is, to enhance the skills and capabilities of local people and communities to benefit their daily lives (Neirotti et al., 2014). A human-centric way of governing cities transforms how people interact with each other and promotes social processes of technological innovation. For instance, education, social learning, and human capital are deemed to be crucial factors for smart city innovation. According to other scholars, this also means that community participation and collaboration should play a crucial role in perceiving, planning, constructing, and managing their cities (McFarlane and Söderström, 2017; Hollands, 2015, 2008).

Caragliu et al. (2011:70) give a comprehensive definition of smart city that is in line with this human perspective on smart cities: "a city to be 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 practice, a number of smart initiatives have been proposed, but it is argued that when it comes to implementation and deployment, many challenges remain (e.g., technological challenges concerning coverage and capacity, digital security, funding and business models, and a lack of participation by civil society). Furthermore, these challenges "surpass the capacities, capabilities, and reaches of their traditional institutions and their classical processes of governing" (Scholl and Scholl, 2014:1). As Barns (2018:6) maintains, the benefits of smart cities cannot simply be achieved by combining ICT with internet-connected devices, but necessitate a "reinvention of governance."

1.2.2.2 Smart governance

Recent research shows that to make cities smarter, efforts have been made to link e-government / e-governance and innovation research to the field of urban governance (Nam and Pardo, 2011). Gil-Garcia (2012: 274) argues that smart governance is about "using sophisticated information technologies to interconnect and integrate information, processes, institutions, and physical infrastructure to better serve citizens and communities.” Nevertheless, there is a lack of general agreement on the definition of smart governance.

Some authors argue that smart governance has strong intelligent properties in mediating the different dimensions and units that constitute the smart city (Batty et al., 2012), as it highlights the importance of ICT in integrating and governing the various elements of a city. Other authors state that smart governance is about employing the intelligence of new ICTs to enhance the capability of decision making (Scholl and Alawadhi, 2016, p. 22). In this perspective, smart governance pays special attention to the role of ICT in collecting, analyzing, modeling, and exploiting the growing amount of data in order to obtain better evidence-based policymaking. Yet other authors argue that smart governance should also promote more proactive and open-minded governance structures, with all actors involved, aimed at achieving better economic performance and improving the quality of life. (Kourtit et al., 2012: 232). For them, smart governance reshapes the administrative structures and processes, and facilitates stakeholder involvement in policymaking. As stated by Nam and Pardo (2014), smart governance should be made a priority in creating collaborative environments and promoting collaboration between different urban actors to make cities smarter.

Meijer and Bolívar (2016) conducted a thorough, intensive literature review intended for clarifying the confusing concept of smart governance. In their literature search, four exemplary types of smart governance were identified: 1) government of a smart city, 2) smart decision-making, 3) smart administration, and 4) smart urban collaboration. These four types of conceptualizations show an increasing shift in power away from states and towards non-state actors to create a smart city. From this, the authors highlight that smart governance “is about crafting use of new forms of human collaboration through the use of ICTs to obtain better outcomes and more open governance processes” (Meijer and Bolívar, 2016). They urge that smart governance should be studied as a sociotechnical practice to optimize the economic, social, and ecological performance of cities. The added value of smart governance in practice has been demonstrated by several studies. For instance, Meijer and Thaens (2018) found that by using enormous amounts of data collected by sensors, shared information strengthens the smart governance of urban safety in the inner district of the Dutch city of Eindhoven. Lin (2018) identified that smart governance enhances e-governance and e-democracy in some Western countries, while it facilitates smart management and services in China. More recently, Garau and

Annunziata (2019) built a smart governance strategy for evaluating the urban polarities of the Italian island of Sardinia.

Despite the proclaimed potentials and added values, smart governance has been criticized for its over-reliance on the power of up-to-date big data and data analytics, leveraged by high-tech companies, to enhance the quality of decision making (Barns, 2018). Smart governance enabled by new ICT and big data analytics is strongly characterized by a technocratic way of governing cities (Kulkarni and Akhilesh, 2020). Underlying this assumption is that user acceptance and adoption of new technologies will automatically enhance their ability to make use of digital technologies and intelligent activities in the processing of information and in decision making (Verrest and Pfeffer, 2019). This also means that the governance process and final decision-making are built on the basis of technically derived knowledge rather than on collaborative rationality, in which it is envisioned that knowledge is socially constructed via communication and consensus building. As a result, it is claimed that the policy development in smart governance is mainly controlled by experts and expert knowledge, ignoring citizens' engagement in policymaking and the design of public services (Cardullo and Kitchin, 2019; Verrest and Pfeffer, 2019).

Furthermore, this technocratic smart governance assumes that technology can create unbiased or impartial knowledge to describe the concerned urban issues or patterns. However, studies show that technology-driven approaches to governing cities significantly neglect the urban social process of smart governance innovations (Verrest and Pfeffer, 2019; Goodspeed, 2015). For instance, the influence of context specificities (e.g., economic, political, social, and historical specificities) on the governance structures, the functional design of ICTs, and the technology interaction with social structures are hardly considered. According to Meijer and Bolívar (2016: 75): "Situational characteristics, such as democratic institutions and culture, the physical environment, the economic production, etc., matter for the effectiveness of smart city governance since these characteristics are either conducive or limiting to different modes of smart city governance." Thus, for transformative smart governance, we should start with the "urban issue," furthermore moving from a technology-driven to a more user-oriented smart governance, and also shaping the technological intelligence more socially.

1.2.3 Planning support ICT in the "smart" era

According to Vonk and Geertman (2008:153), "urban planning concerns the design and organisation of urban physical and socioeconomic space and the measures undertaken to solve existing problems and/or anticipate future problems." It is aimed at mediating and organizing human activities in space (e.g., the analysis, development, and design of the built environment and of the use made of it) in order to achieve better public welfare, such as efficiency, sanitation, protection, and use of the environment. The recent emerging concept of smart city constitutes a promising policy option for dealing effectively with those objectives.

It should be noted that the planning objective is often achieved by using professional knowledge to analyze, model, assess, implement, and monitor a systematic series of actions directed to some end in the public domain (Friedman, 1987). In this respect, the development of the planning framework for guiding policymaking toward the planning of smart cities should pay close attention to the characteristics of knowledge and the knowledge demands of smart city planning. According to, inter alia, Dammers et al. (1999), this knowledge is comprised of experiential and scientific knowledge, technical knowledge and social knowledge, and implicit and explicit knowledge. Rydin (2007) identifies four main claims about knowledge from a planning perspective: empirical knowledge, process knowledge, predictive knowledge, and normative knowledge. However, given the diversity of knowledges, there is a need to incorporate a diversity of actors into policymaking processes (not just government, but also market parties and civil society). This wide involvement leads to a quite complex policymaking process and makes it difficult to handle the distinct knowledges and knowledge claims.

It is against this background that geo-information technology developers have been focusing on developing planning support tools to assist urban planners in handling information and producing the needed knowledge in the smart era. Pettit et al. (2018) maintain that in an era of smart cities, PSS as enabled by big data, new data analytics, and ICTs can provide higher quality support to the planning of smart cities. The underlying idea is that the urban planning practice has experienced a long period of development of and research on these planning support tools, and those experiences can offer help in the form of dedicated information, knowledge, and instruments that can support those involved in the planning process (e.g., planners, designers, and researchers) and inform their planning tasks and activities with regard to smart cities.

As early as the 1960s, large-scale system models were developed (e.g., urban transportation models, and large-scale metropolitan land use and integrated municipal information systems) to produce knowledge about the relevant issues (Chadwick, 2013; Klosterman, 1994; Lee Jr, 1973). However, the information technologies in this period were aimed at collecting data and promoting efficient transaction processing to improve operational tasks, which was inconsistent with the needs of practice at that time (Klosterman, 1997). Then, in the 1970s, the need to build rich connections with different stakeholders to operate on the edge of social uncertainty and instability became urgent. However, planning support ICT in this period was aimed at serving management needs and supporting executive decision-making (Geertman, 2006). As a result, planning support ICT failed to meet the need to pursue citizen engagement, interpersonal dialogue, and debate. In the 1980s and 1990s, functionalities that can handle poorly structured decisions were needed; however, there was a lack of capabilities to generate and evaluate a number of alternative solutions that could help guide iterative, integrative, and participative decision processes. And in the past 20 years, a new generation of geo-information technologies known as planning support systems (PSS) is argued to provide new potentials for supporting urban planning. Here, PSS can be defined as "… geoinformation technology-based instruments that incorporate a suite of components that collectively support some specific parts of a unique professional planning task" (Geertman, 2008: 217). For instance, PSS are expected to support the various tasks of urban planning, such as "problem diagnosis, data collection, mining and extraction, spatial and temporal analysis, data modelling, visualization, etc." (Geertman and Stillwell, 2004:292). Nevertheless, due to the influence of the technology-driven approach of developing PSS, this field has been dominated by the "PSS implementation gap": A large diversity of PSS were developed first in academia and later in the private sector, but their implementation in spatial planning practice lags far behind the supply of tools (Geertman, 2006, 2017; Te Brömmelstroet, 2017). Among the solutions to close this gap, it has been asserted that PSS should be closely attuned to the needs of users and existing practices by considering the embedded context. Notably, a sociotechnical approach is recommended to replace the current systems engineering approach in developing and implementing PSS (Pelzer, 2015; Vonk and Ligtenberg, 2010). Rather than emphasizing the knowledge and views of experts in developing an optimal system, it is acknowledged that the outcome of knowledge delivered by a system is shaped and constructed via the interaction between developers and users in a specific situation (Cels et al., 2012). Or as O'Neill (2011) puts it, a sociotechnical approach enables users to perform a task analysis, which can improve functionalities; in addition, by considering user perceptions, expectations, capacities, and skills, it increases the usability of a functionality. For instance, in participatory urban planning, citizens may require communicating tools to facilitate their dialogue and debate with other participants; thus, a focus on developing functionalities that can effectively exchange data and information is valuable.

The above shows that the innovative development and application of new ICT is not something completely new and merely linked with the field of smart city and its subfield of smart governance. In this dissertation, I argue that a planning support perspective on the role of ICT in smartening urban governance is needed.

1.2.4 Toward a conceptual model of smart urban governance

The above analysis shows that urban governance is confronted with new situations and new challenges in urban areas that require governance innovations. The development of smart cities indicates that the potentials provided by big data and new ICTs should be employed to facilitate the transformation of government and engage non-state actors to make cities smarter. Besides, a planning support perspective shows that the knowledge that centers on the evolving roles of ICT in supporting planning can be used to provide guidelines on how ICT can be better applied to smarten urban governance. The results accord with the argument of a range of authors that more comprehensive and integral institutional arrangements should be developed to transcend current technocratic and corporate-led smart governance (Yigitcanlar et al., 2018; Ruhlandt, 2018; Hartmann and Geertman, 2016; Meijer and Bolívar, 2016; Meijer, 2016).

To respond to this, I argue that the mentioned perspectives can learn from each other to arrive at smart urban governance. Unlike previous technocratic smart governance approaches in public administration, this dissertation highlights that urban space and its unveiled problems and potentials constitute an inseparable part of smart urban governance. For a planning-support ICT perspective, it means that more specific emphasis should be put on how ICT can be developed and implemented to smarten urban governance in the realm of smart cities. However, at a conceptual level, we still lack such a potentially valuable framework for smart urban governance, let alone the actual operability of such an approach. Because of this limitation, this dissertation specifically focuses on how the smart urban governance approach can be conceptualized and what role ICT could play in such governance.

Figure 1.2 presents the conceptual model, which has three main parts. Part I shows that smart urban governance is comprised of three intertwined key components (i.e., spatial, institutional, and technological components) and considers the influence of context on the conceptualization and interactions of three components (spatial, institutional, and technological components) of smart urban governance and its relevant outcomes. Part II takes a planning support perspective on the role of ICT in smartening urban governance. It shows that the dominant planning perspective influences how planning complexity and planning rationality are perceived and acknowledged. Then the perceived planning complexity and planning rationality together determine the role ICT could play in planning. Part III shows that empirical evidence is needed to examine the relation between urban issues and an ICT system and the interaction between governance processes and an ICT system and focus on the value ICT could add to smart urban governance.

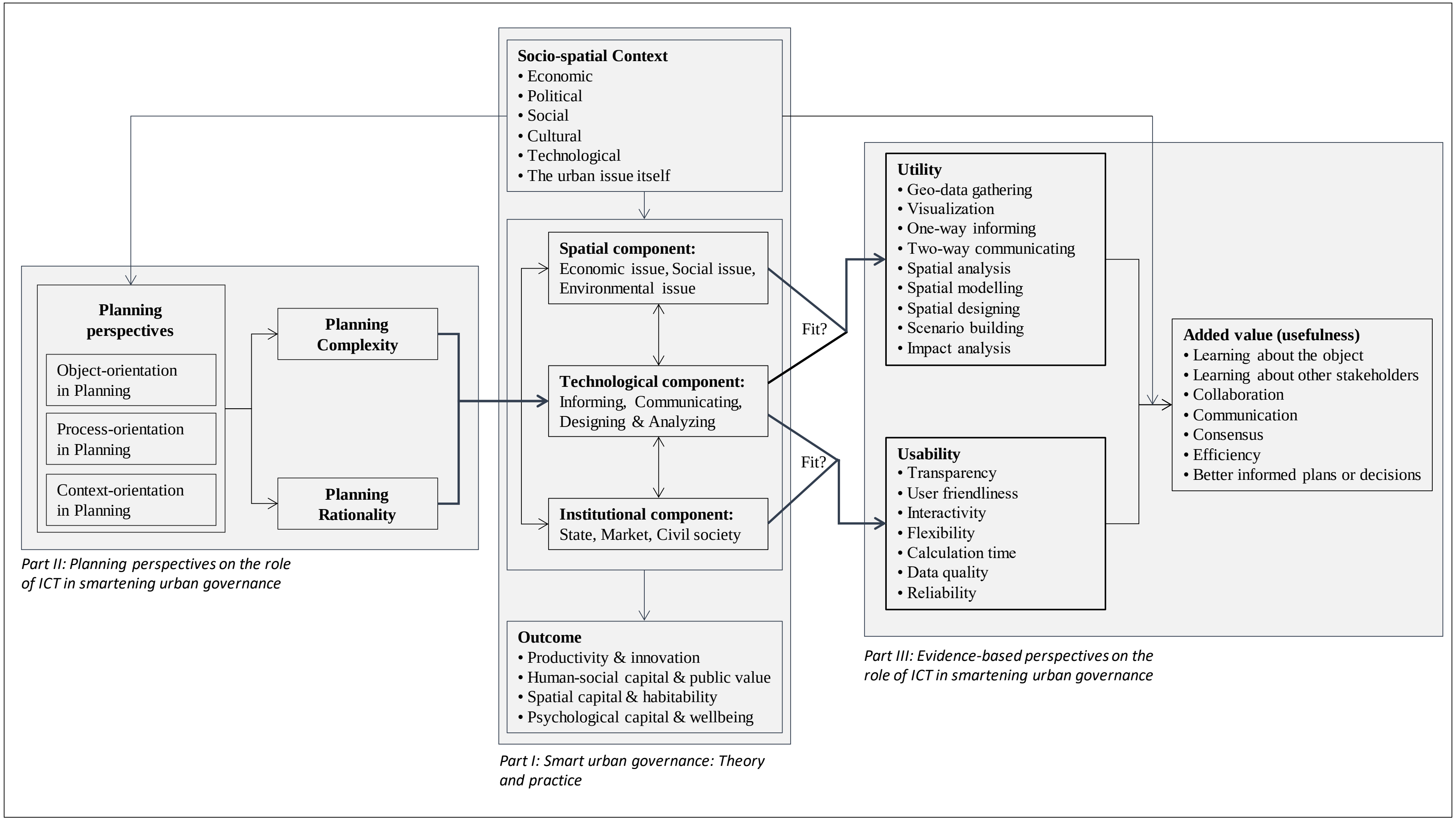

Figure 1.2 Conceptual mode

1.3 Research questions

The main research question was how smart urban governance can be conceptualized and what role ICT can play in smart urban governance. To answer the question, three groups of research questions were developed.

Part I: Smart urban governance: theory and practice

As mentioned, the “what” (urban issues) and the “how” (the social organization of knowledge and action from different stakeholders) have been argued as being central to the challenges of urban governance. In smart city and smart governance literature, ICT has received a large amount of attention regarding the development of innovative governance arrangements to achieve better governance processes and outcomes. Smart urban governance indicates that a focus on the factual and urgent urban challenges associated with a smart city is badly needed (Shelton et al., 2015; Vanolo, 2014). Furthermore, a planning support perspective is expected to provide guidelines on how ICT can be better used to smarten urban governance. This dissertation maintains that these perspectives can learn from each other to arrive at a new smart urban governance approach. Hence, the first research question was:

How can smart urban governance be conceptualized in the realm of smart cities?

Based on literature about urban governance, e-governance/e-government, and ICT-facilitated participatory planning, this question is answered in Chapter 2 in a conceptual way.

In contrast to the present technocratic way of governing cities, real smart urban governance should go beyond the technocratic way of governing cities (Verrest and Pfeffer, 2019) and highlight the importance of a sociotechnical approach. Based on the framework of smart urban governance in Chapter 2, Chapter 3 further zooms in on the three essential components of smart urban governance and highlights that smart urban governance should be conceptualized as an emergent sociotechnical practice. Thus, the second research question was:

How can the components of a smart urban governance approach and their interactions be conceptualized from a sociotechnical approach?

Building on an intensive literature research and two real-world smart city projects, this research question is answered in Chapter 3.

Chapters 2 and 3 show that the urban context plays an important role in shaping the urban social process of a smart urban governance approach. In this dissertation, the urban context refers to the circumstances in which smart urban governance is embedded, and through which its meaning can be fully understood. Thus, a specific focus on the extent to which technological innovations interact with urban governance, mediated by the specific urban context, would help produce different types of smart urban governance approaches. Thus, the third research question was:

How does the urban context influence the conceptualization of and the sociotechnical interaction between the components of smart urban governance?

Based on an extensive review of index systems, research reports, key literature, national and local policies and documents, three real-world cases are analyzed to answer this question in Chapter 4. This contributes to clarifying the role of contextual factors in the design, development, implementation, and outcomes of a smart urban governance approach.

Part II: Planning support perspectives on the role of ICT in smartening urban governance

Building on Chapters 2–4, Chapters 5–6 examine the role of ICT in smartening urban governance from a planning support perspective. In Chapter 5, it is argued that the evolving perceptions of planning together with the changing roles of ICT in supporting planning over the past 70 years provide the foundations for an up-to-date and factual planning supportive role. In accordance with Klosterman (1997), this paper highlights that the continued failure of practitioners and researchers to use smart technologies to augment the planning process and deal with the planning issues in the realm of smart cities results less from the limitations of hardware and software, and more from a limited understanding of the complexity and rationality of planning in determining the proper role these tools should play. Thus, the fourth research question was:

What can be learned from the evolving perceptions of planning and ICT-enabled planning support to improve the role of ICT in governing and planning cities?

This study is based on a combined research method presented in Chapter 5. First, since the different roles of ICT in supporting planning are well documented in the scientific literature (e.g., Vonk, 2006), a literature survey was applied as a research method. Then, expert views on ICT in supporting planning were compiled via an interview survey. By zooming in on the changing roles of ICT in planning history, this paper contributes to providing a solid theoretical perspective on enriching the supportive role of ICT in governing and planning cities.

As mentioned in the previous sections, smart governance is characterized by a technocratic way of governing cities in which decision making is based on information and knowledge produced by technology. In Chapter 6, it is argued that the policy implementation of smart governance can learn from the experiences in urban planning practice to overcome the PSS implementation gap. The underlying idea is that the practice of urban planning already possesses lots of experience in overcoming the PSS implementation gap and that the newly emerging smart governance developments are in need of, and should be able to learn from, these experiences. Thus, the fifth research question was:

What can smart urban governance learn from efforts in urban planning practice to overcome the PSS implementation gap?

This question is answered in Chapter 6. Departing from existing theoretical and conceptual approaches in PSS literature to overcome the implementation gap and linking these to the critiques with regard to smart governance, this chapter distils those useful dimensions that are currently underdeveloped, or even significantly overlooked, in smart governance debates. By drawing on these dimensions, I aim to advance the further development of smart governance.

Part III: Evidence-based perspectives on the role of ICT in smartening urban governance

In Chapter 7, empirical research into the role of ICT in smartening urban governance is presented. The sixth research question was:

How can ICT add value in smartening urban governance?

The key argument made in this paper is that technological innovations should be closely embedded in the governance processes and be closely attuned to the urban issue at hand to be able to achieve its added value in smartening urban governance. In seeking support for this argument, a combined international questionnaire (268 survey respondents) and interview (12 semi-structured expert interviews) survey was conducted to explore the model and test the argument.

Chapter 8 discusses the determinants of PSS usefulness in smart cities. The literature shows that the rapid development of new ICT and big data in the realm of smart cities has opened up new opportunities for the development and application of PSS (Geertman and Stillwell, 2020; Barns, 2018; Vallicelli, 2018). It also shows that in the actual application of PSS, a range of factors influence the degree of usefulness of PSS (e.g., the quality of PSS functional support, the perceived user-friendliness, and the dynamic characteristics of planning processes) (Geertman and Stillwell, 2009; Vonk, 2006; Klosterman, 1997; Harris and Batty, 1993). Based on this literature research, the seventh research question was:

What are important success and failure factors determining the usefulness of PSS in the realm of smart cities?

Based on empirical research, this chapter discusses the factors that influence the usefulness of PSS in practice.

Empirical studies have demonstrated that contextual factors have an important influence on PSS usefulness in smart cities (Luque-Martín and Pfeffer, 2020; McEvoy et al., 2019; Zhang et al., 2018). However, there is a lack of studies on theorizing the role of different contextual factors and their effects in practice. Thus, the eighth research question was:

What are important contextual factors influencing the usefulness of PSS in practice?

An ordinal regression model was applied to data gathered from an international questionnaire survey to quantify the relation between the identified contextual factors and the PSS usefulness.

1.4 Research methodology

In this section, an overview is provided of the research techniques and data used in the conceptualization of smart urban governance and in the investigation of the role that ICT can play in smartening urban governance.

Literature review

A systematic literature review was conducted to identify, critically evaluate, and integrate the findings of all relevant, high-quality studies addressing the topic of smart urban governance. According to Ruhlandt (2018), a systematic review approach specifies its rule-based selection procedure and precludes the possibility of one-sidedness and bias of the literature review. In addition, a stringent systematic literature review enhances "the sophistication of reviewers' efforts in pursuit of theoretical progress and more original empirical study" (Wolfswinkel et al., 2013, p. 45). This dissertation applied the systematic literature review method proposed by Wolfswinkel et al. (2013), which consists of four stages: define (determine relevant search terms, choose databases, and specify inclusion/ exclusion criteria), search (explore suitable texts), select (filter out doubles, refine samples based on title, abstract and keywords, refine samples based on full text, and add forward/backward citations) and analyze (coding).

Two groups of literature are discussed in this dissertation. The first is the reviewed literature on the smart city and smart governance. This review was conducted in March and April 2017, and updated in October 2018 and January 2019. This group of literature is used to conceptualize and theorize smart urban governance in Chapters 2–3. The second group concerns literature on planning support ICT, which was retrieved in March 2018 and updated in November 2019. This group is used in Chapters 5–6 to examine the role of ICT in smartening urban governance from a planning support perspective.

Second-hand index systems

An extensive review of index systems, research reports, key literature, national and local policies and documents is used to illustrate how smart urban governance works in practice. The data were mainly retrieved from smart city and smart governance project websites via Google searches. Content analysis and discourse analysis were then used to analyze the data. According to Zhang et al. (2019, p. 6), "the units of analysis of the content analysis are empirical evidence of the latent meaning found in discourse analysis." Therefore, content analysis was used to determine the features, while discourse analysis was applied to investigate the difference between these features and their significance. In Chapter 3, these index systems are used to illustrate how interconnected components of smart urban governance contribute to a sociotechnical way of governing cities in practice. In Chapter 4, the index systems are used to show how the urban context influences the sociotechnical interaction between technological innovation and urban governance and produce smart urban governance.

Questionnaire survey

A questionnaire survey was used to gather statistical information about the actual usage and performance of ICT in smartening urban governance in practice. The questionnaire was mainly distributed to the Computers in Urban Planning and Urban Management (CUPUM) research community. By employing electronic and regular mailing lists, between May and September 2019 about 1,300 people worldwide were invited to complete the questionnaire. Simple statistical analysis was then carried out to make sense of and draw some inferences from the questionnaire data. In Chapter 7, a frequency analysis is applied to compare the different uses of ICT in smartening urban governance. In Chapter 8, by calculating, analyzing, and comparing the average scores of the identified factors, I investigate the important success and failure factors influencing the usefulness of PSS in smart cities. In Chapter 9, the questionnaire data are used to analyze the effects of contextual factors on PSS usefulness in smart cities via an ordinal regression model.

Expert interviews

Expert interviews were used to cross-check the role of ICT in smartening urban governance and the actual application of ICT in smart city planning. Three sets of semi-structured expert interviews were held over the course of four months (June–October 2019). The first set of expert interviews were conducted during the 2019 Wuhan CUPUM Conference[1] (July 8–12, 2019) in Wuhan (China), with eight internationally highly recognized experts in the field of PSS and urban planning. The second set of interviews were conducted in August 2019, in Beijing (China); only one expert from the PSS field was available at that time for an interview. In September and October 2019, three additional experts from the fields of PSS and smart governance were interviewed. It should be noted that two of them were interviewed online. Each interview lasted 30–60 minutes. The majority of the experts had worked in the PSS and/or smart governance field for over 20 years, and some for more than 50 years. These experts enabled us to gain valuable insights into and opinions about the role that ICT can play in smartening urban governance. Although the selection of interviewees was limited and selective, it was nevertheless a very important sample of key experts in this field of research. The analysis of the expert interviews is mainly presented in Chapters 5 and 7.

[1] CUPUM Conference: International Conference on Computers in Urban Planning and Urban Management

1.5 Reading guide

This thesis consists of 10 chapters, the first being this introduction. Chapters 2, 4, 5, and 7–9 are based on papers that have been published in peer-reviewed journals. Chapters 3 and 6 are based on papers that have been submitted or resubmitted to peer-reviewed journals. The structure of this thesis is as follows (Figure 1.3).

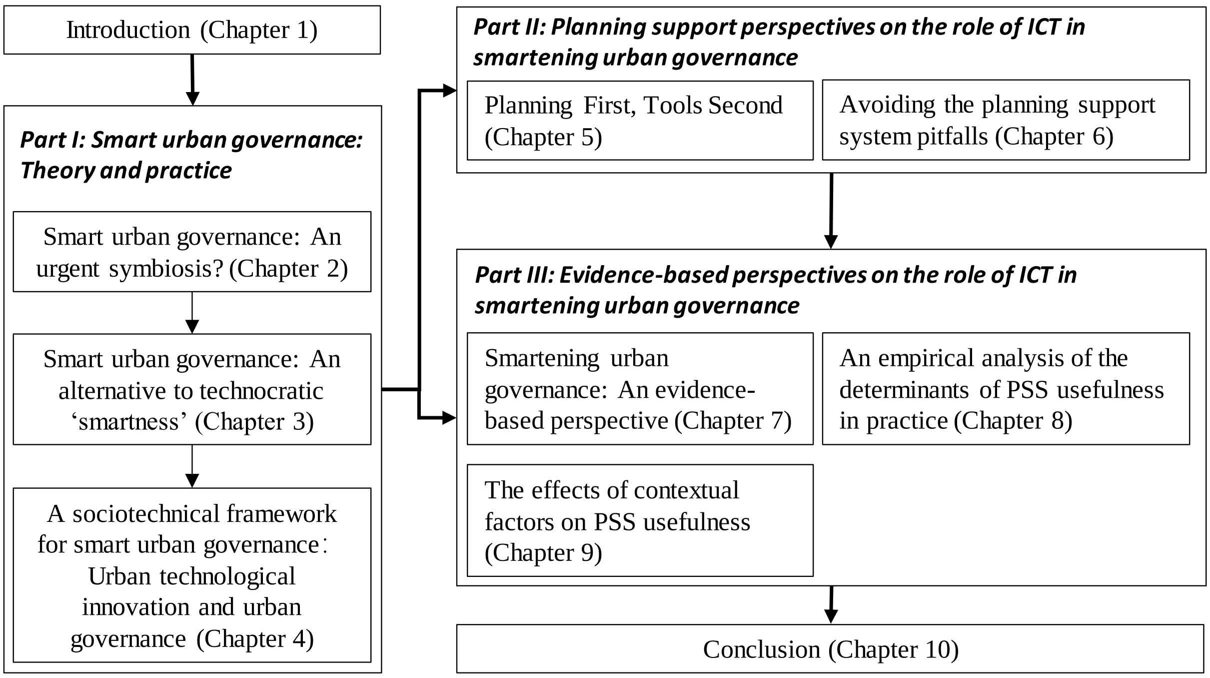

Figure 1.3 Thesis structure

Part I focuses on the theory and practice of smart urban governance. More specifically, Chapter 2 conceptualizes smart urban governance as a sociotechnical practice. Chapter 3 focuses on the three interconnected components of smart urban governance. Chapter 4 examines the role of the urban context in influencing the conceptualization of and the sociotechnical interaction between the components of smart urban governance.

Part II takes a specific planning support view on the role of ICT in smartening urban governance. Chapter 5 first evaluates the evolving views on ICT in supporting planning, while Chapter 6 discusses efforts in spatial planning practice to overcome the PSS implementation gap.

Part III looks further into the role of ICT in smartening urban governance in evidence-based practice. Chapter 7 analyzes the added value of ICT in smartening urban governance. Chapter 8 looks at the success and failure factors that determine the usefulness of ICT in smart cities. Chapter 9 examines the effects of contextual factors on PSS usefulness.

Chapter 10 summarizes the main findings of this dissertation, reflects on the conceptual framework and methodology, suggests some policy implications for practice, and outlines academic recommendations for further research.

Table 1.1 Article publications and/or status

Chapters	Titles	Publication or Status
Chapter 1	Introduction	—
Chapter 2	Smart urban governance: An urgent symbiosis?	Information Polity. DOI: 10.3233/IP-190130
Chapter 3	Smart urban governance: An alternative to technocratic 'smartness'	*Resubmitted*
Chapter 4	A sociotechnical framework for smart urban governance: Urban technological innovation and urban governance in the realm of smart cities	International Journal of E-Planning Research (IJEPR). DOI: 10.4018/IJEPR.2020010101
Chapter 5	Planning first, tools second: Evaluating the evolving roles of ICT in urban planning	*Submitted*
Chapter 6	Avoiding the planning support system pitfalls? What smart governance can learn from the planning support system implementation gap	Environment and Planning B: Urban Analytics and City Science. https://doi.org/10.1177/2399808320934824
Chapter 7	Smartening urban governance: An evidence-based perspective	Regional Science Policy & Practice. https://doi.org/10.1111/rsp3.12304
Chapter 8	Ignorance is bliss? An empirical analysis of the determinants of PSS usefulness in practice	Computers, Environment and Urban Systems. https://doi.org/10.1016/j.compenvurbsys.2020.101505
Chapter 9	The effects of contextual factors on PSS usefulness: An international questionnaire survey	Applied Spatial Analysis and Policy https://doi.org/10.1007/s12061-020-09352-5
Chapter 10	Conclusion	—

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Chapter 2

Smart Urban Governance: An Urgent Symbiosis?

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Abstract: Over the past decade, two dominant perspectives prevail on the governance of smart cities. From a public administration perspective, 'smart governance' emphasizes the importance of technology-based tools in transforming government institutions. From an urban planning perspective, the governance of smart cities focuses on the institution interaction with spatial challenges. Within this backdrop, these perspectives can learn from each other to arrive at new transformative smart governance approaches. This paper proposes a specific urban planning perspective on smart governance, labeled as 'smart urban governance'. It is aiming specifically at the transformative governance of the socio-spatial context of urban challenges associated to smart cities via technological innovations and opening up new possibilities for city transformation. To this end, the meaning of smart urban governance is conceptualized from three dimensions: purposes, components and contexts. Based on a systematic literature review, these three dimensions are integrated into one holistic framework. A case illustration was applied to demonstrate the added value of this framework. From this, this paper concludes that smart urban governance, by explicitly taking into account the specific socio-spatial context, can improve our understanding of the urban challenges associated to smart cities and contribute to its appropriate and 'smart' governance.

2.1 Introduction

The notion of smart city has gained significant momentum to deal with the impact of industrialization and urbanization over the past decade (Kitchin, 2019; Gil-Garcia and Bolívar, 2016; Batty et al., 2012; Hollands, 2015, 2008). It appeared as a merging of thoughts and ideas aimed at fueling sustainable economic growth and a high quality of life by the mobilization of information and communication technology (ICT) and participatory governance (Caragliu et al., 2011). To address the challenges of smart cities, smart governance is proposed to strengthen government institutions and integrate all sections of society through the use of various ICTs (Meijer and Bolívar, 2016; Bolívar and Meijer, 2016; Giffinger et al., 2007). In practice, the added value of smart governance for smartening a city is evidenced by a range of smart initiatives. For instance, Scholl and AlAwadhi (2016) find that smart governance in the city of Munich arouses interest of local needs and helps government to make smarter decision-making by conducting major ICT overhaul with regard to government organization. Meijer and Thaens (2018) reveal that by providing functionalities such as geo-data gathering and visualization, smart governance can effectively strengthen urban safety. Despite the claimed potential, for the past decade practical smart governance overemphasizes the role of technocrats and technology-based tools as a way to achieve the governance of a smart city (McFarlane and Söderström, 2017). Indeed, this approach often neglects the role of substantive urban challenges in shaping governance structures and the functions of ICT (Shelton et al., 2015). Consequently, smart governance is more or less deemed as a way to take advantage of various ICTs, aimed at bringing changes in public policy and government institutions from a public administration perspective (Jiang et al., 2019; Meijer, 2016).

Therefore, many authors from urban planning highlight that there is a necessity for governance processes to focus more on the factual and urgent urban problems linked to smart cities (Kummitha and Crutzen, 2017; Bertot et al., 2016; Hollands, 2015). As Shelton et al. (2015) argue, the governance of smart cities should be situated in time and space. Studies in this view focus on how varying forms of cooperation and partnership (e.g., public-private partnership, self-governance) can be built between different stakeholder groups (e.g., government, market parties and civil society) to cope with these problems and reshape the spatial urban environment. Although positive results have been achieved so far, particularly with regard to urban infrastructure upgrading (Shahrour et al., 2017), critiques show that the urban planning perspective on smart city governance is overly "attributed to local state entrepreneurial governance based on a close relationship between the local state and enterprises" (Xue and Wu, 2015:10). For instance, some of the prominent smart city projects (e.g., Tianjing Smart Eco-city in China, Songdo Ubiqutous Eco-city in South Korea, and Masdar in the United Arab Emirates) are largely controlled by large high-tech companies (Jiang et al., 2019; Hollands, 2015). These companies typically contend that technology is fundamentally beneficial to urban development; however, technology's usefulness in dealing with real urban problems and augmenting urban governance processes is seriously weakened by a lack of considering the social dimensions (Meijer and Thaens, 2018; Cels et al., 2012). According to Kitchin (2015), the so-called smart city projects just serve the interests of investors and big companies looking for capital.

The discussion above shows that up till now, two dominant perspectives on the present governance of smart cities can be identified. First, so-called 'smart governance' emphasizes the importance of technology-based tools in transforming government institutions from a public administration perspective (i.e., technology interaction with institution). Second, from an urban planning perspective a focus on the urban spatial challenges associated to a smart city highlights the varying forms of cooperation and partnership between government, market parties and civil society to cope with these challenges (i.e., institution interaction with spatial challenges). However, both perspectives are insufficient to deal with the challenges in the realm of smart cities. According to some authors, a lack of considering the specific socio-spatial context of urban challenges associated to smart cities constitutes the main hindrance to the present governance of smart cities (Jiang et al., 2019; Ruhlandt, 2018; Gil-Garcia and Bolívar, 2016; Meijer, 2016). Too often urban measurements in one city are considered appropriate to other cities too, without critical assessment of its contextual specificities. As a result, the identified shortfalls along with the context ignorance within the two present dominant perspectives have impeded the transformation of cities. Therefore, some authors urge that more integrative and context-oriented approaches should be developed to transcend these two dominant perspectives (Ruhlandt, 2018; McFarlane and Söderström, 2017).

Within this backdrop, we claim that the mentioned perspectives can learn from each other to arrive at new transformative smart governance approaches. Based on an intensive literature review, this paper therefore proposes a specific urban planning perspective on smart governance, labeled as 'smart urban governance'. It is aiming specifically at the transformative governance of the socio-spatial context of urban challenges associated to smart cities via technological innovations and opening up new possibilities for city transformations. In doing so, it intends a symbiosis between the 'smart' from smart governance literature and the 'urban' from urban governance literature, as a means to 'smartening' urban governance as well as drawing attention to the importance of socio-spatial transformations in shaping smart governance. This is how smart urban governance orginates from, but at the same time goes beyond, the two present perspectives on governance of smart cities.

This paper is structured as follows. Section 2 elaborates on the theoretical background of smart urban governance. Section 3 presents the research methodology to conceptualize smart urban governance. Next, three key dimensions of smart urban governance (i.e., purpose, component, context) will be investigated in Sections 4 to 6. Section 7 will integrate the dimensions and present a general framework of smart urban governance. Then, a case illustration is used to demonstrate the framework's use and advantages. Section 8 reflects on the findings of this study and suggests some avenues for further research.

2.2 Theoretical foundations

Research on the governance of smart cities can be conducted either from a public administraton perspective or from a spatial planning perspective. This section reviews the five most significant forerunners of 'smart urban governance' from both fields, that is: 1) e-government, 2) e-governance, 3) smart (city) governance, 4) urban governance and 5) ICT-enabled participatory planning. It purposes at analyzing the conceptual roots that arguably lead to the novelty of the proposed smart urban governance concept.

2.2.1 E-government

First, e-government is understood as the use of ICTs such as websites, social media and mobile devises to improve public service delivery (Manoharan and Ingrams, 2018). Driven by the need for government transformation, ICT has become the core element of e-government in a short period of time (Bertot et al., 2016). The deployment of e-government has focused on technological and operational matters for a long time, focusing attention mainly on the role of ICT in transforming the internal operations of the public sector (Savoldelli et al., 2014). By integrating various ICTs into government structures, operations and processes, e-government to a large degree increases government efficiency, accountability and transparency (Janowski, 2015). Apart from changes in the internal governmental operations, e-government also aims to create new opportunities for external actors, such as private companies and non-governmental organizations, for instance in the sense of delivering information and developing new services (Mahou-Lago and Varela-Álvarez, 2016). However, relying heavily on the control from government to expand their reach, e-government has failed to build up effective mechanisms for different stakeholders to really engage in the decision-making process. Shortcomings in transforming e-government are expected to be overcome by increasing participation and engagement (Janowski, 2015; Savoldelli et al., 2014). Or, as stated by Linders (2012:453), there is a need to transform e-government into "we-government, in which society place more trust in—and empowers—the public to play a far more active role in the functioning of their government".

2.2.2 E-governance

Second, e-governance is a broader concept which includes the utilization of ICT by government, private and civil society to encourage greater participation of non-state actors in the governance of public issues (Palvia and Sharma, 2007). Compared to e-government in which ICT usually supports one-way information publishing, in e-governance ICTs can better facilitate two-way communication between the state and non-state actors (Marche and McNiven, 2003). By empowering citizens through access to government information and policy-making processes, interactions between different groups have been largely improved in e-governance. Besides, unlike e-government, which treats citizens as consumers of services, e-governance is “more about engaging citizens and stakeholders and allowing them to co-produce public services” (Meijer, 2015:199). According to Scholl and Scholl (2014), co-production in public services through the use of ICT builds the foundation for e-governance.

In fact, by conscientiously allowing open-minded participation and collaboration, e-governance manifests its transition from traditional top-down administration to flat institutional arrangements—that is, to emphasize external government transformation and improve the possibilities for citizens and businesses to participate in the policy-making process (Milakovich, 2012). Nevertheless, Johnston and Hansen (2011) note that the evolving relationships between government and non-government need not to be limited to the public sector but can also be applied to the private sector. For instance, e-governance can be used to collectively foster a common sense of community among different stakeholders and facilitate the building of self-governing communities (Paskaleva, 2013). However, Meijer (2015) argues that institutional-cultural and technological barriers, such as technological restraints, individual preferences, and resistance from government, impede innovations in e-governance; therefore, creative strategies are needed to reframe e-governance.

2.2.3 Smart (city) governance

Third, smart governance aims to establish a new type of governance arrangement through the use of new technologies (Meijer, 2016). Smart governance goes beyond e-government/e-governance as it has escalated from the public sector to a higher and broader city level (Meijer and Bolívar, 2016). Hence, city governments are forced to ”rethink, change, and improve their governing routines, procedures, and processes” (Van Dijk et al., 2017:3). Currently, smart governance is elaborated from two perspectives. First, a technology-centric perspective highlights the process of information exchange between different actors by employing smart e-participation devices (Johnston and Hansen, 2011). This ICT-enablement enhances the management and functioning of a city, which is treated as the key driver of the governance of smart cities. Second, a human-centric view underlines the role of smart people as being central to smart city governance. In this view, human capital and/or human resources are the key feature of smart governance. Building on the characteristics of 'smart' people, smart governance relies heavily on the ideas, information, knowledge, skills, and cooperations acquired by these people that contribute to the prosperity of a smart city. Nevertheless, in practice more importance has been given to new technologies rather than empowering individuals and groups to determine agency decisions in a self-organized manner. Therefore, Ruhlandt (2018) argues that effectively integrating technology into the participatory process of urban governance mediated by context-specificities is crucial for developing a transformative form of smart city governance. This means that smart (city) governance in practice should focus more on the synergy between technical and social systems.

2.2.4 Urban governance

Fourth, urban governance refers to the concept of governing cities from a broad perspective (Obeng-Odoom, 2012). Land, capital, information, labor, and technology are integrated to seek sustainable development of cities. In a narrow sense, urban governance refers to multi-agent governance networks in which government, private sector, and civil society are interdependent for solving urban issues (DiGaetano and Strom, 2003). Although a lot of empirical case studies have been conducted to explore the concept of urban governance, its meaning still remains undefined (Obeng-Odoom, 2012). Aspects of definitions can either focus on various theories of power to investigate the behaviour of actors (Nicholls 2005) or highlight a neoliberal model of urban governance (Harvey, 1989) or emphasizes the decision-making process restrained by contextual factors (e.g., Beumont & Nicholls, 2008).

Focusing on power relations, urban governance involves a complex process of political decision-making between different stakeholder groups (Stoker, 1998; Pierre, 1999). The interaction between different actors can either regain control and restore traditional structures, thus underlining bureaucracies and hierarchies, or shift to a decentralized structure centering on self-governing networks (Jessop, 1998). As a neoliberal model, urban governance is deemed as a partnership mechanism for alliances between the government and enterprises to promote local development. Then, referred as "the process of coordinating political decision making" (DiGaetano and Strom, 2003:373), urban governance is largely shaped by the economic-political, cultural and agency-level factors. Therefore, new research and application possibilities for urban governance should consider the impact of the broad socio-spatial contexts on decision-makers and the decision-making process.

Although urban governance has gained much momentum, it should also be noticed that problems such as under-equipped infrastructures, tensions and social conflicts over access and/or control of the city, dysfunction of urban services, and overlapping or incoherent responsibilities between institutions have gone beyond its capacity (Devas, 2014). Van Dijk et al. (2017:3) argue that ”cities need to develop *smart* governance in order to become smart”. Despite urban governance being a mature academic field, technology and innovation should be connected to develop smarter urban governance approaches to confront the recent “smart urbanism” (Meijer and Bolívar, 2016).

2.2.5 ICT-enabled participatory planning

Finally, participatory planning is a policy-making process that includes affected stakeholders, especially non-governmental parties (Healey, 1997). In a typical participatory planning endeavor, such as a community development planning, different stakeholders will get involved in the processes of decision-making on certain issues. The purpose of participatory planning is to contribute to public awareness of local issues and to give the public opportunities to state their concerns. To facilitate participation and engagement from individuals and the local community, a large variety of instruments and tools have been developed and applied. For instance, computer-based information systems such as Decision Support Systems (DSS) and Planning Support System (PSS) are often used to support the decision-making process in ICT-enabled participatory planning (Geertman, 2015). Currently, new ICT tools such as social media, websites, crowd-sourcing and Internet-of-Things are applied by planners and governments to increasingly include private sector and citizens in planning processes (Sebastian et al., 2018). Nevertheless, fierce debates remain about the use of ICT in planning. For instance, the digital divide that restricts some residents’ access to the planning process is still very real (Crowe et al., 2016). In addition, individuals’ engagement in ICT-enabled participatory planning can be seen as skewed due to power imbalances between bureaucrats and citizens (Zhang, et al., 2018). In the future, ICT-enabled participatory planning is expected to enhance its adaptiveness to consistently changing societal environments and conditions and satisfy the real needs of relevant stakeholders (Zhang, et al., 2018; Pelzer, 2017; Geertman, 2015).

2.2.6 Integration: towards smart urban governance?

On the basis of reviewing the five most significant forerunners of our notion of ‘smart urban governance’, it can be concluded that the academic debates on contemporary smart governance and urban planning approaches mainly focus on three factors. First, technology is perceived as a key driver of developing *smart* governance approaches. Second, the need for restructuring public organizations reflects the interdependency and high degree of mutuality between various stakeholders, including governmental and non-governmental bodies and persons. Third, many scholars have argued that ICT-enabled governance does not operate in a vacuum but is deeply rooted in urban space, thus socio-spatial contexts of urban challenges should be taken into account explicitly. Accordingly, smart urban governance originates from, but should go beyond, these five antecedents.

Besides, the review of the five forerunners also uncovered the following main categories of the broad research relative to the governance of smart cities: 1) purpose (or outcome), 2) component, and 3) context (e.g., Jiang et al., 2019; Lin, 2018; Webster and Leleux, 2018; Ruhlandt, 2018; Bolívar and Meijer, 2016; Meijer, 2016). For our conceptualization, we refer to these three variables that in our view reflect three key dimensions of smart urban governance, that is: *purpose, component* and *context*. The *purpose* concerns the goals or intentions of smart urban governance to be achieved. The *component* constitutes the process, that facilitates the formation of smart urban governance arrangements. The *context* rephrases what was explained earlier about the socio-spatial context of urban challenges associated to smart cities initiating the need for smart urban governance. These three dimensions will be integrated into one holistic framework.

2.3 Methodology

By conducting an inventory and analysis of the purpose, component and context dimensions of smart urban governance, this paper aims to conceptualize and frame smart urban governance. According to Ruhlandt (2018), a systematic review approach specifies its rule-based selection procedure and precludes the possibility of one-sidedness and bias of the literature review. Besides, a stringent systematic literature review enhances “the sophistication of reviewers’ efforts in pursuit of theoretical progress and more original empirical study” (Wolfswinkel et al., 2013:45). Therefore, this paper follows the wellexplicated systematic literature review methodology proposed by Wolfswinkel et al. (2013) to collect, analyze and integrate dimensions of smart urban governance. Steps for conducting the literature review were shown in Table 2.1.

Table 2.1 A method for rigorous literature review (Created by authors based on Wolfswinkel et al. (2013))

Stage	Task	Guidelines
1. Define	Determine relevant search terms	Provide relevant keywords related to the current research area
	Choose database	Determine the database to be adopted for document retrieval
	Specify inclusion/exclusion criteria	Confine the search to the most suitable literature within the database (e.g., language, year, peer-reviewed, journal requirements)
2. Search	Explore suitable texts	Navigate the databases and conduct the actual search for the suitable literature for the research topic (this process involves iteration, namely refinement and adjustment)
3. Select	Filter out doubles	Identify and remove duplicate records from systematic review
	Refine sample based on title, abstract and keywords	Select the sample that is accurately connected to the main topics of the study based on title, abstract and keywords
	Refine sample based on full text	Pick out articles that are closely associated to the research topic based on a full reading of the material
	Add forward/backward citations	Including some of the most important articles that are not included in the selected sample based on forward/backward citations
4. Analyze	Coding	Read the final sample and code and classify the findings and insights in the text that are significantly related to the main topics of the study

Based on the steps of Table 2.1, the five mentioned forerunners of smart urban governance were used as stepping stones to first determine relevant search terms. This step acquired 8 relevant search terms used in our literature review: e-government, e-governance, smart city management, smart governance, smart city governance, urban governance, participatory planning and smart urban governance. Then, in our literature review we only focused on peer-reviewed international journals and papers. Scopus was used for selection purposes because it is the world's largest abstract and citation database of peer-reviewed literature, delivering a comprehensive overview of the world's research output in the fields of science, social sciences, and arts and humanities[2].

Further, we limited our review to publications dated from 2010, up to and including the year of 2018. The year 2010 is chosen as a delimiter because the strong 'boom' in articles concerning this theme of smart city and its governance started in 2010 (Dameri and Cocchia, 2013). Then, we restricted our retrieval to publications written in English. Although the notion of smart city has been widely studied in Asian countries such as China and India (Jiang et al., 2019), ICT-enabled governance such as smart city governance and e-governance is mainly studied in Europe and the USA (Lin, 2018). The literature review was first conducted from March 2017 to April 2017 and later updated in October 2018 and January 2019.

The systematic literature search comprised of four major phases. The first phase was restricted to journal articles that consist of carefully identified key terms. Eight thematic searches in Scopus were conducted by combining each of the identified 8 key terms with the term "smart city" in an iterative manner. The Boolean operator was: ((Combined:("*Key search term*")) AND ((Combined:("smart city"))). The key terms applied in all searches were directed to the title, abstract and keyword of the articles. This phase in the end produced 1578 papers published and the majority of the articles originated from the field of e-government/e-governance and smart (city) governance.

The second phase produced a selection of relevant articles on the basis of the title, abstract and keywords. All the articles from the first broad literature search were analyzed for their relevance to debates on smart urban governance. We read the abstract and introduction section, surveyed the structure of the paper and then selected the papers that were most relevant to our requirements. This process resulted in a sample of 365 journal articles. The third phase involved a full-text analysis of all articles to develop consensus regarding the purposes, components and contexts linked to smart urban governance. The key requirement of selecting these articles in this phrase is that each article should have a conceptual framework that consists of terms relevant either to the purpose, or the component or to the context, even when these terms are expressed with an alternative word (Table 2.2). The full-text reading produced 98 articles. Subsequently, a forward and backward searching for relevant references in the citation index was conducted. This phase produced 10 articles that fulfill our requirements.

[2]https://www.elsevier.com/solutions/scopus

At last, 108 journal articles were identified. Then, a detailed conceptual analysis to decide the framework elements related to the proposed three dimensions (i.e., purpose, component and context) of smart urban governance was carried out. The systematic analysis in the end identified thirteen key terms as the purpose dimension, fifteen key terms as the component dimension and eight key terms as the context dimension (Table 2.2). We analyzed the frequency of each term that appeared in these articles (Figure 2.1 to 2.3). Based on a further analysis of these key terms (See Apprendix 1), we identified semantic repetition and condensed the originally identified key terms into a smaller set of selected key terms. These selected key terms made a conclusive understanding of the purposes, components and contexts identified.

Table 2.2 Identification of selected key terms for smart urban governance

Identified dimensions	Criteria for identification	Originally identified key terms	Selected key terms
Purpose	What were seen as the main effects or purposes explained in earlier forerunner literature?	Efficiency & productivity; learning & innovation; technological savviness; human & social capital; public services & value; organization improvements; social inclusion & cohesion; transparency & trust; improvements to city; ecological performance; sustainability; quality of life & well-being; belonging & liveability	Economics: productivity & innovation Politics: human and social capital & public value Ecology: spatial capital & liveability Culture: psychological capital & well-being
Component	What constitute the main components explained in earlier forerunner literature?	Government or governance; political actors or stakeholders; participation or engagement; collaboration or partnership; openness & transparency; leadership & accountability; power & empowerment; policy; management & organization; decision-making; strategies & visions; legal & regulatory; technology or ICT; big data; place or space	Institutional: governance Technological: smart tools Spatial: urban space
Context	What were the main contexts (constraints) explained in earlier	Economic structure; technological development; political system and institution; culture and customs; personal rationality & preference; geographical particularity; resources	Social context Spatial context

	forerunner literature?	constraints; urban problems as context

2.4 Purpose of smart urban governance

The purpose dimension states the reasons for which smart urban governance is created. Figure 2.1 illustrates the frequency of the 13 variables that can be characterized as key purpose-relevant terms of smart urban governance. It can be seen that ‘public service and value’, ‘efficiency and productivity’, and ‘transparency and trust’ are the three highest scoring indicators whereas ‘technological savviness’ and ‘belonging and liveability’ have relatively low scores. In this paper, the four domains of social practice—economics, politics, ecology and culture, proposed by James (2014)—were adopted to regroup the original key purpose terms into four new categories, aimed at substantiating the purpose of smart urban governance. For a long time, the dominant approach focusing on economic, social and environmental sustainability has been used to delineate the purposes of urban governance or spatial planning (Campbell, 2016). However, this approach “centers on economics and gives it a prominence that threatens to expand to consume the realm called society” (James, 2014:46). In agreement with James critiques, this newly proposed category was adopted to center on the socialized urban life—the ‘urban’.

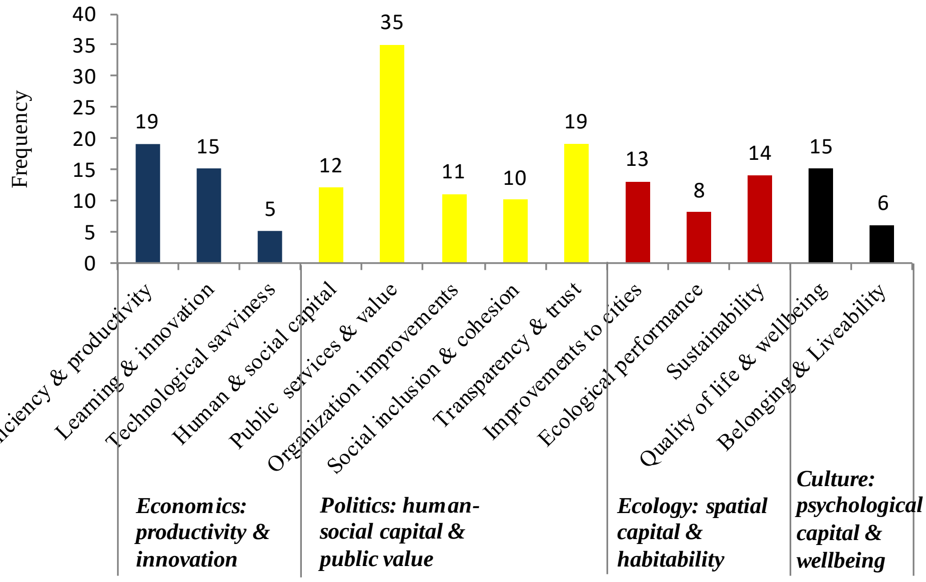

Figure 2.1 Key ‘purpose’ terms of smart urban governance

2.4.1 Economic purpose: productivity and innovation

If governance concentrates on productivity and innovation associated with the production, use and management of resources, the purpose is economic. In the field of smart city goverance, one of the main purposes found in literature is to promote economic growth. In this sense, pro-growth smart city governance treats the improvement of productivity and economic growth as an overarching goal for local economies (Hollands, 2015). According to Kumar et al. (2017:1), “smart urban economies are largely the result of the influence of ICT applications on all aspects of urban economy”. Adoption of ICT-enhanced policies or governance nowadays is on top of the economic agendas for governments in most countries (Pradhan et al., 2018). For instance, the governance of smart cities in China to a large degree revolves around productivity, entrepreneurship, innovation, as well as economic competitiveness in the global market (Jiang et al., 2019).

In addition, Gil-Garcia et al. (2014) highlight the role of a creative mix of emerging technologies in facilitating the producitivity of service delivery and innovation. By promoting transparent decision-making, open information sharing use, and ICT-enabled participation and collaboration, smart initiatives will alter how people interact with each and lead to advancements in term of technological innovation (Kummitha and Crutzen, 2017). An example is Barcelona Smart City (Bakici, 2013). This project integrates top-down and bottom-up approaches towards urban digitalization and incorporates big data and smart sensors into everything from parkland irrigation to air quality, trash collection, parking and transportation. By effectively integrating smart technologies with smart people, Barcelona has improved its economic competitive edge.

2.4.2 Political purpose: human-social capital and public value

If governance is defined to emphasize the contributions of human-social capital and public value to a social life held in common, the purpose is political. In ICT-enabled governance, by offering a variety of ICT tools to citizens, it not only empowers human actors to access knowledge, information and data in an efficient and economical manner, but also enables community members to communicate with each other (Meijer, 2016; Linders, 2012). Investments in interactive learning and collaboration are essential for ICT-enabled governance to foster the capabilities of citizens and the accumulation of human and social capital dispersed in civil society (Caragliu et al., 2011). The acquisition of human and social capital often has a considerable influence upon the generating of value and the process of problem solving (Angelidou, 2015).

In smart governance literature, public value is highlighted as the main goal of smart cities (Meijer et al., 2016). Described as "a reflection of collectively expressed, politically mediated preferences consumed by the citizenry" (O'Flynn, 2007:358), public value evaluates the extent to which the demands of individuals, organizations and society as a whole can be satisfied (Bozeman, 2007). In fact, public value not only generates value from the experiences provided by different stakeholders but also provides them values in return (Pérez González and Díaz Díaz, 2015; Williams and Shearer, 2011). According to Meijer et al. (2016), three types of public value produced by smart governance can be identified: 1) efficient government organization; 2) better relationships between government and other urban actors and 3) improvements to cities. In practice, the production of public value is closely connected with learning, innovation and common pool resources. For instance, by using open data as a way to facilitate the 'smart' governance of Rio de Janeiro, interactions and communications between city government and citizens have been largely improved. Through becoming custodians of public data, Rio de Janeiro government demonstrates trustworthiness and enhances its skills for urban service delivery in smart city contexts (Pereira et al., 2017).

2.4.3 Ecological purpose: spatial capital and habitability

If governance strives to contribute spatial capital and habitability across the intersection between social and natural realms, the purpose is ecological. In this, spatial capital is the information and resources accumulated by cities and communities that enable different actors to exploit the spatial dimension of a society (Roche, 2016). According to Roche (2017), the acquirement of spatial capital is closely linked with digital technology, especially geo-technology. For instance, emerging technologies such as social media, electronic maps, Internet-of-Things, and peer-to-peer sharing applications have enhanced citizens' access to geography-related information and data. However, critiques also show that the current urban infrastructure upgrading and many smart city initiatives are mainly controlled by high-tech companies, which demonstrates a sense of privatizing public space (Kummitha and Crutzen, 2017). In reality, improved quality of life for its citizens might not be produced best through a well-planned urban system.

In this context, Leydesdorff and Deakin (2013:53) declare that the increasing growth of ICT should facilitate the interactions between "the intellectual capital of universities, the industry of wealth creation and their participation in the democratic government of civil society". In this sense, smartness is not merely about the deployment of technologies but more related to how to cultivate a technology-based ecological and habitable surrounding—a place of vibrant life and livelihoods that everyone can efficiently get involved and gain access to things that are wanted or required. An example of this kind of *smart* city governance is the Smart Nation Singapore project, which strongly encourages the private sector and civil society to smarten their living surroundings with their own creative ideas, knowledges and technologies. It is worth noting that the integration of technology into the daily life of the Singaporean has contributed to the creation of new forms of techno-cultures and habitable environments. For smart urban governance, more attention should be transferred to the intersection between the social and natural realms, since here spatial capital is concentrated and habitability is fostered.

2.4.4 Cultural purpose: psychological capital and well-being

Finally, if goverance centers on psychological capital and well-being of social meaning of a life held in common, the purpose is cultural. Psychological capital is conceptualized as the positive and developmental state of an individual as characterized by high hopes, self-efficacy, optimism, and resiliencey (Luthans and Youssef, 2004). Well-being is the satisfaction of objective needs (e.g., food) or subjective needs (e.g., respect) (Oswald & Wu, 2010). In smart governance, participation through empowerment is the main enabler of improving stakeholders' psychological capital and well-being (e.g., mutual trust, shared understanding) (Webster and Leleux, 2018). Empowered participation in governance processes allows actors to gain mastery and control over their own affairs, which help them to build a sense of accountability for their communities (Granier and Kudo, 2016). For instance, the Amsterdam Smart City project organizes smart collaboration between citizens, enterprises, knowledge institutions and municipalities which effectively fosters social inclusion among society (Lin, 2018).

Long-term continued engagement and collaboration assists actors to cultivate a supportive sense of belonging and membership. In smart cities projects, ICT creates more space and opportunities for different actors to get involved in debates about their living surroundings (Bolívar and Meijer, 2016). Social media, websites, and living labs are widely utilized to encourage collaborative policy-making. Characteristics of both the objective and subjective factors that improve health and quality of life have been identified in multiple ICT-enabled governance initiatives (Battarra et al., 2018; Ojo et al., 2013). For instance, by developing long-term cooperation among business firms, citizen, knowledge insitutions, and municipal agencies, the Smart Aarhus project in Denmark has built a strong psychological sense of community among its citizens (Snow et al., 2016). For smart urban governance to be considered successful in the eye of local people, more human-oriented configurations will enable ordinary people to become contributing members of the city.

2.5 Components of smart urban governance

The component dimension identifies the main constituting elements of smart urban governance. Figure 2.2 illustrates the frequency of the 15 variables that can be characterized as component-relevant terms of smart urban governance. It can be seen that 'technology or ICT', 'participation and engagement', and 'governance (government)' are the three highest scoring indicators whereas 'power and empowerment', and 'legal and regulatory' have relatively low scores. Attentively, the importance of urban space (place) in shaping ICT-enabled governance is highlighted by journals. Based on their semantic repetition, fifteen key component terms were regrouped into three component groups: institutional, technological and spatial.

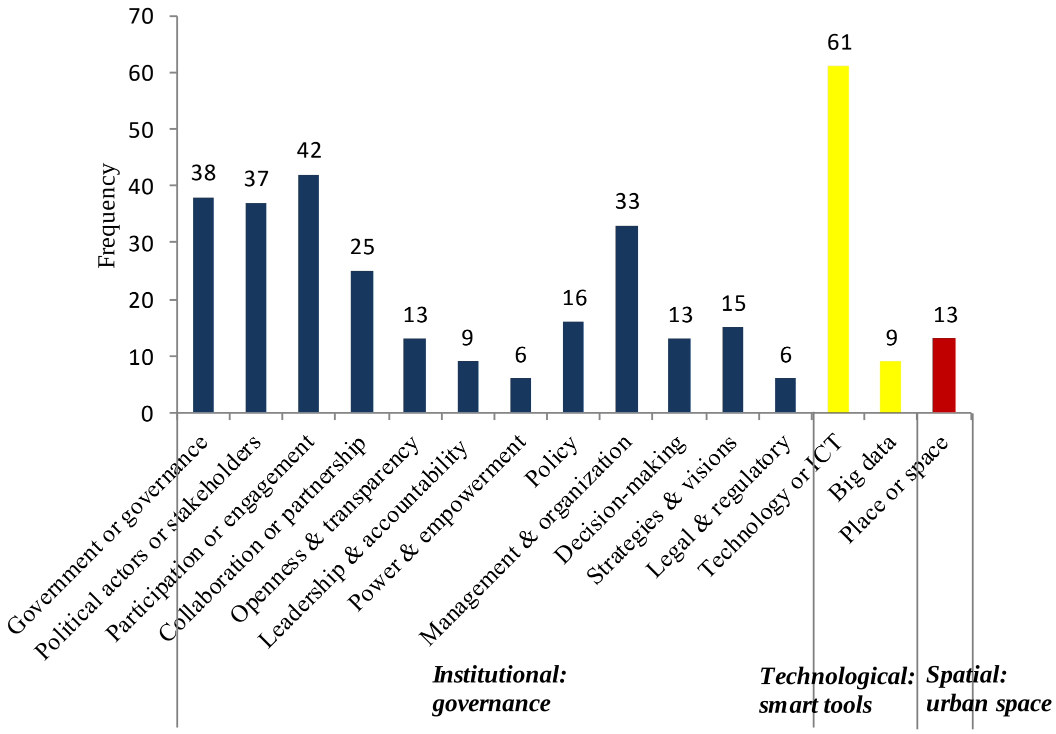

Figure 2.2 Key 'component' terms of smart urban governance

2.5.1 Institutional component: governance theories

From the perpective of public administration, governance theory encapsulates eleven key terms illustrated in Figure 2.2. Three aspects of governance can be identified: governance as as an analytical framework; as a set of norms and rules; and as a decentralized process rather than government control (Nuissl and Heinrichs, 2011). In ICT-enabled governance, this is conceptualized as a way to promote participation and collaboration from non-governmental actors to deal with collectively concerned issues via ICT (Caragliu et al., 2011). In this process, political actors or stakeholders are both the subject and object of governance (Rhodes, 1997). By using ICT, different political actors and stakeholders can get engaged and empowered in the decision-making process (Misuraca and Viscusi, 2015). Giving authority to the "have-not citizens" through ICT enhances the abilities of communities, groups and/or individuals to participate. Governance also contains the formulation of strategies and visions, which are usually deemed as legal or regulatory objectives that indicate the way to implementing decision-making or policies. According to Hufty (2011:405), "the processes of interaction and decision-making among the actors involved in a collective problem" finally "leads to the creation, reinforcement, or reproduction of social norms and institutions". Accordingly, governance entails the way different norms, rationalities and actions are structured, arranged, formed and sustained.

Although a rapidly growing number of ICT-enabled governance literature focuses on the concept of governance at different descriptive and analytical levels, this paper conceptualizes governance as an institutional arrangement aimed at steering and coordinating interdependent actors to deal with collective concerned issues. As governance theory provides an angle to understand the various aspects of ICT-enabled governance (e.g., political actors and stakeholders, participaton and collaboration, power and empowerment, decision-making, management and organization, and so on), it is designated as the institutional component of smart urban governance.

2.5.2 Technological component: smart tools

The second component of smart urban governance is technology, mainly composed of smart tools. Zook (2017) highlights that the appropriate integration of ICT into governance is necessary because of the ability of ICT to innovatively adapt to contextual environments. In practice, the incorporation of ICT into governance can technically promote the smartness of governance (Scholl and Scholl, 2014). For instance, new technologies such as sensors or sensor networks used in smart city governance help government to collect different kinds of data. These data enhance the rationality and effectiveness of government's decision-making (Walravens, 2012).

Scholl and Scholl (2014:163) argue that "the actionable and omnipresent ICT are substantial prerequisites and backbones for developing (various) models of smart (democratic) governance". The applications of ICT for the development of innovative and smart governance contributes to enhancing communication and collaboration between different stakeholders within communities and cities. By mining various resources and expertise distributed among different actors in the cities, ICT-enablement will support 'to maximize the socio-economic and ecological performance of cities, and to cope with negative externalities and historically grown path dependencies' (Kourtit et al., 2012). However, Hollands (2015:61) criticizes that the great facilitating role of ICT does not imply technological determinism. Instead, research should be designed to investigate the creation of smart tools that cater for the particularities of specific working groups and organizations (Pelzer, 2017). In sum, smart tools are driving the technology component of smart urban governance.

2.5.3 Spatial component: urban space

The third component of smart urban governance is the spatial component, reflected in urban space. In accordance with Lefebvre (1991), urban space can be perceived as a set of social relationships. In governance literature, socialized urban space is closely linked with urban governance. As an object of urban governance, it delineates the content to which a specified governance action is directed. As a spatial characteristic, it brings about situational influences on the structure of urban goverance. However, this treatment of urban space is seldom considered in ICT-enabled governance. For instance, spatial scale is often postulated as a hierarchical model of scales, in which the portraying of actor constellations and power relations is limited within these nested and linear scales (Smith, 2010).

Distinctive from previous conceptualization of urban space as an analytical tool, this paper focuses on the social process of urban space—urban space as a category of practice—as Moore (2008) advocates. This means that concepts of urban space (such as scale and place) are no longer grasped as an instrument to analyze the decision-making process; instead, it is regarded as a spatial variable that interacts with the other components (institutions and technology) under specific socio-spatial contexts. As such, urban space is socially structured, formed, constructed and altered. Yigitcanlar et al.

(2018) argue that urban space also drives the development of technology-based smart cities. Consequently, urban space' interaction with the smart city process should be conceptualized as a crucial element in defining the meaning of smart city governance. Based on this, this paper highlights that it is the spatially-enabled practice (such as ideas, claims, assumptions, and actions with regard to urban space), along with the institutional and technological components that construct and define the meaning of smart urban governance.

2.6 Context of smart urban governance

Context refers to the circumstances and situations that form the setting for one specific governance approach, and in terms of which it can be fully understood and assessed. Figure 2.3 shows the frequency of the 8 key contextual terms that were found in the reviewed literature. The result illustrates that 'political system and institution' and 'urban problems as context' are the most frequently mentioned contextual factors, while 'economic structure' is least frequently found. Based on their semantic relationships, the eight key contextual terms were re-categorized into two groups: social context and spatial context.

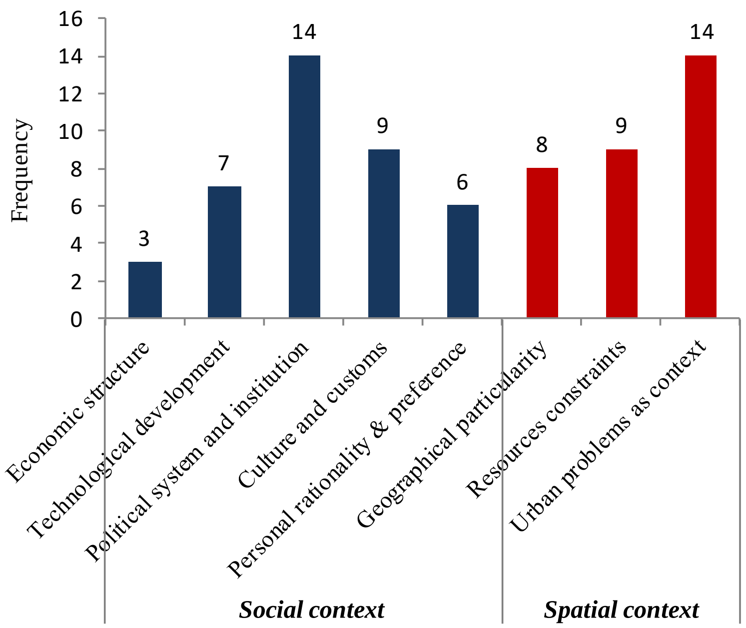

Figure 2.3 Key 'context'-related terms of smart urban governance

2.6.1 Social context

Social context includes factors that relate to the way people live together (Figure 3). These include first, financial/economic barriers that have limited the development of structural forms of citizen engagement in ICT-governance innovation (Meijer, 2015). Second, the accessibility or availability of technologies enable governments to collect, connect and analyze data and initiate policies (Alathur et al., 2016). Normally, a higher level of technology development enriches people who would like to participate in the governance of smart cities (Anttiroiko, 2016). Third, the political system and institutions influence the degree of uncertainty regarding strategic decisions, power relations, interdependence, etc. (Nielsen and Pedersen, 2014). For instance, Lin (2018) identifies that different institutions in China and Europe have largely affected their smart governance strategies, arrangements and outcomes. Fourth, culture and customs, deemed as a set of informal rules or norms embedded in people's daily life, influence the behaviors of particular political actors (DiGaetano and Strom, 2003). Meijer (2015:199) claims that e-government under bureaucratic cultures tends to 'preserve the traditional ways of interacting with citizens'. Finally, governance often fails when personal preferences and rationality of different political actors are not fully considered (Healey et al., 2017). According to Hollands (2015), constructive inclusive communication between different stakeholders in smart city governance can facilitate engaging with multiple perspectives.

2.6.2 Spatial context

Distinctive from the spatial component, which is closely related to social practice and produced by human activities, spatial context refers to the spatial characteristics related to urban issues—geographic particularity, resource contraints and the nature of urban problems. Geographic particularity refers to the geographical attributes of an area such as place, space or scale (Gupta et al., 2015). Resource constraints represent the limitation and enrichment of spatial resources (e.g., facilities and utilities) to be utilized in dealing with social and urban issues. The availability of relevant resources for different locations, places, communities and countries influences the willingness and the governing capability to tackle a common-concerned problem (Howlett, 2009). Sufficient resources allow actors and cities to perform a thorough analysis of the alternatives while a lack of resources can be detrimental to the whole city governing system, causing city operations with elevated amounts of errors, transport delays and high stress levels (Sorensen, 2018). The nature of urban problems is about the challenges related to industrialization and urbanization. According to Meijer (2016:75), the nature of urban problems in smart city governance portrays the conditioning of a problem that "interacts with a series of political, administrative, and technological choices regarding the use of new technologies for urban governance".

Many studies on ICT-enabled governance have recognized the role of socio-spatial transformations in offering effective and meaningful directions for governance research. However, so far, few papers in the governance of smart cities have discussed, theorised or investigated the usefulness of this socio-spatial context. According to Ruhlandt (2018), the influence of contextual factors on the transformative governance of smart cities still remains concealed. Contextual factors are argued to influence the governance of smart cities, at least in part, but a lack of empirical evidence has weakened this connection. Besides, governance approaches from public administration often give prominence to social contexts (e.g., political system, institutions, and culture), while urban govenance and planning literature centers on spatial contexts without treating the social factors in an earnest manner (Healey, 1997). As a consequence, an effective smart urban governance approach should study a wide range of socio-spatial transformations in reality, since these contextual factors are not mutually exclusive, but are complementary and reciprocally beneficial to understand smart urban governance practices.

2.7 Towards a framework for smart urban governance

The body of work reviewed in the previous sections offers evidence that the impact of socio-spatial contexts upon the governance of smart cities has been increasingly receiving importance. However, urban space along with institutions and technology acting as key drivers of governance process have not been adequately recognized and conceptualized. These findings suggest that existing ICT-enabled governance and urban governance are not sufficiently able to deal with an alternative smart urbanism—that is, actor relation, technology along with urban space all that matter (McFarlane and Söderström, 2017).

To extend this discussion, the model of smart governance elaborated by Meijer and Bolívar (2016b: 650) was adapted to integrate the selected contexts, components and purposes into a holistic framework (Figure 2.4). The framework for smart urban governance developed in this paper comprises the socio-spatial context of urban challenges associated to smart cities, three interlinked components (institutions, technology, urban space) and four sustainability-oriented purposes (economic, political, ecological and cultural). The internal logic of this model suggests 1) a potential relation between the socio-spatial context and smart urban governance arrangements, 2) that the potential effect of the socio-spatial context on smart urban governance arrangements relies on the interaction between technology, institution and urban space, 3) that smart urban governance arrangements intends to realize desired purposes, and 4) a feedback effect of smart urban governance purposes (or outcomes) on the socio-spatial context. Based on this, smart urban governance can be defined as "a dynamic institutional arrangement, operating within certain socio-spatial contexts, and enabling with the help of smart technologies public participation and stakeholder collaboration to accomplish urban sustainability."

This conceptual framework distinguishes itself in three aspects. First, smart urban governance decision-making consists of an in-depth understanding of the specific influence of socio-spatial contexts. Quite often, a governance approach that succeeds in generating excellent policies in one place may fail in another (Meijer, 2015), since contextual specificities act as "a frame of reference for co-operative activities" (Lang and Roessl, 2011:726). Second, distinctive from other ICT-enabled governane approaches, this framework stresses that urban space is an inseparable component of smart urban governance. In e-governance or smart governance, urban space is presented as a surface with little conception of the urban at work. In this paper, the substantive content of urban space as a category of practice is explicitly proposed. In other words, "the presence or otherwise of technology, and the nature of that presence, then follows the identification of what the urban problem is and how the people are living those issues' frames and redefines an alternative 'smart' urban governance" (McFarlane and Söderström, 2017:313). Third, smart urban governance intends to facilitate particular efforts by people, communities, countries and other social units to strive for an ongoing lifeworld of urban flourishing – urban sustainability—based on James' (2014) conceptualization of sustainability. In this, sustainability is more related to the socialized urban life—the 'urban'. This argues for a move beyond the aim to achieve a tangible technology-based outcome such as better infrastructure, clean energy and economic development, but towards more intangible gainings such as human well-being, public value and smart habitability. To tentatively demonstrate how the framework works in practice, an illustration case was applied in the following subsection.

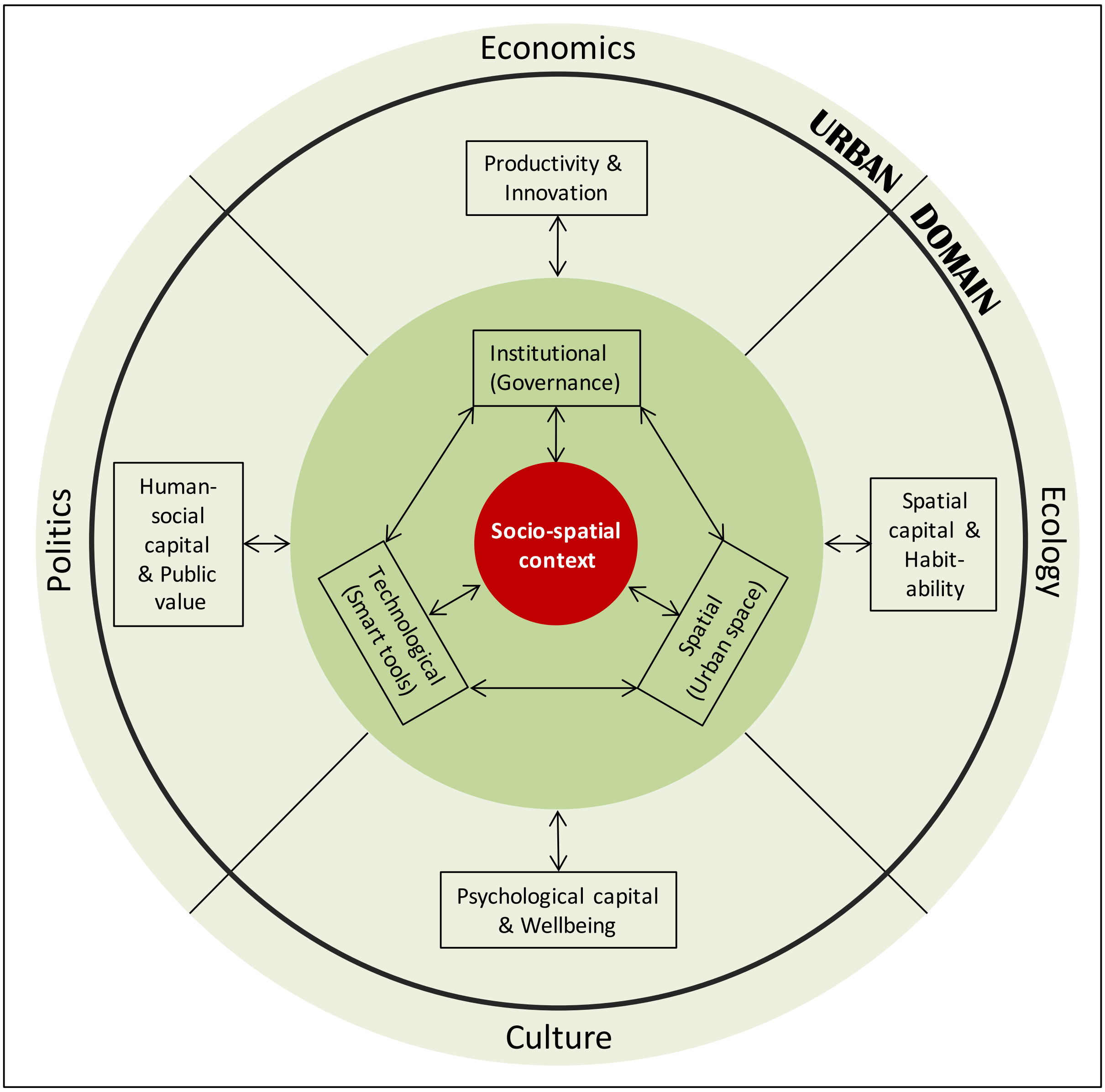

Figure 2.4 A conceptual framework for smart urban governance

2.7.1 A case illustration for the smart urban governance framework

Helsinki is confronted with fierce competition from other cities globally. At the local level, the city faces the challenges of urban economic renewal. Devoted to dealing with these challenges and improving residents' quality of life, the project City-as-a-Platform was proposed by taking a broader contextual view[3].

[3] Note: the review of this case is largely based on the work by Anttiroiko (2016).

First, to make full use of Finland's democratic tradition and citizens' strong sense of participation in the city affair, the smart city discourse and practices in Helsinki provided a sense of democratizing innovation, i.e., cooperation and aggregation of ideas and knowledge of public sector, academia, business and citizens. One example is the Smart Kalasatama program, which built a network of actors in which innovations were created and tested. By initiating numerous activities that brought business and civil society together, this platform had a special role in Helsinki's smart city-inspired development (e.g., open access to public data, smart city services testing and growth companies services). Another example is the Climate Street Project. Focusing on environmental protection, firms, real estate owners, universities and residents were invited to contribute their ideas and knowledge of energy saving and carbon emission reduction. A range of positive results have been achieved such as using shared spaces more efficiently, the provision of climate friendly products and trust building between stakeholders.

Second, although user-driven platforms in Helsinki to some extent enhance the interdependence of different stakeholders, but its ability to reinforce the interconnected ecosystems for urban innovation is weakened by a lack of mechanisms that can intensify collaboration between the key institutional actors and mobilize innovation potential of the city. Thus, Helsinki government intervention, strongly influenced by its welfarism, involved in extending user-driven platforms or living labs into the city level. By making a clear strategic plan, the Helsinki Strategy Program 2013-2016, Helsinki government integrated open participation and custromership, open data and interfaces, and open innovation platforms into a comprehensive city platform. The best example of this integration is the Forum Virium Helsinki. By aggregating most of the platforms in one place, this project succeeded in applying the platform thinking to Helsinki and reshaping interaction potential in urban communities.

Third, it should be noticed that the dynamics of Helsinki's City-as-a-Platform did not stand alone but revolved around Helsinki's technological ability to strengthen social behaviors and practices. As an important center for knowledge economy and innovation in Europe, Helsinki is capable of providing hardware and software solutions for extracting meaningful intelligence and smartening city operations. The user-driven online/offline platforms created in Helsinki provided technological intelligence to organize and process data and information that were dispersed and distributed amongst individuals. This ICT-enabled platformatization not only restructured Helsinki's urban infrastructure, but also provided collaborative supports for economic development and urban services innovation.

Influenced by Finland's democratic tradition and technological basis, it shows that both firms and individuals in Helsinki tend to share their innovations with others, creating more open innovation processes (Anttiroiko, 2016). Then, facilitated by government intervention, these user-driven platforms or living labs had contributed to Helsinki's City-as-a-Platform, characterized by enhanced connectivity, better access to products and services and user-innovation communities. As a result, urban space is no longer a physical entity but an interconnected system in which people can obtain and exchange information and knowledge in a timely manner. Within this system, tensions between pro-growth and anti-growth coalitions had been effectively eased by participatory processes and the enhanced quality of life.

In this case, smart urban governance is about integrating technologies into a city and building participatory and collaborative spaces to inspire Helsinki's urban innovativeness and improve its global competition. Taken together, the case well demonstrates the linkages between socio-spatial contexts, interactions between technology, institution and urban space, and the desired outcomes. It also reveals that socio-spatial contexts of urban challenges associated to smart cities, if properly considered, can maximize the potentials of interactions between technology, institution and urban space and produced smart urban governance.

2.8 Conclusion and future research directions

At present, a public administration perspective (like in the elaboration of the concept of Smart Governance) and an urban planning perspective (characterized by entrepreneurial forms of urban governance) have dominated the governance of smart cities. However, the identified shortfalls along with the context ignorance within the two present dominant perspectives have impeded the transformation of cities. To put a fundamental step forward, this paper proposes a specific urban planning perspective on smart governance, labeled as 'smart urban governance'. It is aiming specifically at the transformative governance of the socio-spatial context of urban challenges associated to smart cities via technological innovations and opening up new possibilities for city transformation. In doing so, it intends a symbiosis between the 'smart' from smart governance literature and the 'urban' from urban governance literature, as a means to 'smartening' urban governance as well as drawing attention to the importance of socio-spatial transformations in shaping smart governance. To this end, the meaning of smart urban governance is conceptualized from three dimensions: purposes, components and contexts. Based on a systematic literature review, these three dimensions are integrated into one holistic framework. Taken together, smart urban governance can be defined as a dynamic institutional arrangement, operating within certain socio-spatial contexts, and enabling with the help of smart technologies public participation and stakeholder collaboration to accomplish urban sustainability.

This understanding proves useful in expanding our view of how a context-oriented governance approach in the era of the smart city can be established. According to Kummitha and Crutzen (2017), a city that is smart only exists when it applies ICTs to enrich governance and build creative and inclusive urban space. In this, neither technology determinism nor a human-centric view is sufficient to realize the governance of smart cities. Instead, this paper shows that only through real-time and dedicated interaction between governance, urban space, and ICT, attuned to specific socio-spatial transformations under which it operates, will the opportunities for innovation of urban governance be achieved. By offering guiding principles such as the consideration of socio-spatial context, urban space as a category of practice, technology as a means instead of an end, and comprehensive purpose indicators, our suggested framework reorients the technological orientation to urban space more towards a human-centric approach, in which more intangible gainings such as human well-being, public value and smart habitability (see e.g., Webster and Leleux, 2018; Granier and Kudo, 2016) also play a prominent role. In addition, the applied case illustration has demonstrated the presumed added value of this framework. This paper concludes that smart urban governance, by explicitly taking into account the specific socio-spatial context, can improve our understanding of the urban challenges associated to smart cities and contribute to its appropriate and 'smart' governance.

Despite the potential of smart urban governance for handling city transformations, our conceptual framework is in its initial stage, and certain blind spots and biases still exist. From this perspective, we set out some suggestions for future research, to further enhance our conceptual and theoretical understanding of smart urban governance and its usefulness in practice. First, we think an international survey on practical smart urban governance projects can benefit the discussion on what are the contextual factors influencing smart urban governance in practice. Second, research could concentrate on the interrelationship of ICT with governance and urban space, mediated by context-specificities. Questions for this research include: what is the added value of ICT within smart urban governance? How does ICT shape urban space and governance processes in smart urban governance? What kinds of smart urban governance modes can be produced through the interaction between urban space, institutional actors and ICT in practice? Third, research could focus on the mechanisms of how present-day ‘urban governance’ can be transformed into ‘smart urban governance’. Problem statement for research can be: key success/failure factors that transform traditional urban governance into smart urban governance in practice. In our research we provided the first steps, but these need further elaboration to stress the urgency of the symbiosis between the smart governance and urban governance discourses.

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Chapter 3

Smart Urban Governance: An Alternative to Technocratic "Smartness"

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Abstract: This paper argues for a specific urban planning perspective on smart governance that we call "smart urban governance," which represents a move away from the technocratic way of governing cities often found in smart cities. A framework on smart urban governance is proposed on the basis of three intertwined key components, namely spatial, institutional, and technological components. To test the applicability of the framework, we conducted an international questionnaire survey on smart city projects. We then identified and discursively analyzed two smart city projects—Smart Nation Singapore and Helsinki Smart City—to illustrate how this framework works in practice. The questionnaire survey revealed that smart urban governance varies remarkably: As urban issues differ in different contexts, the governance modes and relevant ICT functionalities applied also differ considerably. Moreover, the case analysis indicates that a focus on substantive urban challenges helps to define appropriate modes of governance and develop dedicated technologies that can contribute to solving specific smart city challenges. The analyses of both cases highlight the importance of context (cultural, political, economic, etc.) in analyzing interactions between the components. In this, smart urban governance promotes a sociotechnical way of governing cities in the "smart" era by starting with the urban issue at stake, promoting demand-driven governance modes, and shaping technological intelligence more socially, given the specific context.

3.1 Introduction

The pressure of urbanization coupled with lingering economic instability and global climate change has created various new challenges for cities, such as traffic congestion, crime, economic stagnation, population segregation and air pollution (Batty et al. 2012; Hollands 2008). To deal with these urban challenges, the notion of the smart city has been proposed as a potential solution. In many countries, smart cities are developed to increase equitable access to basic urban services, such as education, healthcare, sanitation, drinking water, and mobility. Local governments expect that by employing various smart ICTs, operational and managerial efficiency, citizen engagement in service co-production, and quality of life can be significantly improved. Although the concept of the smart city is considered to have great potential, associated governance challenges have prevented cities from achieving the expected outcomes (Ruhlandt 2018). As Barns (2018:6) comments, the ideals of the smart city in seeking to benefit from digital services necessitate a "reinvention of governance."

The recent increase in research into the concept of smart governance is one such effort seeking to achieve the better governance of the smart city (Ruhlandt 2018; Webster and Leleux 2018; Scholl and AlAwadhi 2016; Scholl and Scholl 2014). Smart governance emerges mainly due to the growing role of technology in the functioning of cities, which has made governmental agencies rethink their roles in such data-rich cities (Bolívar and Meijer 2016). Smart governance can use various smart technologies (e.g., big data, Internet of Things (IoTs), and Artificial Intelligence (AI)) to upgrade traditional administrative systems (e.g., e-government) to the city level by streamlining city operations, making better decisions, and delivering improved quality of life (Pereira et al. 2018; Webster and Leleux, 2018).

However, smart governance in practice is strongly characterized by a supply-oriented, technocratic way of governing cities (e.g., Marvin et al. 2015). In this process, much emphasis is put on the role of technology in collecting data and producing knowledge to smarten government operations and automate urban system functions (Jiang et al., 2020a, 2020b; Verrest and Pfeffer 2019; Kitchin et al. 2016; Kitchin 2014). Such an approach focusing on digital and technology-driven innovation is often considered to be a universal solution to varied urban issues in different cities (Verrest and Pfeffer 2019). According to some authors, technocratic "smart" governance conceals those urban issues, conflicts, and controversies that cannot be represented by digital tools and data analytics (e.g., social discrimination and mental illness) (Bina et al. 2020; Cardullo and Kitchin 2019; Hashem et al. 2016; Rathore et al. 2016).

Therefore, many authors urge that more transformative and sociotechnical governance approaches are needed to transform the current form of smart governance (Jiang et al. 2019a, 2019b; Dano et al. 2019; Joss et al. 2019; Webster and Leleux 2018; Ruhlandt 2018). For instance, Meijer and Bolívar (2016) argue that smart governance should promote new forms of human collaboration through the use of ICTs to obtain better outcomes and more open governance processes. For them, more emphasis should be put on social inclusion, social capital, and sustainability; thereafter, we should study smart governance as a complex process of institutional change and acknowledge the political nature of appealing visions of sociotechnical governance. Verrest and Pfeffer (2019:1329) highlight that there is a failure to consider the "urban" as a response to "what urban challenges related to smart cities are and what appropriate [governance] solutions are." This perspective indicates that we need to become more aware of how urban problems and their proposed smart solutions are socially constructed. In response to the calls for transformative "smart" governance, some authors argue that we must start with the "urban" and not with the "smart," shifting from a technology-pushed to an application-pulled governance approach, and shaping technologies socially (Jiang et al. 2020a, 2020b; Tomor et al. 2019; McFarlane and Söderström 2017; Stratigea et al. 2015).

Based on the above, the aim of this paper is to present a specific urban planning perspective on smart governance: smart urban governance. The contribution of smart urban governance moves away from technocratic smart governance toward promoting an urban social process of smart governance innovation. In this context, Jiang et al. (2019b: 247) stress that real "smart" governance should integrate "the 'smart' from smart governance literature" with "the 'urban' from urban governance literature," as a means of "smartening" urban governance and highlighting the importance of urban dynamics in shaping smart governance. This paper presents three interconnected components of smart urban governance, namely the spatial (substantive urban challenges), institutional (modes of governance), and technological components (technological intelligence). By examining them and showing how they interact with each other, mediated by context specificities, it proffers a context-based, sociotechnical response to urban challenges related to smart cities and opens up new possibilities for transformative city governance.

The remainder of this paper is organized as follows. Section 2 focuses on the theoretical background and evaluates the dominant perspective on the smart governance debates. The three abovementioned components are discussed in detail in Section 3 and a context-based, sociotechnical governance approach—smart urban governance—is framed to connect these components. Section 4 introduces the research methodology. Two sets of empirical analyses are presented in Section 5 to show the added value of the framework. Section 6 discusses the findings and their potential implications, and concludes this paper.

3.2 Theoretical background

3.2.1 Smart city: opportunities and challenges still coexist

It has been over ten years since the smart city concept was explicitly advocated by Hollands (2008). In literature, there are two overarching approaches to discussing smart cities, namely the technology-driven approach and the human-driven approach. A recurring aspect in the definition of a smart city is the use of ICTs. According to the technology-driven approach, smart cities focus on the acceptance and use of technologies, and their integration into the city infrastructure, to increase efficiency and effectiveness in the city environment (Greenfield 2013; Batty et al. 2012). Accordingly, policymakers and ICT suppliers are expected to come together to plan smart cities and deploy ICT-based solutions (Cardullo and Kitchin 2019; Simonofski et al. 2019; Calzada and Cobo 2015; Shelton et al. 2015).

In contrast, the human-driven approach highlights that the use of ICTs by communities must enable them to participate more fully in so-called knowledge societies (Barns 2018; Jiang et al. 2020a; Leydesdorff and Deakin 2011). For instance, Neirotti et al. (2014) argue that smart cities should take advantage of the opportunities offered by ICT to involve multi-actor, multi-sector, and multilevel perspectives and promote community-based smart city building. Kummitha and Crutzen (2017) emphasize that smart cities need to create more avenues for social interactions between different stakeholders and enhance the skills and capabilities of local people and communities to benefit their daily life. In this perspective, smart cities should be seen from a user-centered view with more emphasis on citizens and other stakeholders than on the technology itself.

Based on the differing priorities within smart cities, Caragliu et al. (2011) stress that a comprehensive definition of the smart city concept is needed to incorporate the multiple strands. They consider a city as 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" (Caragliu et al. 2011:70). According to this definition, the concept of smart cities should promote people-centered development, incorporate ICTs into urban management, and stimulate the design of an effective government that includes collaborative planning and citizen participation.

In practice, however, the development of smart cities is over-reliant on the deployment of ICTs or technological infrastructures, and neglects social services of general interest (Monachesi 2020; Desdemoustier et al. 2019; Simonofski et al. 2019; Datta 2015). As a consequence, many smart city initiatives are criticized for their "self-proclaiming and self-congratulatory" notions of such smartness (Hollands 2008: 62). As noted by some scholars, the concept of smart city is simply used as a business model for large high-tech companies to market their technology products and to privatize public space (Kitchin et al. 2016; Marvin et al., 2015). It is seen by some authors as paving the way for a corporatization of city governance that largely excludes the interests and contributions of ordinary people (Shelton and Lodato 2019; Grossi and Pianezzi 2017).

The failure to recognize the value of bottom-up innovation has increased social inequality (Simonofski et al., 2019; Effing and Groot 2016). Although there is no doubt that ICTs can help create new knowledge and discover improved ways of governing cities, ICTs are just an enabler, not a panacea for all the problems and issues faced by cities and humankind (Joss et al., 2019; Kummitha and Crutzen 2017). Various services can be offered to citizens via ICT-augmented government systems, but not everyone in the city can benefit from those services, especially people with a low socioeconomic status and those who are marginalized or excluded in some way (e.g., refugees, migrants, asylum seekers) (Cardullo and Kitchin 2019; Simonofski et al., 2019; Willis 2017).

As Bolívar (2018:1) asserts, "many of the challenges to be faced by smart cities surpass the capacities, capabilities, and reaches of their traditional institutions and their classical processes of governing." For smart cities to be effective, there is a need to critically evaluate the present governance of smart cities and to promote more transformative governance approaches (Jiang et al., 2020b; Dano et al., 2019; Ruhlandt 2018).

3.2.2 Smart governance: a critical review

As a component of smart cities (Caragliu et al., 2011), the smart governance concept is being increasingly employed by policymakers and private companies to create smarter cities by using key terms such as smart decision-making, smart administration, and smart collaboration (Ruhlandt 2018; Scholl and Scholl 2014). However, there is no commonly accepted definition of smart governance. Based on an extensive literature review, it seems that smart governance can mean 1) making the right policy choices (cf. Nam 2012), 2) developing innovative governance structures via ICT (cf. Meijer and Bolívar 2016), or 3) governing with a focus on the outcome, that is, dealing with substantive urban challenges (cf. Jiang et al.,, 2019b). Elaborating on the concept of smart governance from these three angles adds to a better understanding of the concept.

In practice, many authors have demonstrated the added value of smart governance for smartening a city and promoting a high quality of life. For instance, Scholl and AlAwadhi (2016) show that ICT-enabled governance facilitates collaboration between different cities to provide smart services that no single municipality can provide alone. Meijer and Thaens (2018) assert that smart governance supports the collection of data to strengthen the governance of urban safety. More recently, smart governance has been used to handle the COVID-19 pandemic in South Korea by facilitating proactive information-sharing and enabling citizens to understand the situation and follow the newly released safety guidelines (Choi et al., 2020).

Although smart governance shows great potential for "smart" city developments, smart governance has been criticized for its technocratic way of governing cities (Jiang et al., 2020a, 2020b; Verrest and Pfeffer 2019; Barns, 2018). In this process, governments treat the smart governance of cities merely as a management issue that can be dealt with by making use of the power of data analytics (Krivý 2018; Shelton et al., 2015; Kitchin 2014). In practice, several examples can be found of decision-makers in government that perceive important urban problems as being solvable primarily through the application of technologically derived knowledge; for instance, by transforming the characteristics of local places (geology and landform) and human-related variables (gender and religion) into configurable report tables and graphs (Hashem et al., 2016; Rathore et al., 2016). The assumption underlying this technocratic approach is that knowledge produced with the help of technology is considered "value-free" and "objective," and will unbiasedly help governance. Furthermore, due to the failure to consider the urban setting, the place-based knowledge of local people can hardly be received and reflected in the formulation and production of policy content (Bina et al., 2020; Cardullo and Kitchin 2019; Söderström et al., 2014). In short, technocratic smart governance neglects the role of contextualization in shaping the governance process.

In addition, the implementation of smart governance is often closely related to the ideological nature of the discourse around neoliberalism, implying its close association with corporate interests (Jiang et al., 2020a; Sadowski 2020; Barns 2018; Hollands 2015). According to Springer et al., (2016), neoliberalism in practice is usually aligned with policies of economic liberalization, such as privatization, lowering taxes, free trade, and reductions in government spending and regulations. As for urban governance and urban development, neoliberalism implies making the public sector more efficient through processes of marketization and the outsourcing of urban services to private companies (Jessop 2002). As many smart city initiatives show, ideas about urban development are often closely related to the imaginations and plans of key private corporations (e.g., IBM's Smarter Planet and Cisco's Smart+Connected Communities) (Wiig 2015). Governments then play an active role in facilitating the process of designing, creating, and implementing policies for smart city development (Hollands, 2015). As Luque-Ayala et al., (2016) note, the implementation of smart governance helps private corporations to sell their "smart" packages and local governments to promote their political and social interests. However, the interests of local people are usually largely excluded from such governance processes (Jiang et al., 2020a; McFarlane and Söderström 2017). Consequently, smart governance in practice typically presents a situation in which power, wealth, and business capital play a key role in directing and controlling the discourses and practices of smart cities (Krivý 2018; Kitchin 2014).

Furthermore, in some countries—for example, China, Vietnam, and Saudi Arabia—technocratic smart governance controversially enhances the authoritarian and potentially oppressive systems of governance (Keegan 2020; Anderlini 2019; Fountain 2001; Pali and Schuilenburg 2019). For instance, in China the governance-oriented City Brain project in Hangzhou employs advanced video monitoring, facial recognition systems, and predictive policing to monitor, anticipate, and influence the behavior of individuals and certain groups (Beall 2018; The Trend Letter 2017). Although it significantly enhances the governing capabilities of Hangzhou city government, according to some authors, the networks and techniques of surveillance and control largely acted as generators of feelings of discomfort and uneasiness in citizens (Beall, 2018) and consequently reduces their mental health and wellbeing (Whittaker 2019; Pali and Schuilenburg 2019). Similarly, in other projects like Songdo Ubiquitous City, South Korea, and Masdar City in the United Arab Emirates, actions taken by governments, businesses, and other organizations as a result of big data analytics produce privacy and security concerns (Kuecker and Hartley 2020; Angelidou 2017).

Thus, rather than offering innovative and effective approaches for dealing with various urban problems, the shortfalls of present-day smart governance have created extra challenges for smart city developments. Several authors argue that smart governance has focused too much on the technical, engineering, and economic dimensions, while there is a lack of consideration for the role of urban social processes in shaping and configuring its meaning in practice (Faraji et al., 2019; Krivý 2018; Marvin et al., 2015; Söderström et al., 2014). Smart governance largely leaves the smart to the powerful (government and corporate elites) rather than foregrounding smart in the lifeworlds of different stakeholders (especially citizens) in the city (Datta 2015). The "place-based, experiential" knowledge generated through the wishes, demands, requirements, and conditions of ordinary people—especially the urban poor and the marginalized—is often ignored (McFarlane and Söderström 2017:318). In addition, the technocratic way of governing cities can hardly take into account the ways in which residents learn what really matters in their urban environment and how that might be supported. The outcome of technocratic smart governance may be highly unequal in urban societies, characterized by unequal power relations, social exclusion, and unbalanced distributions of costs and benefits

(Kitchin et al., 2016). Therefore, for transformative smart governance, we must better understand the reasons for the acceptance or rejection of a technology as an appropriate solution for specific urban problems (Jiang et al., 2020a, 2020b; Tomor et al., 2019; Verrest and Pfeffer 2019; Joss et al., 2019; Ruhlandt 2018).

3.3 Smart Urban Governance: three interrelated components

In line with the foregoing, in this section we further elaborate upon smart urban governance by identifying its three key components—namely its spatial, institutional, and technological components—and their interrelationships.

3.3.1 Spatial component: urban challenges

When smart governance is concerned with urban space, it considers this foremost as the spatial carrier of governance objects (Jiang et al., 2019b). However, from a smart urban governance perspective, the urban space constitutes the diversity of urban challenges that ask for governance action. It should be noted that urban studies have a long tradition of critically examining the interface between urban challenges and digital technologies (Graham and Marvin 2002). For instance, the introduction of a technological innovation often originates from handling urgent urban challenges like mobility congestion or social segregation issues (Vonk 2006). Consequently, in smart urban governance, narratives and practices around the notion of smartness should focus not merely on the problem-solving powers of big data, city sensors, and intelligent infrastructure, but primarily on the role of urban challenges in stipulating the functional support of technological innovations (Jiang et al., 2020b). In that, a prime focus on the pressing urban challenges can enhance the capabilities of ICT to contribute to the problem-solving nature of the governance object.

In accordance with the concept of "sustainability," Figure 3.1 illustrates the associated main urban challenges, namely "to grow the economy, distribute the growth fairly, and in the process not degrade the ecosystem" (Campbell 1996:3). It points out the main urban challenges faced by contemporary cities and indicates the targets that smart rationalities and techniques should meet. In particular, the trade-offs between the sustainability goals can be considered a huge urban challenge. As such, we believe that the model of economic, social, and ecological claims and the trade-offs between them to arrive at "sustainability" is in itself of value to frame the nature of urban challenges; it thus constitutes the “spatial” component of our concept of smart urban governance.

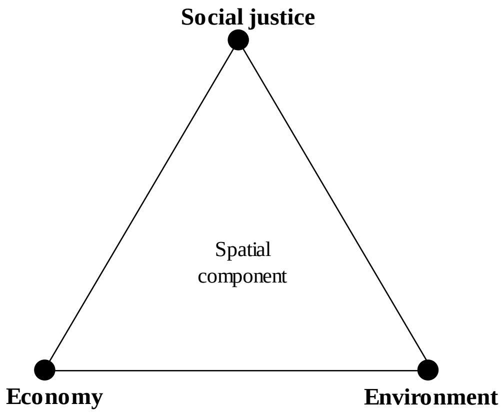

Figure 3.1 Spatial component: urban challenges

3.3.2 Institutional component: modes of governance

Smart urban governance also needs input and contributions from various groups and organizations. To successfully deal with pressing urban challenges, actors from the state, market, and/or civil society have to collaborate in innovative ways, or “modes of governance” (Driessen et al., 2012). This differs sharply from the notion of technocratic smart governance, which emphasizes either the government as the prime initiator of innovative solutions, or the private sector as the provider of ICT-based smart solutions.

The literature discusses distinct structures of governance. However, each mode of governance implies the involvement, in some form, of the three mentioned types of actors (Driessen et al., 2012). Based on the degree of power sharing between these actors in the decision-making process, the structure of governance can be classified as either authoritative, competitive, or cooperative (Roberts 2000). Figure 3.2 integrates the abovementioned actors and their collaboration, which constitutes the institutional component of smart urban governance. The basic idea of this triangle is that the institutional component within smart urban governance is composed of the interactions between actors from the state, market, and/or civil society to arrive at well-intended solutions.

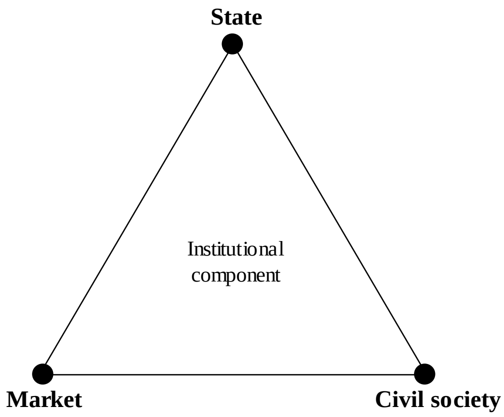

Figure 3.2 Institutional component: modes of governance

3.3.3 Technological component: functional intelligence

The previous subsections show that smart urban governance should start from urban challenges and be attuned to the wider group of involved urban actors. As for the role of technology in smart urban governance, it means that technological innovation should satisfy the real needs of the actors within governance practices to be able to deal with pressing urban challenges (Jiang et al., 2019a, 2020a, 2020b; Meijer and Thaens 2018).

In technological innovation studies, each technological artifact has different meanings and interpretations for various actors. Thus, smart urban governance should build upon the knowledge, ideas, and opinions of different actors to create innovative technological functions that can satisfy their real needs. To do so, in smart urban governance the technological component is envisioned by its functional intelligence. Based on Geertman (2014) and Vonk (2006), these information-handling capabilities of technologies can be categorized into three groups: "informing ICT," "communicating ICT," and "analyzing and designing ICT." The first capability—informing ICT—is intended to make governance-related knowledge and information accessible and interpretable from an access point or sender toward a user. The second—communicating ICT– is aimed at facilitating communication and discussion processes between those involved in the governance process by supporting flows of information between them. And the third capability—analyzing and designing ICT—is intended to facilitate the advanced processing of data to detect urban patterns and the underlying processes, in order to facilitate the perception, creation, and presentation of design ideas (Geertman 2014). These distinctive functional intelligences provide different urban actors with the proper support capabilities to deal with the diversity of urban challenges. For instance, the communicating capability of ICT can help build collaborative forms of decision-making, while the analyzing capability of ICT can help users to process data and facilitate the simulation of potential solutions to urban problems. The functional intelligence represents the "technological" component of smart urban governance and is illustrated in Figure 3.3.

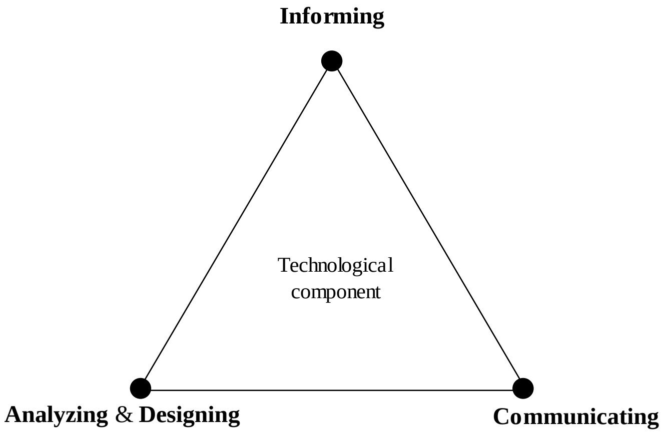

Figure 3.3 Technological component: functional intelligence

3.3.4 A context-based, sociotechnical governance approach

The three abovementioned components can be integrated into a conceptual framework for smart urban governance (Figure 3.4). This framework indicates how the three interrelated components can achieve a balanced governance structure. The three thicker arrows show the interrelationships between the spatial, institutional, and technological components. The figure thus represents a state of co-evolution whereby one component interacts closely with the others and in which changes in one component will have consequences for the others. These interactions are crucial to avoid the previously mentioned technocratic way of governing cities and form the sociotechnical response to smartening city governance.

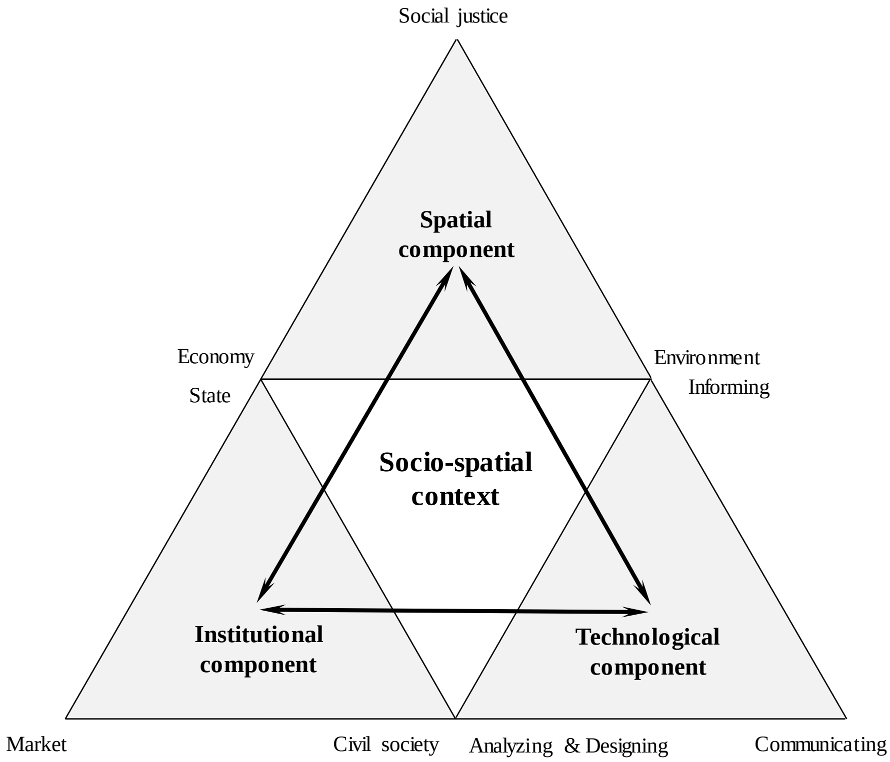

Figure 3.4 Smart urban governance framework

In addition, smart urban governance can only function properly when it is put into the specific socio-spatial context of a city (Geertman 2006; Jiang et al., 2019b). According to Jiang et al., (2020a), five key contextual factors can be identified from the smart city governance literature, that is, economic, political, cultural, and technological factors and the urban issue itself. Unlike previous smart governance approaches, this smart urban governance framework underlines the importance of these local urban contextual characteristics that should therefore be explicitly taken into consideration.

Smart urban governance strives to create a context-focused, sociotechnical governance approach to coordinate and steer the objectives, actors, and artifacts, namely urban challenges, institutional modes of governance, and technological intelligence. It stresses that smart urban governance departs from the urban challenges (= goal) and from that identifies the appropriate modes of governance and technologies (= means), given the context in which it is embedded. Thus, the smartness of smart urban governance refers to the potential of its components' interactions, in a specific context, to increase our capacity to handle urban challenges, enhance stakeholders' capabilities for collaboration, and improve technology's usefulness, all aimed at achieving smart city development. In the following sections, with the help of an international questionnaire survey and two illustrative cases collected via index systems, we demonstrate the added value of this framework in practice.

3.4 Methodology

We first discuss how we conducted the questionnaire survey, which was used to show the applicability of the smart urban governance framework. We then explain how we selected the two illustrative cases to demonstrate the detailed working mechanisms of the framework.

3.4.1 Survey on smart city projects worldwide

In May–July 2019, we sent a questionnaire to the Computers in Urban Planning and Urban Management (CUPUM) research community via electronic and regular mailing lists. About 1,300 people worldwide were invited to fill in the questionnaire. The reason for selecting the CUPUM community as respondents was that: 1) CUPUM is a major international academic conference that provides an advanced platform for the dissemination of information and knowledge on the science and technology of big data, smart cities, and smart urban futures (Geertman et al., 2019); and 2) participants of CUPUM (mainly scholars, technologists, and doctoral students) possess comprehensive knowledge and skills and rich experiences related to ICT application in city governance and planning. Thus, they offered a highly professional overview of smart urban governance in the context of smart cities. Of the approximately 1,300 questionnaires sent out, 268 were completed by respondents (response rate of just over 20%). Of these completed questionnaires, 175 had been filled out by respondents who had been professionally involved in smart city projects. We therefore used their questionnaires in our analysis.

The questionnaire had two parts. The first part gathered basic data on the (anonymous) participants, such as gender, age, profession, origin, and expertise in the use of ICT. Respondents were also asked about their expertise and personal experiences with smart city projects. The second part gathered in-depth information about the different features of the framework (e.g., context, urban problems, governance modes, types of technologies) for smart urban governance in practice. We carried out statistical analysis of the statements relevant to this study to demonstrate the applicability of the smart urban governance framework in a wide variety of smart city cases[4].

3.4.2 Stepping into two illustrative cases

Using the data obtained through the questionnaire, we focus on two smart city projects—Smart Nation Singapore and Helsinki Smart City—to illustrate the detailed working mechanisms of the framework. The selection of these two case studies was based on an extensive review of key international literature and of smart city projects worldwide . Two sets of data—policy documents and data related to smart city practices—were gathered and studied to examine the governance processes of the two cases. First, online search engines were used to collect policy-related documents based on keywords (e.g., "Singapore Smart Nation" and "Helsinki Smart City"). A snowball sampling method enabled the tracking and collecting of other potentially relevant policy documents. Second, local government portals and academic search engines were used to gather data related to these smart city practices. The practice-related data were mainly derived from academic literature, governmental portals, social media blogs, and digital newspaper archives.

Discourse analysis—which reveals the meaning of texts and other forms of communication in their social and institutional contexts—was applied to investigate the various features and their significance for smart urban governance in both cases. The present research employed two key dimensions of discourse analysis developed by Fairclough (1995). First, the units of analysis of a text analysis are empirical evidence of the latent meaning found in the discourse analysis. Therefore, text analysis was used to determine the features of the smart urban governance framework. Second, social practice requires a study of discourses in relation to wider power structures and social and cultural contexts. Based on the discursive analysis of each case, we compared the similarities and differences between smart urban governance in these two projects.

3.4.3 Analysis guidelines

Following the conceptual framework, the analysis 1) focused on the urgent urban issues facing cities; 2) examined how the characteristics of the urban issue influence or define the choice of a specific mode of governance; 3) explored how the urban issue and the selected governance mode together determine the choice of functional intelligence (ICT

[4] See Appendix II on detailed information of the statements.

functionality); and 4) enquired into the role of contextual factors in mediating the interactions of the components of smart urban governance. Below we demonstrate how the smart urban governance framework can contribute to analyzing a context-focused, sociotechnical way of governing cities.

3.5 Smart urban governance in practice

In this section, the results obtained via the questionnaire survey are presented to show the applicability of the smart urban governance framework in a wider range of smart city cases. This is followed by two illustrative smart city cases, which show the detailed working mechanisms of the framework.

3.5.1 Applicability of smart urban governance in wider contexts

Concerning geographical origin, most of the respondents (53%) came from China; the others came from Europe (15.4%), Asia (excluding China) (14.2%), Oceania (5.1%), South America (5.1%), North America (5.1%), and Africa (2.3%). This indicates the variety of the socio-spatial contexts in which smart urban governance is embedded.

In terms of types of urban issues handled, the majority of issues (61.2%) were mixed urban issues (combinations of either economic, social, or environmental issues), while 24.6% of the projects were related to only economic issues, 8.5% to only social issues, and 5.7% to only environmental issues.

To handle these issues, various modes of governance were applied: 12.6% of the projects adopted a centralized mode of governance, 28% a decentralized mode of governance, 8% public–private governance, 44.6% an interactive mode of governance, and 6.9% self-governance. The frequency (absolute number) of use of each governance mode in handling the different types of urban issues (see Jiang et al., 2020c) shows that centralized and decentralized governance were mainly employed to solve economic issues (mostly transportation and mobility), while the other governance modes were typically used to solve mixed urban issues. No governance modes were created to exclusively handle either social (e.g., housing) or environmental issues.

Furthermore, in terms of types of ICT applied to support governance processes and handle urban issues, 2.8% of the projects used only informing ICT, 1.7% only communicating ICT, and 48% only analyzing and designing ICT; 47% adopted hybrid ICT tools (combinations of either informing, communicating or analyzing and designing ICT). We also calculated the frequency (absolute number) of the use of each type of ICT in supporting governance processes and handling urban issues (see Jiang et al., 2020c). First, concerning the linkages between ICT and governance processes, analyzing and designing ICT was mainly used to support decentralized and interactive governance modes, whereas informing ICT and communicating ICT were primarily applied to improve interactive governance modes; few ICT tools were adopted to support public–private governance and self-governance. Second, concerning the linkages between ICT and urban issues, analyzing and designing ICT was typically used to handle mixed urban issues, while informing ICT and communicating ICT were applied to handle economic issues (mainly transportation and mobility issues); few ICT tools were exclusively used to handle either social or environmental issues.

The questionnaire revealed that smart urban governance varies significantly in different socio-spatial contexts. As urban issues differ in different countries, the modes of governance and types of technologies applied also differ. This implies that smart urban governance contextualizes itself and forms a sociotechnical response to urban challenges in the context of smart cities. In the next subsections, we discuss two illustrative cases to show how this context-based, sociotechnical way of governing cities (smart urban governance) works in practice.

3.5.2 Two specific illustrative cases

3.5.2.1 Smart Nation Singapore

Urban issues

In recent decades, Singapore's main urban issues (high energy consumption; insufficient transportation infrastructure and solid waste management; inadequate housing; high unemployment; and environmental vulnerabilities) have been exacerbated by rapid urbanization, increasing urban density, and the high demands of urban environments. More recent changing structures of international competitiveness, along with Singapore's increasing burdens of an ageing population, a widening income gap, and declining productivity, further magnify the negative impact on the city's sustainable development (Bhaskaran 2018). Against this background, the Smart Nation project was launched by the government as a nationwide effort to take advantage of the recent emergence of smart ICTs (e.g., immersive media, AI, IoT, and robotics) to handle these sustainability challenges (Tan and Zhou 2018).

Governance choice

Influenced by Singapore's massive urban issues, along with its top-down institutions and dominant government-led approaches (Ho 2017), the government adopted a "whole-of-government" centralized approach to govern the Smart Nation initiative at the national scale (Khern 2019). Two key government agencies—Smart Nation and Digital Government Group (SNDGG) and Government Technology Agency (GovTech)—placed under the Prime Minister's Office (PMO) were established in 2017 as the central governing body for the Smart Nation initiative. The position of Singapore as a city-state with limited natural and social resources requires it to stimulate innovative advances (e.g., productivity improvement and knowledge economy) and create successful transitions to a more sustainable and resilient future (Cavada et al., 2019; Hoe 2016). As Chesbrough (2006) argues, the nature and characteristics of innovative activities call for the involvement of multiple stakeholders to jointly test, develop, and create smart solutions. Accordingly, the focal point of urban governance in Singapore has also witnessed the emergence of government-led participatory and collaborative approaches to solve its complex and intertwined urban problems (Tan and Zhou 2018).

Selection of ICT functionality

To support the whole-of-government approach and handle service-relevant issues, the abovementioned "informing" functionality was initially created and applied to facilitate the governing of the Smart Nation initiative. For instance, web-based ICTs were used to radically overhaul the city-state's existing government systems and to build a comprehensive, digital government administration platform—Core Operations, Development Environment, and eXchange (CODEX)—to deal with the segmented e-citizen services and applications. A transformative open government data portal (data.gov.sg) was then launched to provide one-stop access to the government's publicly available datasets, covering health, transportation, education, housing, the environment, etc. Various communicating ICTs such as online platforms and networks were also developed by government-linked companies to build a system of mechanisms for collaborative innovation. The best illustration of this government-led, ICT-enabled collaboration is the development of startup companies and innovations in technology-based services and products. For instance, AI Singapore—an online innovation platform aiming to engage all Singapore-based ecosystems of AI startups, AI producers, and research institutions—was established by a government-wide partnership comprising the SNDGG, National Research Foundation, Integrated Health Information Systems, etc.

Through crowdsourcing, hackathons, and living labs, it supports new startup companies and/or develops technology-based solutions to address Singapore's urban problems[5].

The government's efforts in recent decades to improve Singaporeans' digital literacy and technology skills have enabled ordinary people to utilize neighborhood forums, blogs, and websites to improve the way they live, work, and play (Cavada et al., 2019). For instance, a government-facilitated crowdsourcing portal "eCitizen Ideas" allows citizens to share or contribute their opinions, suggestions, and ideas related to daily issues faced by the public, often through campaigns, competitions, and hackathons organized by various government agencies (Woo 2018). Also, collaborations between elderly people and state-owned companies have facilitated the development of the Smart Elderly Alert System, which tracks the movement and activities of the elderly and enables them to live independently. In addition, social media like Twitter and Facebook are also used by innovation enthusiasts to engage in some of the aforementioned innovation activities (e.g., co-production of healthcare services), or curate events and host discussions around new technologies such as blockchains, MedTech, and IoT (Khern 2019).

Role of contextual factors

Looking at the interactions of urban issues, governance modes, and ICT functionality in Singapore, we also see the importance of the embedded context (e.g., political institutions, resource constraints, and technological basis) in analyzing the development, implementation, and effects of smart urban governance. For instance, influenced by Singapore's massive urban issues and its top-down political tradition, a whole-of-government approach was initially applied to enhance the participatory efforts of various government agencies and enable data to be exploited across individual, organizational, and national boundaries. Then, the position of Singapore as a city-state with limited resources led to more collaborative approaches aimed at mobilizing the strength of the whole of Singapore to address its issues. However, due to the government's special relationship with the consortium (i.e. government-linked companies), the government and its agent companies still have a role within the collaboration process (Cavada et al., 2019). Influenced by this, ICTs and web-based telecommunication technologies were used either to improve the government's capabilities to deliver efficient and effective services, or to make use of the knowledge and insight of local people to boost urban innovations and

[5] https://www.aisingapore.org/

improve residents' quality of life. This thus reflects a combination of more state-led, informing intelligence and more collaborative governance approaches in Singapore.

3.5.2.2 Helsinki Smart City

Urban issues

Helsinki's rapid urbanization over the past twenty years has led to a range of urban issues that could restrict its ability to create a sustainable future. Population growth driven by migration has greatly increased the demand for public services, such as energy provision, transportation infrastructure, housing, and employment. In addition, localized environmental problems such as indoor air pollution, vehicle emissions, and the pollution of lakes and coastal areas threaten the living conditions of Helsinki's residents. Against this background, in 2014 the Helsinki government initiated the Helsinki Smart City program to handle these sustainability challenges (Research and Innovation Strategy for Regional Development 2014–2020, updated by Helsinki Smart Region—Strategy Update 2018–2020 in 2017). As Laakso (2017) illustrates, the overall purpose of Helsinki's transition toward a smarter city is to create new business models, improve residents' quality of life, and make Helsinki more sustainable and resilient.

Governance choice

According to Anttiroiko (2016), Helsinki—Finland's capital city—is characterized by its democratic tradition and bottom-up institutions and decision-making processes. Influenced by this, smart urban governance in Helsinki has been approached, since its inception, from an integrative perspective on urban problems, using triple helix collaborations (Hämäläinen 2020). An ideal illustration of Helsinki's smart urban governance is the Smart Kalasatama project initiated by Helsinki City Council in 2013 to become a co-created model district for smart living (e.g., unique housing, accessible and flexible living, sports, recreation, greenery). Considering city residents both as the most precious resources and the beneficial owners, the Smart Kalasatama project itself acts as the test and experimentation environment for different stakeholders (mainly enterprises, urban planners, local citizens, and students) to co-create the district.

Selection of ICT functionality

To support Helsinki's smart urban collaboration, practices showed that right from the beginning, the Helsinki government has used an integrative innovation platform—Forum Virium Helsinki—to co-produce the Helsinki Smart City with universities, companies, and local citizens. The platform serves a wide range of roles (e.g., innovation communities, growth services, participatory and collaborative urban design, and investment). Since its establishment in the mid-2000s, Forum Virium Helsinki has advanced and witnessed a booming growth of living labs, crowdsourcing, open data, urban services, and mobile apps. For instance, Helsinki Living Lab was established and is coordinated by Forum Virium Helsinki to engage interested groups and absorb their new ideas and innovative concepts for service innovation. By using distributed user interfaces on the spot or via the web-based platforms, interested groups can participate in various co-production and/or co-creation activities, such as healthy neighborhoods, mobile services tests, waste collection systems, and future schools.

The applied participatory and citizen-based governance not only enhanced the capabilities of Helsinki to provide functional services, but also fostered social responsibility for tackling urban issues that are of collective concern. Influenced by this, integrating digitally assisted tools with face-to-face interaction creates self-organized innovation spaces that allow local residents to collaborate at the same level as experts (researchers) to discuss and make community-based plans. An example of this is the Aalto Built Environment Lab[6]. Facilitated by large projection displays and support equipment, such as microphones and cameras, planning experts from Aalto University work and communicate collaboratively with broader community stakeholders (e.g., city planners, politicians, residents, and landowners). By further using ICT-enabled data analytics and visualizations to present the issues of concern, discussions between engaged stakeholders co-produce a large variety of ideas, suggestions, and knowledge as the foundation for planning their community. According to Anttiroiko (2016), the governance of Helsinki Smart City is largely built on ICT-enabled, user-oriented "platformization" to mobilize public data and local knowledge and provide tailored services and solutions.

Role of contextual factors

Helsinki's democratic culture and active civil society, along with its bottom-up decision-making process, have enabled the municipal government to tackle its sustainability challenges based on wider collaboration between governments, businesses, citizens, and research institutions. In such an environment, civic engagement and collaboration are often considered the key features of Helsinki's smart city development. Many solutions to Helsinki's urban challenges have been the result of community-based collaborations

[6] https://www.aalto.fi/en/aalto-built-environment-laboratory

between citizens, businesses, and local government, rather than being produced in a top-down bureaucratic way. Various smart technologies (e.g., living labs, platforms, and service- and user-oriented apps) have been developed to engage different stakeholders, especially citizens, to participate in the co-production of services that meet their real needs. Consequently, smart urban governance in Helsinki shows how a people-centered issue (smart living) provides a co-innovative setting in which diverse stakeholders jointly test and create smart solutions through online and offline platforms (Anttiroiko, 2016).

3.5.2.3 Comparison and reflection

The analysis first indicates that, as urban issues differ in Singapore and Helsinki, the appropriate governance modes and relevant ICT functionalities applied also differ. As mentioned, "smart nation" Singapore endeavors to handle both strategic issues that have a long-term impact on survival, and daily issues that influence the quality of life (Hoe 2016). Because of this, it adopted a combination of whole-of-government, centralized, and more collaborative approaches. As for the role of technological intelligence, informing and communicating ICTs are developed and implemented to either deliver public services or facilitate collaborative activities (e.g., product and service innovation). In contrast, "co-created smart" Helsinki shows more concern about the living environment and the level of wellbeing offered to its inhabitants. Therefore, more citizen-centric, integrated, and ICT-facilitated flat structures were selected to govern the Helsinki Smart City project. In terms of the role of technologies, integrative functionalities (informing, communicating, and/or analyzing and designing) allow decision-makers to derive valuable insights into issues, something that previously was not possible. In addition, these technologies greatly facilitate open innovation, experimentation, and citizen engagement in the co-creation and co-production of urban services and urban living.

Second, the analysis also shows the importance of the specific context (cultural, political, economic, etc.) in influencing the choices both within each component and in their interaction, resulting in distinct forms of smart urban governance. In Singapore, massive urban issues along with top-down institutions put the government at the center of efforts to develop and pilot government-led, informative platforms seeking smart solutions. The position of Singapore as a city-state with limited natural and social resources and its efforts to equip people with digital skills, have also created ICT-facilitated, city-wide collaborations with businesses, interested citizens, and knowledge institutes. Taken together, smart urban governance in Singapore indicates the nationwide and whole-of-government effort along with the increased state-citizen engagement to reshape Singapore's policy processes and transform the living environments of Singaporeans (Hoe 2016). In Helsinki, influenced by Finland's democratic tradition, innovation culture, and strong technological basis, triple helix collaborations and integrative innovation platforms were developed to handle major issues and problems confronting residents' everyday lives. As a result, smart urban governance in Helsinki suggests an extended public-sector innovation, with technologically enabled platforms serving to enhance the reach and efficacy of co-creation and co-production mechanisms. According to Zhou (2017), context is vital since the environment in which a typical governance is embedded limits, confines, or shapes the development and implementation of that governance approach. Stakeholders should therefore understand that urban processes are always interlinked and intertwined, and that smart governance mechanisms ought to be contextualized and comprehended as compound, synthesized actions.

Third, the analysis shows that the smart urban governance framework (Figure 3.4) provides an effective analytical method to decide how to govern cities in the smart era. Although Singapore and Helsinki are confronted with different urban issues and are embedded in different urban contexts, both have obtained positive outcomes and needed improvements in terms of economic development, e-government innovation, public service delivery, quality of life, etc. (Monachesi 2020; Calder 2016). The key to this is that by adopting a forward-looking and problem-oriented strategy, both highlight that the development of modes of governance and relevant ICT functionality should accord with the perceived economic, social, and/or environmental urban challenges. In addition, the framework explicitly proposes analyses of both the choice of each component and the interactions of the components in a larger urban context. By doing so, smart urban governance moves away from a simple technology-based policy intervention toward a more compound and contextualized comprehension of how interactions of the urban issues, urban actors, and urban technologies engage in generating smart solutions and of their impacts on contemporary urban life.

3.6 Conclusions

We have argued for a specific urban planning perspective on smart governance (i.e., smart urban governance) that aims to overcome the deficiencies of the present technocratic way of governing smart cities. The smart urban governance framework departs from pressing urban challenges, selects appropriate modes of governance, and advocates the proper application of the technology to the problem at hand and the needs of users within the particularities of the socio-spatial context. Such a governance approach integrates technology into the urban setting and facilitates an interactive relation between the urban dynamics and technology-facilitated governance. It implies that the smartness of smart urban governance is not just derived from its power to implement and reconfigure technology, but also relies heavily on its ability to respond to the changing urban setting and create new sets of social relations.

The questionnaire on smart city projects worldwide revealed that smart urban governance varies remarkably in different socio-spatial contexts. As urban issues differ in different countries, the governance modes and relevant ICT functionalities being applied also differ. The case studies of Singapore and Helsinki showed that taking the urban challenges as a starting point helps to define appropriate governance structures and to develop dedicated technologies that contribute to the successful governance of these smart cities. In general, this asks for the close attunement of the particular spatial, institutional, and technological components to the context at hand. In terms of transforming the role of technology in current smart cities, it implies that the technology should be closely embedded in the appropriate mode of governance and be closely related to the substantive urban problems at hand. Both empirical analyses highlight the importance of the specific context (cultural, political, economic, etc.) in analyzing the interactions between the components of and/or the development of smart urban governance.

To sum up, this paper highlights that smart urban governance promotes a context-focused, sociotechnical way of governing cities in the smart era. More specifically, smart urban governance sees the definition of urban issues (i.e. economic, social, and environmental) as perceived and constructed through interplays between the state, market, and/or civil society. In terms of innovations of modes of governance, smart urban governance especially explores the role of situated agents and their dedication to offering the types of place-based knowledge needed for well-intended policies. For a convincing supportive role of technological intelligence, multiple functions of ICT (i.e. informing, communicating, and analyzing and designing) are required to support governance processes and handle the perceived urban problems in an appropriate way. Finally, we explicitly acknowledge the decisive role of context in analyzing the creation, application, and impacts of smart urban governance. We therefore propose smart urban governance as a sociotechnical way of governing cities in the smart era by starting with the urban issue at stake, promoting demand-driven governance modes, and shaping technological intelligence more socially, given the specific context.

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Chapter 4

A Sociotechnical Framework for Smart Urban Governance: Urban Technological Innovation and Urban Governance in the Realm of Smart Cities

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Abstract: Over the past decade, the dominant entrepreneurial form of urban governance has seriously hindered the transformation of cities by neglecting the role of urban contexts in shaping governance structures and outcomes. To promote alternatives, this paper presents a sociotechnical framework for smart urban governance. This framework explicitly examines the impacts of urban contexts on the sociotechnical interaction between urban technological innovation and urban governance in the realm of smart cities. Three real-world cases were used to demonstrate how the framework can be applied in different urban contexts. The results show that the alleged smartness in smart urban governance by no means implies the simple acceptance, adoption, and use of technology; instead, it needs to be conditionate. For successful smart urban governance, urban technological innovation should be effectively attuned to the wider urban actors and preexisting urban challenges (i.e., the urban governance process), with a special focus on the urban context.

4.1 Introduction

Over the past decade, the notion of "smart cities" has been proposed as a way to deal with dramatically increasing urban issues (housing, crime, air pollution, traffic congestion, etc.). However, according to several authors (e.g., Grossi and Pianezzi, 2017; Hollands, 2015; Shelton et al., 2015; Lee et al., 2013), the governance of smart cities is largely in conjunction with an entrepreneurial form of urban governance. In practice, the notion of smart city is promoted by local governments to attract global capital and boost local economic growth (Shwayri, 2013). Some of the most extensively elaborated examples of these initiatives—for example, Songdo Ubiquitous Eco-City (South Korea), Genoa Smart City (Italy), and Masdar (United Arab Emirates)—are places where large high-tech companies and real estate companies have dominated the planning, design, and construction of facilities and entities (Grossi and Pianezzi, 2017; Hollands, 2015; Kitchin, 2015; Shwayri, 2013). Consequently, the application of various electronic and digital technologies to cities is largely promoted by "the profit motive of global high-technology companies" (Hollands, 2015). High-tech companies typically emphasize that the adoption and implementation of new technologies will bring benefits to cities; however, this corporate vision of smartness has caused an emergence of "business-led technological solutionism" (Kitchin, 2014). In practice, various information and communication technologies (ICTs) are packaged and promoted by private sectors, whereas their substantive added value for augmenting urban operation and urban governance is far less considered.

Meijer (2016) claims that any successful smart city governance is closely related to our perception and use of technologies across the entire city. The idea is that the usefulness of technology for augmenting urban governance in the realm of smart cities can only be enhanced by studying the interaction between urban technological innovations and governance processes in specific urban contexts (Bolívar and Meijer, 2016; Meijer, 2016; Meijer and Bolívar, 2013). In this paper, urban technological innovation refers to the creation, diffusion, adoption, and utilization of new technologies. According to Cels et al. (2012), it is the social dimension that determines the meaning and function of technologies and makes them work. Hollands (2008) argues that the governance of smart cities should consider the input and contribution of various groups of people in the production of knowledge, techniques, and new technologies. It is argued that the opportunities only arise when technological solutions are developed and implemented in close collaboration with research institutes, businesses, and citizens (Chesbrough, 2006). So far, little attention has been paid to this connection. In fact, new technologies developed in smart cities have often been criticized for their negligence of the embedded governance processes (Capra, 2016; Shelton et al., 2015; Meijer and Bolívar, 2013).

The aim of the present research was to connect the two and investigate the extent to which urban technological innovations interact with urban governance in specific urban contexts and produce alternatives for the governance of smart cities. Special emphasis was put on the impacts of urban contexts on the sociotechnical interaction between urban technological innovations and urban governance. In this paper, these alternatives driven by technology interaction with urban governance are called “smart urban governance.” Thus, our attention shifted from a focus on the entrepreneurial form of urban governance, to a sociotechnical process of smart urban governance. Here, a sociotechnical method indicates that a system that is intended to be optimal should only be situated in a particular setting, and that the optimum is always the result of the sharing of the views and knowledge of people in a social process (Vonk and Ligtenberg, 2010). Thus, the usefulness of urban technological innovations in the realm of smart cities should only be integrated into an urban governance process, enabling participants or urban actors and the context specificities to determine its added value.

The following section discusses the scientific literature on urban technological innovation and urban governance in the realm of smart cities and shows how the two research areas can converge and offer new opportunities. The developed sociotechnical framework is then presented to illustrate how alternatives for the governance of smart cities (i.e., smart urban governance) can be produced. Section 3 explains the research methodology and steps. In Section 4, three real-world smart city projects are presented to account for the dynamics of technology interaction with urban governance and to reveal the resulting meanings of smart urban governance. In Section 5, the findings of the case analysis are presented. Section 6 presents the conclusion.

4.2 Urban technological innovation and urban governance in the realm of smart cities

4.2.1 Urban governance

There is a large body of literature on the meaning of urban governance. Some authors explore the use of various theories concerning power to analyze the political struggle between different actors (Obeng-Odoom, 2012), while others focus on the transformation of government institutions toward more open and inclusive processes (Nicholls, 2005). Influenced by neoliberalism, urban governance can also be understood as a form of entrepreneurialism (Harvey, 1989). Although the concept of urban governance in academia remains vague, Pierre (2005) argues that urban governance can be tailored to the real needs of cities. This indicates that the meaning of urban governance can be understood according to the specific urban context. Nevertheless, urban governance in general refers to "a range of actors and institutions; the relationships among them determine what happens in the city" (Avis, 2016:5). It involves a continuous process of negotiation and contestation over the allocation of social and material resources and political power. Throughout this paper, we use this encompassing definition of urban governance and discuss how urban governance can be adapted to deal with the governance of smart cities with the help of technology.

4.2.2 Urban governance in the realm of smart cities

A smart city is about integrating ICTs into various physical devices (e.g., transportation, smart living and utility) to optimize the efficiency of city operations (Batty et al., 2012). ICTs developed in smart cities range from big data, social media, and the Internet of Things, to transport systems, traffic regulation systems, and even artificial intelligence. Both researchers and practitioners have argued that these ICTs and sensor networks can be used to enhance the capabilities of current urban governance structures (Meijer and Bolívar, 2016; dos Santos Brito et al., 2015; Scholl et al., 2014; Kitchin, 2014). However, Luque-Ayala and Marvin (2015) argue that at present, a relatively exclusive set of policy, technology, and commercial interests dominate the debate on the smart city and its governance. Practical urban governance in the realm of smart cities is just a straightforward or simple extension of the neoliberal city (Shelton et al., 2015). Many smart city initiatives have been dominated by private technology developers such as IBM, Cisco, and Huawei (Jiang et al., 2019; Deakin, 2013). Large high-tech companies inherently think that the idea and vision of smart cities are transformational and affirmative. As a consequence, "the governance trend has continued with an increased emphasis on efficiency savings, privatization and the promise of a high-tech future" (Hollands, 2015:68).

For instance, POSCO Engineering and Construction, a South Korean consortium, was granted the right to partner with an American developer to plan, build, and operate the Songdo International Business District—a part of the Songdo Ubiquitous Eco-city. But a key question raised here is the extent to which this corporate entrepreneurial smart city can truly serve all citizens and promote the city's transformation (Shwayri, 2013). Due to a lack of opportunities for citizens to engage in the creation and operation of this project, urban local government and large high-tech companies in particular dominate economic and business interests, disregarding wider social and environmental priorities. Consequently, some of South Korea's real urban problems (unemployment, overcrowding, slums and squatter settlements, social inequality and discrimination, etc.) are largely ignored in this neoliberal urban vision (Shwayri, 2013).

In fact, the outcomes produced by the governance of smart cities are rather controversial, since the access to, use of, or impact of ICT has seldom been considered (Colding and Barthel, 2017; Przeybilovicz et al., 2015). Kummitha and Crutzen (2017) argue that the prevalence of entrepreneurial urban governance leads to a technological deterministic view on smart city developments. The danger of this corporate dominance in urban technological innovation, is that such solutions are overly technocratically packaged as one-size-fits-all solutions. Technology itself has been designed as an end—its adoption will automatically produce increased quality of life for citizens in a smart city setting. Technology developers believe that the adoption of technology can smarten a government's city management capabilities and produce ideal results for the city. However, this corporate-led techno-imaginary has seriously neglected the particular context that enables participants to define and revise the functionality of one typical technical tool (Kling, 1996). Therefore, it remains unclear whether technology can contribute positively to urban improvements.

At the same time, some authors highlight that this technology-driven approach could subject ordinary people to the complete control and authority of the government power (Krivý, 2018). For instance, the massive use of big data in crime control enhances the government's social control capabilities, but it also introduces ethical and legal concerns with regard to "discrimination, privacy, and the presumption of innocence" (Završnik, 2017). Although some authors claim that using new digital telecommunications infrastructure can empower citizens to decide what governments should do (Fung, 2015; Linders, 2012), it is apparent that this "splintering urbanism"—examining the role of urban infrastructure, especially ICT-enabled infrastructural networks, in fostering social and spatial inequality (Graham and Marvin, 2002)—might not be able to support multi-stakeholder problem-solving. According to Gabrys (2014:43), "the very responsiveness that enable citizens to gather data does not extend to enabling them to meaningfully act upon the data gathered, since this would require changing the urban 'system' in which they have become effective operators." This indicates that new forms of urban governance in the realm of smart cities should explicitly consider the sociotechnical processes, since it is the perceptions, expectations, capacities, and skills of users and the practical urban issues that determine the usefulness of technologies.

4.2.3 Urban technological innovation

As Hollands (2015) claims, the technology-driven approach to augmenting urban governance is, to a large degree, merely an attempt to create a modernist image of the smart city. It has failed to put the interests of local people at the center. Sassen (2011) argues that the large-scale utilization of technologies has an anti-urban character, since the technologies applied to drive the development of cities have not been sufficiently urbanized. If this problem cannot be solved, technology could soon become the "censored," which would be altered to command and control urban actors. To avoid this, Meijer and Bolívar (2013) state that a stronger empirical understanding of the relation between urban technological innovation and governance processes is needed. As Janowski (2015) suggests, the implementation of technology in the city should be contextualized to consider the importance of local specificities and particular settings, since it is the context that enables technology to work. Thus, the functionality to augment urban governance should be closely connected to the real needs of different urban actors and existing governance practices. This view helps to shift our awareness from a focus on the technology-driven approach, to a sociotechnical process of urban technological innovation.

In this paper, urban technological innovation is sociotechnical in the sense that technology and social settings develop in a process of mutual shaping in specific urban contexts. It involves the adoption and utilization of new technologies and also "changes in routines, collaborations, and roles of actors" in the governance of smart cities (Meijer and Thaens, 2018). To highlight the different perceived values of technology in the innovation process, the four perspectives of urban technological innovation—a technological, an instrumental, a collaborative, and a symbolic perspective—elaborated by Meijer and Thaens (2018) are referred to. Their corresponding meanings are shown as:

Technological value: the acceptance, adoption, and use of technology in itself are deemed valuable.

Instrumental value: the technology supports the participants in achieving their desired goals.

Collaborative value: the technology builds a platform to meet other actors and develop collaborations.

Symbolic value: the technology offers rationale/legitimacy to the innovation process because of the idea that technology can help build a better future.

The four perspectives indicate that the meaning of technology is not just objective, as most people think; instead, it is embedded in its social context and constructed in a sociotechnical process. The reasons for the acceptance or rejection of a technology should be connected to the social world; in other words, we must investigate how the standard of being "the best" is delimited and what individuals, groups, and stakeholders are getting involved in designating meanings to technology. Thus, relating the meaning and content of technology to the wider socio-spatial milieu is urgently needed, since it is the socio-spatial context that explains the origins of the technological brief, shapes the design and development of technological functions, and assesses the success or failure of technological implementation (Cels et al., 2012).

4.2.4 Why context matters

As mentioned, the integration of urban technological innovation into urban governance in the realm of smart cities should consider the specific urban context. Here, context refers to the circumstances or situations that form the setting for the sociotechnical interaction between urban technological innovation and urban governance processes, and in terms of which it can be fully understood and assessed. In fact, several articles have theorized and investigated the importance of contextual factors in affecting the governance of smart cities. For instance, Meijer (2016) emphasizes the hidden role of “the local cooperative knowledge potential” and “the nature of the problem domain” in shaping the technology interaction with urban actors. Bolívar and Meijer (2016) highlight the impact of factors such as “political or demographic factors, administrative cultures, and technological factors” on the structure of smart city governance. According to Lin (2018), different institutional and technological contextual factors have made smart city governance in some Western countries relate more to e-governance and e-democracy, while smart city governance in China is focused more on smart management and services. Kalathil and Boas (2010) also argue that the level of economic development will influence how technology is organized and used in ICT-enabled governance. In addition, some studies also indicate that the nature of the urban problem itself—such as the social, economic, and environmental challenges associated with urbanization—is also an important contextual factor (Lin, 2018; Meijer, 2016).

To summarize, the smart city governance research revealed six contextual factors, namely economic, political, demographic, cultural, and technological factors, and the urban problem itself. Nevertheless, Ruhlandt (2018:9) claims “the influence of contextual factors on smart [city] governance still remains unclear” and a lack of empirical studies weakens this connection. Thus, more detailed analyses of the governance of smart cities in different contexts are urgently needed (Meijer et al., 2016).

4.2.5 A conceptual framework for “smart” urban governance

To examine the potential role of contextual factors in influencing smart governance arrangements, Jiang et al. (2019) developed a new model that includes two main dimensions: urban contexts and technology interaction with urban actors. They suggest that this model can be used to investigate the impacts of urban contexts on the technology interaction with urban actors and examine the resulting meanings of smart governance arrangements. In fact, the model is helpful in understanding how urban technological innovation (i.e., perceived value of technology) interacts with urban governance (i.e., actor relations) in specific urban contexts and how this interaction produces smart urban governance. Therefore, we adapted the model developed by Jiang et al. (2019) and, based on our previous analysis, created our sociotechnical framework for smart urban governance (see Figure 4.1).

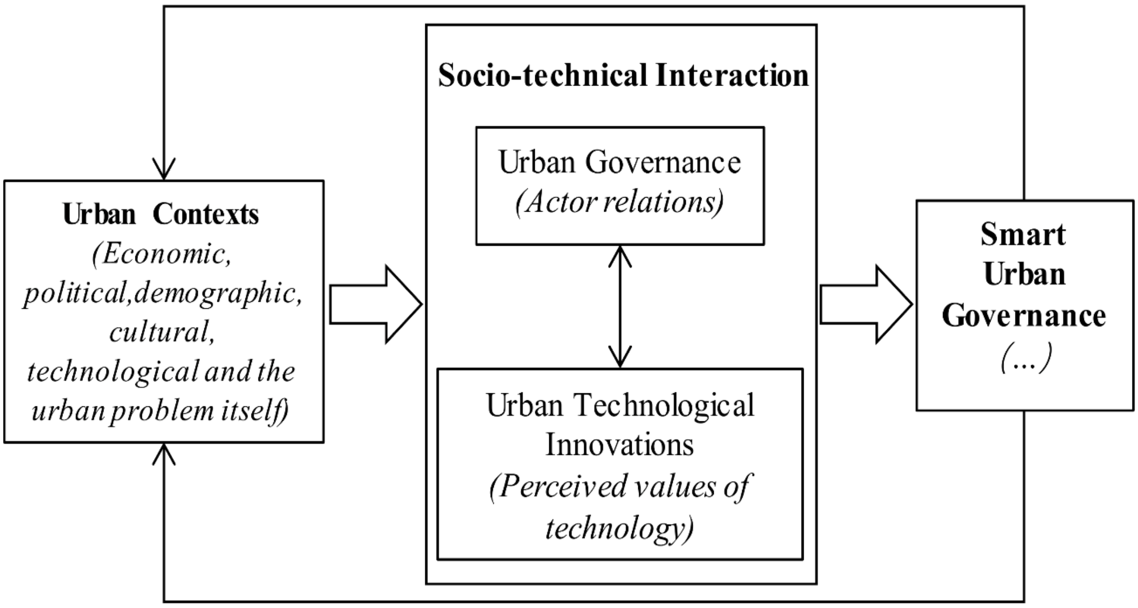

Figure 4.1 A sociotechnical framework for smart urban governance

In this framework, urban contexts are the circumstances that form the setting for the socio-technical interaction, which mainly includes six factors—economic, political, demographic, cultural and technological factors, and the urban problem itself. The socio-technical interaction is the bidirectional influences between urban governance processes and urban technological innovation. Smart urban governance is the outcome of the socio-technical interaction. The combination of these three dimensions suggests four potential relations:

1) The sociotechnical interaction between urban governance and urban technological innovations is potentially influenced by urban contexts;

2) the potential effect of the urban context on sociotechnical interaction relies on the interaction between urban technological innovation (perceived value of technology) and urban governance (actor relations);

3) the sociotechnical interaction in the realm of smart cites would potentially produce smart urban governance;

and 4) a potential feedback effect of smart urban governance on the urban contexts.

In fact, the conceptual model in Figure 4.1 reflects the possible linkages between urban contexts, the sociotechnical interaction, and smart urban governance. The following section applies this framework in practice and explores the extent to which the possible linkages take place in real-life smart city projects.

4.3 Methodology

On the basis of an extensive review of index systems, research reports, key literature, national and local policies and documents, three empirical smart city projects in three countries (i.e., Mongolia, China, and the Netherlands) were selected to explore the added value of the framework. These three cases are: 1) Smart Ulaanbaatar Program, Mongolia; 2) Hangzhou City Brain Project, China; 3) and Amsterdam Smart City, the Netherlands. The primary reason for selecting these three cases is that they differ in their development stage and are in different urban contexts. For instance, stages of urbanization in these three countries vary considerably, which makes a great deal of difference with regard to the most pressing problems faced by these cities. Then, the different political systems in these three countries also made it interesting to see how context-specific characteristics led to different sociotechnical interactions and different forms of smart urban governance.

Data for these three cases was mainly gathered from governmental portals as well as smart city project websites via two search engines, namely Google and Baidu (China's largest search engine). We also used documents from other resources that we reviewed, such as relevant published reports, academic literature, digital newspaper archives, and project policy reports that actually portray substantive discussions on these three cases. We selected five academic articles, 10 government policy documents, 16 web publications and 10 newspaper articles to gain a full understanding of the sociotechnical interaction between urban governance and urban technological innovations. We then created a coding scheme capable of representing Figure 4.1, which mainly includes dimensions of urban contexts, key urban actors and their responsibilities, technologies and their perceived values, technology interaction with urban actors and relevant outcomes, and feedback effects on urban contexts.

Since these documents are the result of deliberations by governments, experts, and journalists, a close discursive analysis of these documents was well suited to interrogate the sociotechnical framework for smart cities. According to Keller (2011), the central focus of discourse analysis is the expression of discourse order and the establishment of a discourse structure. It involves understanding texts to "gain information regarding how people make sense of and communicate life and life experiences" (Allen, 2017:1753). The key for discourse analysis is that the study of discourse meanings should be related to the social conditions and their changes, since a larger social structure influences the discursive construction of meanings. In this paper, aspects of discourse analysis rely mainly on the coding texts of the identified documents (Lin, 2018). A particular focus is how urban context influences the sociotechnical interaction and produces different forms of "smart" urban governance.

4.4 Empirical evidence for smart urban governance

4.4.1 Smart Ulaanbaatar Program, Mongolia

In the 1980s, Ulaanbaatar—Mongolia's capital and largest city—was vibrant. Since then, however, severe droughts, harsh winters, and over-grazing, along with the end of Soviet state support, have caused more than 600,000 nomadic herders to leave their semi-arid grassland and migrate to Ulaanbaatar (Kingsley, 2017; Bassett, 2010). Buildings, streets, and infrastructure in the city have deteriorated severely and green parks and public spaces have been replaced by self-built *gel* (or yurt) houses. Consequently, the fast and disorderly expansion of the urban fringe has posed Ulaanbaatar serious urban challenges, such as a shortage of energy supplies, soil contamination, and a lack of urban infrastructure and housing (Kingsley, 2017).

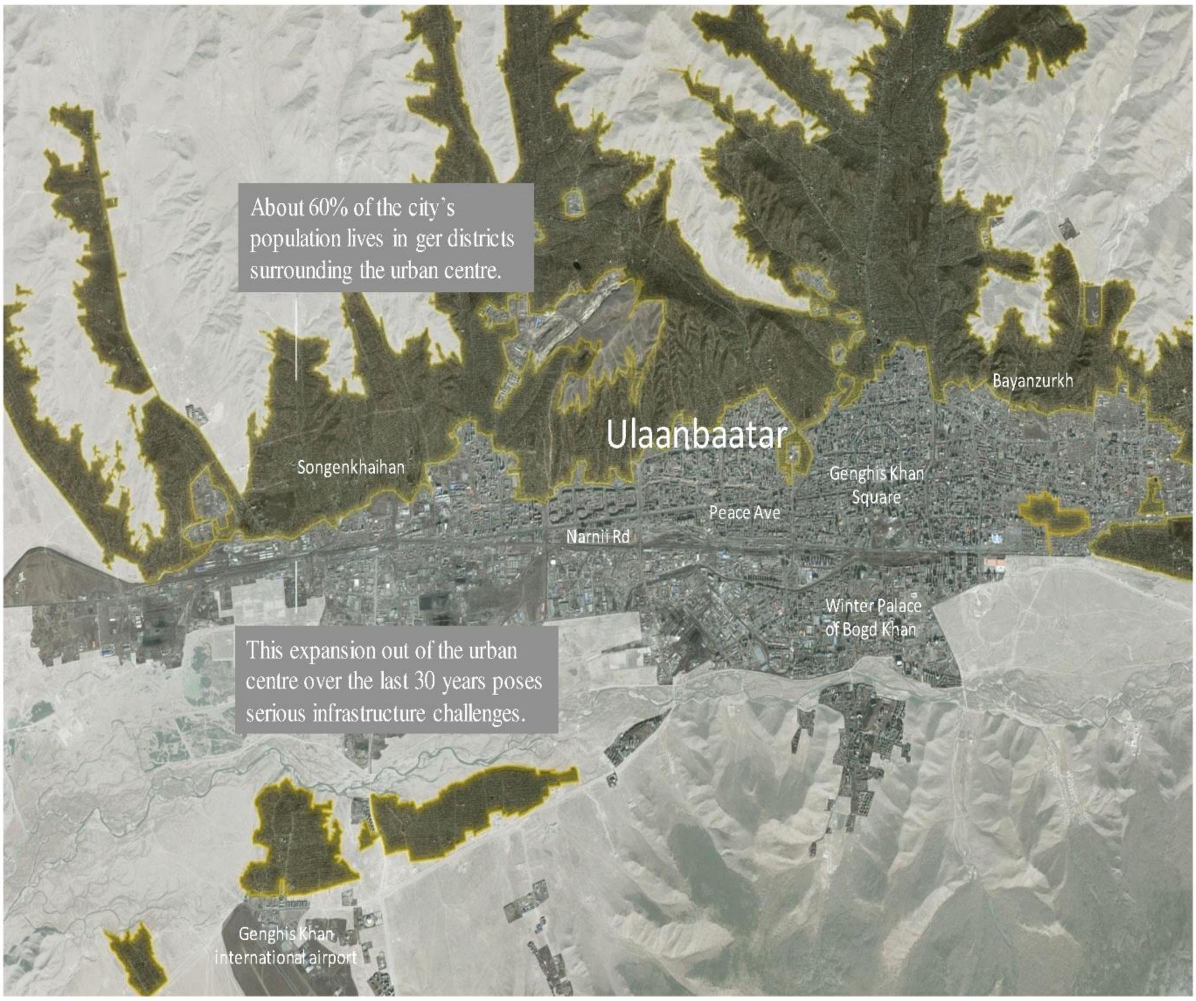

Figure 4.2 Urban infrastructure challenges in Ulaanbaatar (source: https://www.theguardian.com/world/2017/jan/05/mongolian-herders-moving-to-city-climate-change)

To deal with these urban problems, in 2014 Ulaanbaatar City Municipality launched the Smart Ulaanbaatar Program (Batchuluun, 2014). The program was designed to have a broader focus on governance, economy, service, environment, people, and wellbeing, but its foremost purpose is to exhaustively digitalize Ulaanbaatar's infrastructure and improve the internet penetration (Naranmandakh, 2018). Reports shows that both the national government of Mongolia and the city government have committed themselves to staying ahead of the curve and applying ICT innovations to advance governance reform and provide better services to the citizens. However, the country's poor technological capability remains one of the major constraints to its efforts to achieve the desired goals (Theunissen, 2015). Therefore, this program relies heavily on international high-tech companies.

One of the most important partnerships was built with Cisco to develop the Smart Ulaanbaatar Program Solid Infrastructure Master Plan. The aim of this plan is to provide technological solutions for a data center, an emergency response center, network and information infrastructure, and a monitoring system. However, the process of urban technological innovation entailed studying other international smart city models and then developing the smart city solutions that would be introduced in Ulaanbaatar (Byambadorj, 2016). Besides Cisco, The Asia Foundation was also invited to support Ulaanbaatar's municipality in the areas of governance and service delivery (Theunissen, 2015). Their efforts mainly focused on processes of digital cartographic production. For instance, the foundation established the community mapping website as an interactive resource for citizens and city officials to find information and download maps (Norovsambuu et al., 2013). Over 150 land demarcation maps were digitalized to resolve the problem of land permits and issuance. The Chinese company Huawei also joined, as an important equipment provider, and delivered connectivity in some remote areas of the city (Huawei website, n.d.).

In this project, both the national government of Mongolia and the government of Ulaanbaatar have strong intentions to engage in the process of urban technological innovation. However, the severity of the various challenges posed by rapid urbanization and Mongolia's weak technological basis have prompted the Ulaanbaatar government to build partnerships with foreign tech companies. This has led to a situation in which the introduction and implementation of urban technological innovations are almost entirely controlled by these companies. The Ulaanbaatar government thought that the acceptance, adoption, and dissemination of urban technologies would automatically contribute to the effective use of the urban environment, the efficient consumption of the city's resources, and the improvement of service delivery. However, Ulaanbaatar's demographics have negatively influenced the substantive use of these new digital urban infrastructures and services. According to Statista (n.d.), only 23.7 percent of Mongolia's population had access to the internet in 2017. Low digital literacy, especially among people living in the self-made *gel* houses, has prevented disadvantaged groups from gaining access to the urban basic services. Consequently, the so-called smart urban governance in Ulaanbaatar is more or less about government of a smart city via the acceptance and use of privately controlled technologies to digitalize the city's infrastructure.

In fact, the governance of Smart Ulaanbaatar Program is by no means smart, since the government and private companies focus too much on the technological value of urban technological innovation. The lack of internet literacy among nomadic groups, which make up the majority of Ulaanbaatar's urban population, makes it difficult for them to benefit from this project. As a result, there is no clear indication about the extent to which the original goals (public housing, emergency services, social welfare, food subsidies, etc.) of the Smart Ulaanbaatar Program can be achieved. Although technology has been increasingly recognized and perceived as an important enabler of urban governance innovation, urban development, and service delivery in Ulaanbaatar (Byambaakhuu, 2017), an insufficient consideration of demographic characteristics in the governance process has largely made the intended outcomes less approachable. Thus, the feedback effect, according to Sanjaajamts (2018), shows that the Ulaanbaatar government should re-examine the urban context, especially the large number of nomadic groups living in the city, for effective urban development in the future.

4.4.2 Hangzhou City Brain Project, China

Rapid economic development has led to an increase in Hangzhou's population from 1.14 million in 1980 to 9.46 million in 2017 (Hangzhou Statistical Yearbook, 2017). Influenced by this, the number of motor vehicles in Hangzhou reached 2.44 million in 2017, with an annual net increase of 276,000 (Hangzhou Statistical Yearbook, 2017). The per capita ownership of motor vehicles in Hangzhou is much higher than in other large Chinese cities, such as Beijing, Shanghai, and Guangzhou, and this has caused serious traffic congestion. However, an institutional defect of traditional Chinese urban governance whereby traffic management is dominated by government organizations, has made the public department incapable of handling the various traffic issues, such as longer trip times, slower speeds, and longer queues (Su, 2017). Hangzhou is home to Alibaba (the world's fifth-largest internet company by revenue) and one of the most influential hi-tech innovation centers in China, and its government wants to transform its urban governance by leveraging its technological advantages.

The Hangzhou government along with Alibaba proposed the concept of City Brain to solve the city's traffic congestion by collecting, processing, and analyzing big data. The idea behind City Brain is that urban traffic congestion is similar to human diseases, which need diagnosing. The congestion requires a comprehensive understanding of the state of traffic operations by examining the symptoms of traffic infrastructure (traffic flow, congestion index, delay index, main road speed, expressway speed, etc.) (Alibaba Cloud website, n.d.). A large number of artificial intelligence (AI) technologies (e.g., visual/sound capture, machine learning platforms, speech recognition) should be incorporated into cities. Then, by creating a cloud-based system in which large amounts of traffic and mobility data are gathered and processed by algorithms in supercomputers, an effective traffic management platform can be built. In practice, two key urban contextual factors have influenced the sociotechnical process.

First, China has top-down political institutions and is dominated by government-led approaches (Lin, 2018). Influenced by this political situation, the Hangzhou government decided to play a leading role in the project by, for instance, establishing a new organization (Hangzhou City Brain Construction Leading Group) that integrates multiple public sectors (e.g., public security, traffic management department, planning and natural resources department, and finance department) to guide the construction of the project. Second, due to the extensiveness of this project, City Brain requires the presence of high-tech companies. Thus, various private sectors (e.g., Alibaba, Hikvision, and Foxconn) and research institutes (e.g., Zhejiang University and Zhejiang University of Technology) have been invited to carry out relevant research and development (R&D) work, namely planning, designing, developing, and implementing the program. Attentively, Alibaba is developing the entire City Brain software platform. (Alibaba Cloud website, n.d.).

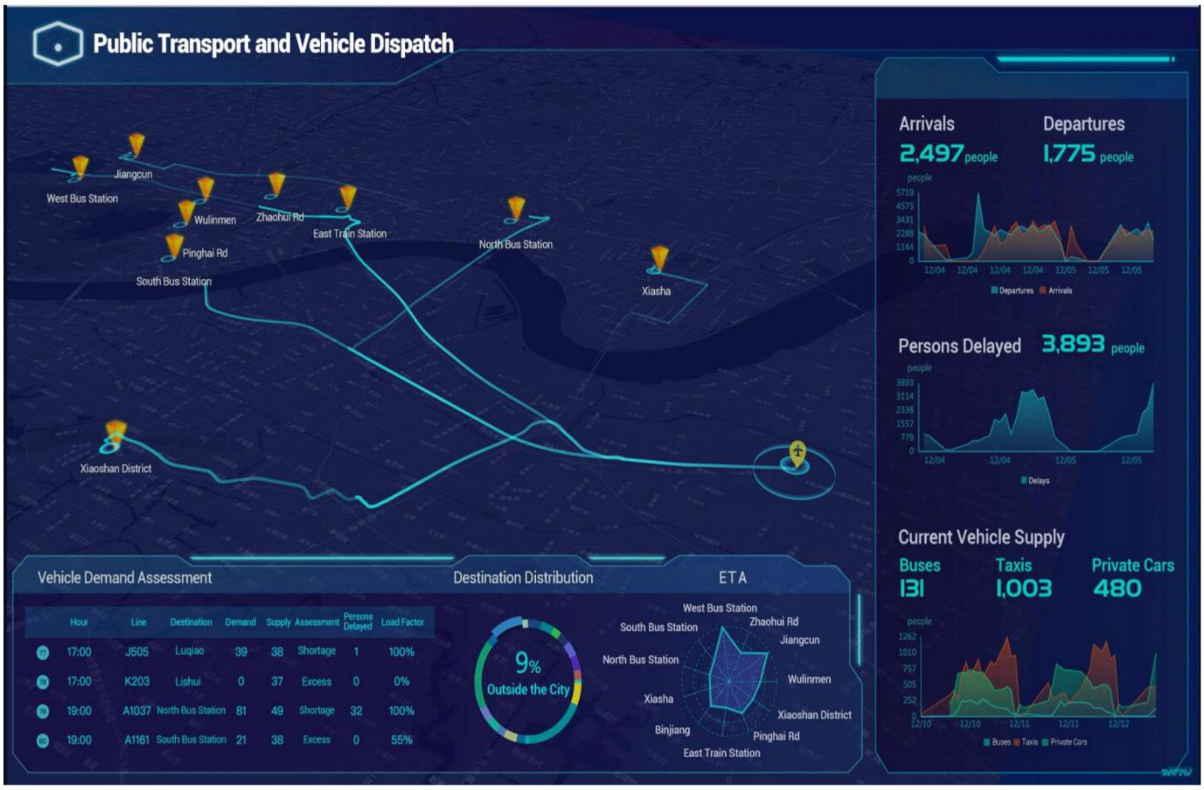

Figure 4.3 City Brain for traffic management in Hangzhou
(Source: https://www.alibabacloud.com/et/city)

A “three-step” strategy has been proposed to integrate City Brain into Hangzhou’s current urban governance (Tencent website, 2018). So far, two phases have been successfully implemented. In the first phase, City Brain 1.0 was launched in some pilot districts in Hangzhou, in order to investigate how this system could be adapted to different traffic situations and how local governments can engage in this experiment process and build their basic technology skills, such as word processing, image analysis, and database skills. Then, driven by joint efforts by the government, universities, and enterprises, City Brain was considerably improved in the second phase (Hsu, 2018). It was transformed into a more cloud-powered and AI-driven urban traffic management system and extended to the whole city in 2018. This 2.0 platform can predict traffic flows, detect accidents, and provide instant feedback; as a consequence, its instrumental value was highlighted to help traffic managers make decisions based on the real-time data. In the third phase, City Brain 3.0 will be developed into a comprehensive platform to effectively govern various other city events (community and public safety, criminal activities, fire emergencies, floods, etc.).

In this project, the political institutions, heavy traffic congestion, and Hangzhou’s technological strength constitute the urban context. Influenced by this context, the Hangzhou government has been actively engaged in promoting new governance approaches to deal with the traffic congestion. Private companies and research institutes, such as Alibaba and Zhejiang University, were invited to design and develop relevant AI technologies. Although it seems that the governance of the City Brain project satisfies the triple helix model proposed by Etzkowitz and Leydesdorff (2000), the Hangzhou government in fact has played a leading role due to its dominant political power. As a result, the instrumental value of City Brain is strongly highlighted by the Hangzhou government to augment Hangzhou’s urban administration. Smart urban governance in Hangzhou is about building smart administration with a government-led triple helix model of urban technological innovations, aimed at optimizing the traffic system.

Smart urban governance in Hangzhou has not only improved the government’s administrative capabilities (e.g., more intelligent and responsive to traffic congestion), but also provided better services and urban data to both enterprises and individuals (Beall, 2018). In addition, a large number of enterprises have greatly improved their innovation capabilities through participation. Despite all the positive effects, City Brain has also caused some controversies and concerns. Since universities and big high-tech companies in China usually have a close relationship with the government, this relatively collusive relationship largely excludes citizens from the sociotechnical process. Thus, residents’ ideas, opinions, and knowledge and the collaborative value of urban technological innovation may not be well reflected in this project. In addition, the physical and policy changes resulting from City Brain have had negative impacts on the urban residents. For instance, a recent survey conducted by Chinese state broadcaster CCTV and a tech firm Tencent (TCEHY) shows that nearly 80% of respondents are concerned with the impact of City Brain on their privacy (Toh and Erasmus, 2019). As Ho (2017) highlights, "the neoliberal-developmental logics of the state [to a large degree] facilitate authoritarian consolidation." Thus, for smart urbanism to effectively enrich people's everyday lives, a more participatory approach to urban challenges should replace the technocratic governance (Ho, 2017).

4.4.3 Amsterdam Smart City

Amsterdam—the capital of the Netherlands—is home to more than one million people. However, over the past two decades a large number of foreign immigrants have contributed to Amsterdam's rapid urban growth (Statistics Netherlands website, 2019), putting a huge amount of pressure on supplies of urban water, housing, infrastructure, education, medical care, and so on. Then, located below sea level, urban safety of Amsterdam has been seriously threatened by recent climate change. Consequently, both the government and the citizens of this city are aware of how fragile Amsterdam can be. Studies show that to deal with this challenge, an ongoing digital revolution and advances in digital technologies have been the city's top priority since 2007 (Mora and Bolici, 2015). This led to the creation and development of the Amsterdam Smart City project as the primary enabler of the city's transformation.

The aim of the project is to build an "innovation platform that brings together proactive citizens, innovative companies, knowledge institutions and public authorities to shape the city of the future" (Amsterdam Smart City website, n.d.). Studies show that three important urban contexts have played a crucial role in influencing the sociotechnical interaction between urban technological innovation and urban governance in Amsterdam (Henriquez, 2018; Capra, 2016; Mora and Bolici, 2015; Lee and Hancock, 2012).

First, Amsterdam is vulnerable to climate change and a rising sea level, and the content of Amsterdam Smart City is closely related to the city's climate program, which is aimed at clarifying Amsterdam's climate goals and reduce local energy consumption (Mora and Bolici, 2015). Influenced by this, the development of technology is largely focusing on dealing with Amsterdam's actual urban ecological problems. For instance, various energy saving technologies have been tested in climate-related living labs (Jacobson, 2012). These technologies have contributed to Amsterdam's smart grids and smart meter systems that are intended to save energy and create new opportunities for Amsterdam's electricity consumption transformation.

Second, the Netherlands' democratic system in conjunction with government transparency is another key urban context that influences the sociotechnical process of this project. As people with varied skills, knowledge, and entrepreneurial capabilities have come together in one place, inclusive institutions and open government can effectively integrate human and social capital into the process of collective problem-solving. For instance, the Amsterdam city government built the Amsterdam City Data platform, to provide free access to various urban datasets (traffic data, land value and ownership information, topographical and address data, healthcare data, etc.) (Gemeente Amsterdam website, n.d.). To create a hyper-connected hub for technological innovations and entrepreneurs, in 2015 a collaboration between the Municipality of Amsterdam and 250 stakeholders launched 'StartupAmsterdam' (StartupAmsterdam website, n.d.). In this ecosystem, ordinary people, private firms, research institutes, and other organizations with an interest in technology and digital and electronic art, can come together to collaborate on technological innovation via the online community and various offline events. Within two years, this led to the launch of a record-breaking 1,500 startups (Macpherson, 2017).

In addition to the aforementioned urban contexts, characteristics of Amsterdam's demographics also influence the sociotechnical process of the project. Internet literacy in the Netherlands is relatively high and this further contributes to "the availability of relevant knowledge among citizens and stakeholders, and the willingness to contribute this knowledge to collective problem-solving" (Meijer, 2016:75). Compared to the previous two cases, a strong awareness and intention to engage among Amsterdam's citizens provide test-bedding sites for the early adoption of technology and solutions, especially environmentally friendly industries and environmentally responsible practices (Henriquez, 2018). This further contributes to the crystallization of the proactive sociotechnical interaction as innovation culture. The best examples of this innovation culture are the various innovation-related festivals. For instance, the 'We Make The City' festival—which enables researchers, students, entrepreneurs, policymakers, artists, civil servants, and active citizens to come together to discuss and debate urgent urban issues (e.g., affordable housing, climate change, quality of life and safety, mobility and division, healthy living)—is regarded as an anchor event for the Amsterdam Smart City program (We Make The City website, n.d.).

Figure 4.4 We Make The City festival
(Source: https://blog.fab.city/urban-conference-91d4abc1ede1)

What we observe in this project is that vulnerable ecological system, democratic system, high internet literacy, and strong awareness of civic engagement in Amsterdam constitute the main urban contexts. Spearheaded by the government, various actor constellations (e.g., public–private partnerships, self-organization, private–university cooperation, community-based governance) are able to contribute their knowledge and ideas to cultivating open and smart ecosystems for the governance of urban technological innovation. For the city government and private companies, this open innovation platform ensures that the citizens' skills and knowledge can be effectively leveraged to strengthen Amsterdam's innovative capabilities and improve Amsterdam's urban and ecological resilience. For citizens, technology-enabled participation means they are no longer regarded as only recipients or customers of a service; instead, they can co-produce or co-create the city. In this process, urban technological innovation not only realizes its technological and instrumental value (e.g., smart grids and smart meters), but is also integrated into Amsterdam's urban governance and achieves its institutionalized collaborative and symbol value (e.g., We Make The City). Consequently, smart urban governance in Amsterdam is about building various open innovation spaces for smart urban collaboration, aimed at integrating urban technological innovations into people's daily lives.

By following a sociotechnical framework to become smarter, the Amsterdam Smart City has become one of Europe's leading smart cities. In 2016, the European Commission declared the city to be the European Capital of Innovation (The European Commission website, n.d.). Indeed, smart urban governance in Amsterdam has succeeded in improving its innovation environment and the quality of people's lives. Amsterdammers do not simply apply technology to create a contemporary environment with impress-all and technology-pushed intelligent settings; what they do is to incorporate the technology into their daily lives and treat it as their cultural heritage and tell the story of who they are, where they are now, and where they want to be in the future.

Table 4.1 Summary of the three cases

Dimensions / Cases	Smart Ulaanbaatar Program, Mongolia	Hangzhou City Brain Project, China	Amsterdam Smart City
Urban contexts	•Mass immigration of nomadic people into Ulaanbaatar •Low technological basis	•Top-down political institution •Heavy traffic congestion •Technological basis	•Vulnerable ecological system •Democratic system and government transparency •High internet literacy and strong awareness of civic engagement
Urban governance	•Public-private partnership	•Government-led triple-helix model (i.e., government, private sector, and universities) •Exclusion of citizens	•Multiple forms of urban governance (e.g., self-governance, network governance, and government-led)
Urban technological innovation	•Private-led technological innovation • The adoption of the technology itself as value •Symbolic value	•Government-led triple-helix model of urban technological innovation •Strong instrumental value for government and market parties •Technological and symbolic value	•Various living laboratories •Start-up ecosystems for innovation •Institutionalized collaborative and instrumental value •Technological and symbolic value

Smart urban governance	•Government of a smart city via the acceptance and use of private-controlled technologies to digitalize city's infrastructure	•Smart administration with a government-led triple helix model of urban technological innovation, aimed at optimizing the traffic system	•Building various open innovation spaces for smart urban collaboration, aimed to integrate urban technology innovations into people's daily life
Feedback	•Improved awareness of technological potentials •To re-examine the urban contexts, especially the low internet literacy among nomadic groups	•Congestion relief •Enhanced government control •Privacy concern •To re-examine the needs from citizens	•Improved urban and ecological resilience •Democracy and participation enhancement •Fostering an innovation ecosystem

4.5 Findings

Table 4.1 summarized how the key dimensions (i.e., urban contexts, urban governance, urban technological innovation, smart urban governance, and feedback) of Figure 4.1 were treated and examined in the three cases. Based on the summary, several findings can be identified.

First, analyses show that the urban contexts in the three cities have a different influence on the formation of actor relations, the perceived values of technology, and their interactive relationship. For instance, although the Ulaanbaatar government fully intended to get involved in the governance of the Smart Ulaanbaatar Project, the severity of the urban challenges combined with Mongolia's weak technological basis prompted it to build partnerships with foreign tech companies. The adoption and use of privately controlled technological innovations are the Ulaanbaatar government's contribution to the governance of smart cities. In Hangzhou, the top-down political institution, heavy traffic congestion, and the city's technological strength produced a government-led triple helix model of urban technological innovation for governing the traffic issue. Citizens and their concerns are largely excluded from this project. Finally, in Amsterdam, vulnerable ecological system, democratic system, high internet literacy, and strong awareness of civic engagement have produced various open and collaborative platforms for different urban actors to participate in the governance process and to contribute their knowledge to shape urban technological innovation and the urban spatial environment.

Second, the dynamic sociotechnical interactions have indeed produced different modes of smart urban governance. In Ulaanbaatar, smart urban governance is about the government of a smart city by adopting privately controlled technologies to digitalize the city's infrastructure, whereas in Hangzhou smart urban governance focuses on smart administration to optimize traffic management. In Amsterdam, smart urban governance is more concerned with creating open innovation spaces for smart urban collaboration, aimed at integrating technology into people's daily life. However, it should be noted that the smartness of the previous two smart urban governance modes has been restricted largely. The sociotechnical process in Ulaanbaatar is largely shaped by international high-tech companies, whereas in Hangzhou the government plays a more dominant role in terms of decision-making processes and the implementation of technology. The successful sociotechnical framework for smart urban governance is nicely illustrated by Amsterdam Smart City. In this project, different urban actors can contribute their knowledge and ideas to urban technological innovation, and in turn urban technological innovation increases diversity and cross-professional collaboration. This case supports the arguments made by some authors that for successful smart urban governance, the urban governance structure should "craft new forms of human collaboration" (Meijer and Bolívar, 2016: 392) by "linking initial enthusiasm based on technological and symbolic value to the long-term dynamics of institutionalized collaboration and instrumental value" (Meijer and Thaens, 2018:365).

Third, the outcome of the sociotechnical interaction (i.e., smart urban governance) has an impact (i.e., feedback) on the urban contexts. For instance, the Smart Ulaanbaatar Program requires a re-examination of the urban contexts that were not explicitly considered in the previous phase. In Hangzhou, the introduction of City Brain has further enhanced the government's political control. In contrast, the success of smart urban governance in Amsterdam has not only reduced its urban problems, but also fostered its collaborative environment for urban future innovation.

4.6 Conclusion

It has been argued that urban governance is being connected to ICT-enabled government and urban technological innovation to make cities smarter (Meijer and Bolívar, 2016).

This paper advances this argument by presenting a sociotechnical framework for smart urban governance to incorporate urban technological innovations with urban governance in the realm of smart cities. This framework is sociotechnical in the sense that urban technological innovations are intertwined with urban governance processes within the specific urban context. On the basis of an extensive review of index systems, research reports, key literature, national and local policies and documents, three real-world cases were used to validate this conceptual framework.

Our analyses show that the urban contexts in different cities indeed have a different influence on the sociotechnical interaction and produce different "smart" urban governance modes. However, the alleged smartness in smart urban governance by no means implies the simple acceptance, adoption, and use of technology; instead, it needs to be conditionate. The comparative study of the three cases shows that a comprehensive consideration of the urban context and a wider focus on the real needs of different urban actors (as in Amsterdam Smart City) can effectively integrate urban technological innovation into urban governance and produce smart urban governance. Compared to traditional urban governance, smart urban governance in Amsterdam nicely illustrates how technological solutions to urban problems can be "developed and implemented in close collaboration with research institutions, business, and groups of—or even individual—citizens" (Meijer and Thaens, 2018: 364).

Thus, for successful smart urban governance, urban technological innovations should be effectively attuned to the wider urban actors and preexisting urban challenges (i.e., the urban governance process), with a special focus on the urban context. Only through such processes can the value of urban technological innovation (i.e., technological, instrumental, collaborative, and symbolic values) be fully achieved and can the knowledge and ideas of different urban actors be reflected in urban technological innovations. However, it is worth noting that the comparison of the three cases just provides a positive reference. As cities in different societies face different developmental stages and transitions, it is vital to identify approaches to sociotechnical governance suitable for their own contexts. In fact, opportunities for or barriers to the sociotechnical interaction are not only created or overcome by direct action; they are also mediated by the context-specificities. Therefore, the implications for urban policymaking and planning are obviously case-dependent. In the future, it will be useful to build further on the findings of this article and conduct policy- and practice-based evaluations of smart urban governance. This could help us to understand how to make the most of the existing opportunities for smart urban governance and how to maximize its societal value in specific urban contexts.

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Chapter 5

Planning First, Tools Second: Evaluating the Evolving Roles of ICT in Urban Planning

Submitted as: Jiang, Huaxiong. Planning first, tools second: Evaluating the evolving roles of ICT in urban planning.

Abstract: Over the past decade, advances in big data infrastructures (accrued through sensors) and associated Information and Communication Technologies (ICTs) have offered huge potential to support planning but are no 'silver bullet'; in fact, their role in practice has been obstructed by fundamental and structural factors. This paper argues that the evolving perceptions of planning together with the changing roles of ICT in supporting planning provide the foundations for solving these structural restrictions. Therefore, it conducts a genealogical investigation of planning thoughts and associated ICT supports over the past 70 years, which is further cross-checked by an expert interview survey. The analysis indicates that for an up-to-date and factual planning supportive role: 1) there should be a strong focus on the planning (urban) issue at hand since it determines the planning mode and the relevant ICT choice; 2) a user-oriented, demand-induced approach towards ICT developments is recommended, aiming at better serving the real needs of ICT users and planning practices; 3) ICT development in supporting planning calls for sensitivity towards the context specificity, since the specific contextual characteristics help to identify the complexity faced by planners, select the relevant planning rationality, and decide on the specific ICT to be applied. As such, this paper highlights the importance of considering planning support as a sociotechnical innovation of transformation shaped through contingent challenges in urban contexts and the relevant planning approaches applied for handling these challenges.

5.1 Introduction

The urban world is changing rapidly. It was reported 2008 was the year when more than half of the world's population live in urban areas; and by 2050 the figure would increase to two-thirds of the world population (United Nations, 2018). However, this growing population has been the major contributing factors to a range of serious urban challenges such as overcrowding, increasing demand for resources, poverty and inequality between rich and poor, destitution, global health crises, crime, environmental degradation and political turmoil (Geertman and Stillwell, 2020). To make a response, it becomes vitally significant to look at how cities grow and evolve and how they can be planned. In urban planning field, there is strong consensus that the information and communication revolutions can be seized by planners to create possible solutions to these urban problems (Harris and Batty, 1993; Huxhold, 1991; Geertman and Stillwell, 2004). It is claimed that meeting the grave urban challenges depends upon combining new technological innovations with urban planning in both the professional field and the academic area

(Geertman and Stillwell, 2004). More recently, the exponentially growing big data infrastructure (accrued through sensors) and associated Information and Communication Technologies (ICTs) in the realm of smart cities provide the momentum for improving the planning support and achieving sustainable development goals (Geertman and Stillwell, 2020; Jiang et al., 2019, 2020). It is expected that new ICT innovations can enhance the intelligence of urban systems, which further improve the capabilities of practitioners and researchers to develop solutions to wicked problems (Pettit et al., 2018; Pelzer, 2015). Several promising signs have emerged in smart city planning field, indicating the ICT potential.

First, up-to-date and real-time (big) data collected via Internet of Things (IoTs) sensors provides planners with new ways of measuring the form and function of the city (Batty et al., 2012). For instance, a (big) data-driven platform called City Brain is developed in Hangzhou (China) to analyze, visualize and manage the spatial-temporal behavior of car drivers. By using these better informed information, traffic flow is monitored and controlled and mobility strategies and plans can be thereafter deployed (https://www.alibabacloud.com/et/city). Then, the emergence of new ICTs enables ways of new working and communicating in society as well as providing the mechanism through which greater knowledge can be produced. An example of this is the online workbench called Urban Intelligence Network in Australia. Via bringing together a network of researchers, planners, and policy-makers from across Australia, new collaborative outcomes can foster multidisciplinary and joint research on sustainable challenges related to smart cities (Pettit et al., 2015). Additionally, big data and new ICTs can be combinedly used to confront some routine planning tasks. For instance, by developing methods from data analytics and by using large volumes of up-to-date data/information/news/figures collected from communities, the Smart Shrinkage Decision Modeling in Baltimore (USA) helps to monitor and visualize the vacant or abandoned properties and provides novel insights regarding ways in which planners can perform vacant property redevelopment (Johnson et al., 2015). In brief, new big data and smart ICTs offer researchers and practitioners with the potential to tackle historically grown path dependencies and address some of the consistently unresolved social, economic and environmental problems.

Nevertheless, critiques indicate that technology's potential in augmenting the planning of cities have been hindered by some fundamental and structural factors (Geertman and Stillwell, 2020; Jiang et al., 2019; Pettit et al., 2018). For instance, various smart ICTs developed by private companies often outpace the ability of policymakers and societies to adapt to the changes. Although many smart ICTs such as cloud computing, artificial intelligence and Internet of Things are developed, insufficient technical skills, knowledge and training have made practitioners (mainly planners) hardly embrace these tools to improve their problem-solving potentials (Geertman and Stillwell, 2020). Then, due to a lack of quality in utility, user-friendliness and ease-to-use, some technological advances do not satisfy real needs of users and planning tasks such as spatial scenario building, interpersonal dialogue, collaborative decision making and consensus building (Flacke et al., 2020). Furthermore, some ICT developments often take place in small teams of academic researchers (i.e., an expert-led systems engineering approach); consequently, the innovation processes have been seldom co-created and practiced by ordinary people (Vonk and Ligtenberg, 2010). Influenced by this, it becomes increasingly difficult to integrate ICTs for e-participatory planning that can support citizen-specific and context-based decision making (Afzalan and Muller, 2018).

The above analysis shows that the emergence of new ICTs has created new opportunities for planners to embrace the shift towards the digital paradigm and increase their awareness and uptake of ICT-based toolkits. However, the identified fundamental and structural restraints in practice significantly hinder the promising role of ICT in supporting planning and in achieving the handling of the planning issue at hand. Innovative approaches to ICT developments therefore is needed to effectively integrate the smart ICTs into supporting planning (Geertman and Stillwell, 2020; Jiang et al., 2019). In accordance with Klosterman (1997), this paper argues that the continued failure of practitioners and researchers to use smart technologies to augment the planning process and deal with the planning issues in the realm of smart cities results less from the limitations of hardware and software than from a limited understanding of the complexity and rationality of planning in determining the proper role these tools should play. This paper suggests that the evolutionary perceptions of planning (explained by complexity and rationality) together with the evolving views of ICT in supporting planning provide the foundations for solving these structural restrictions. Based on this, this paper intends to get insights into the evolving roles of ICT in supporting planning so as for an up-to-date and factual planning support in the ‘smart’ era.

With the aim in mind, Section 2 introduces the research strategy and method. Then, Section 3 presents a genealogical investigation of the evolving views of ICT in planning. In Section 4, learned lessons for an up-to-date and factual planning support are suggested, which is further crosschecked by an expert interview survey. Section 5 describes the conclusion and new questions arising out of this study.

5.2 Research strategy and method

5.2.1 Strategy

Over the past 70 years, studies have been consistently conducted to investigate different views on the role of ICT in supporting planning. Planning support ICT in this paper is defined as geo-information technologies dedicated to supporting those involved in planning in the performance of their specific planning tasks (Geertman, 2006). Some argue that the developments and applications of ICT in supporting planning is mainly because the *complexity* of planning faced by planners is quite profound and vast (Chadwick, 1971; Klosterman, 1994). Decision-makers and planners have need of more or better planning support instruments to be able to handle the ever-accumulating complexity of real-world planning practice. Here, planning complexity indicates to the difficulty of understanding and dealing appropriately with the issue at hand (Innes and Booher, 2010). It comes when aspects of the concerned issue are of complex interdependencies and when planners do not possess the considerable information and knowledge of this problem (Friedmann, 2019; De Roo and Hillier, 2016).

Then, others highlight that planners' faith in the emergency of ICT in support planning results from the efficacy and usefulness that such new computer-based tools have provided to improve the appropriateness of planning (Pelzer, 2015; te Brömmelstroet, 2013; Vonk, 2006). In practice, a diversity of available methods, techniques, and models have then been developed and applied to support those involved in planning in data collection and extraction, spatial and temporal analysis, spatial modeling, visualization, and augmented participation and collaborative decision-making (Batty, 1995). What is worth noting among those authors is that the *rationality* of planning significantly influences how planning-support ICT is developed, organized, applied and evaluated (Vonk and Ligtenberg, 2010). Here, planning rationality has to do with the way planning is performed to deal with the urban issue (Alexander, 2017, 2000). For instance, centralized planning often requires ICTs organized in a hierarchical way to transmit information from a low level to a high level whereas participatory and collaborative planning usually asks for more communicating tools distributed among different stakeholders to support mutual information exchange.

According to some authors, tricky urban challenges in urban context actually form the root cause of the planning complexity and rationality (De Roo and Hillier, 2016;

Alexander, 2017; Geertman, 2006; Klosterman, 1997). After Hartmann and Geertman (2016), one can identify three major periods in planning thoughts – object-oriented period, process-oriented period and context-oriented period – during the last half century within the Western World (Western Europe and Northern America). Due to distinctive characteristics (e.g., time span, the task at hand, actor interaction), each planning orientation tries to fit to a specific complexity of planning, which results into a particular type of rationality to deal herewith. The underlying argument of this view is that instead of an object 'out there', challenges in urban context and their planning solutions are constructed which requires an understanding of how planning is integrated in larger urban networks and circumstances and what this means for the role of ICT. In this paper, the notions of planning complexity and planning rationality, along with challenges in urban context, are applied to explain the supportive role of ICT in planning (Figure 5.1).

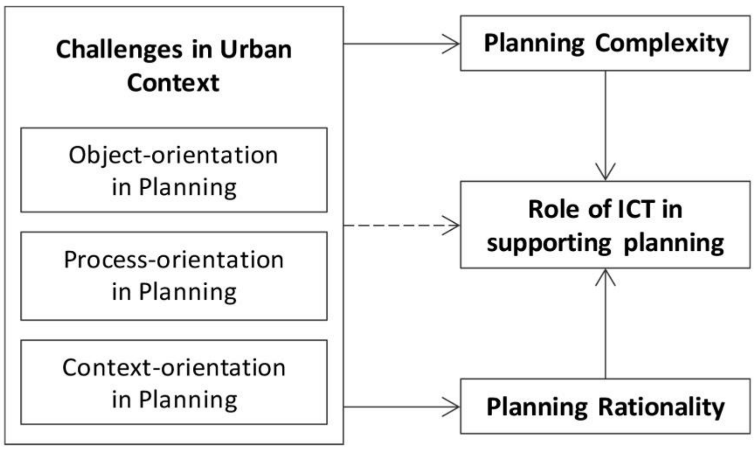

Figure 5.1 A framework for explaining the role of ICT in supporting planning, based on Hartmann and Geertman (2016), Alexander (2000) and Klosterman (1997)

The framework indicates that challenges in urban context define a state of urban concern that a typical planning approach aims to resolve – the specific planning orientation. As Hartmann and Geertman (2016) define, the object-orientation indicates that the focus of planning is clearly on the object – space, built structures, economic effects – whereas the process-orientation means planning moves towards governing the process of decision-making, with an emphasis on actor interaction and deliberation; then, the context-orientation highlights the importance of contextual factors in analyzing and designing urban developments and in the implementation of specific planning measurements. Each planning orientation relates to a certain planning rationality to deal with the specific planning complexity. And likewise, each planning orientation asks for certain ICT tools for its support to be able to deal with the identified planning complexity (see the dotted arrow line). It should be noted that there are no strict dividing lines between the identified planning orientations: although certain periods in history can be linked to a certain dominant planning orientation, this should not be interpreted as exclusive. Altogether, this framework reveals that the perception of planning – the planning orientation – is closely linked to the identified planning complexity and associated planning rationality to handle the challenges in the urban context, which lays the foundations for the appropriate role that dedicated ICT should play in planning. In the following sections, the framework will serve as a guideline for a genealogical investigation of the evolving roles of ICT in supporting planning. It is expected that the genealogical investigation will help us gain valuable insights into the way ICT can be effectively integrated into supporting planning in the 'smart' era.

5.2.2 Method

This study is based on a combined research method. First, since different roles of ICT in supporting planning have been well recorded in the scientific literature (Vonk, 2006), literature survey as a research method was thus applied. The selection of suitable literature concerning planning support ICT was built on the definition given in Section 2.1. By referring to the method proposed by Wolfswinkel et al. (2013) for rigorous literature review, the retrieval was conducted in March 2018, updated in November 2019. Since computer-based information technology began to play an important role in planning especially after World War II (Geertman, 2006), we limited the review to literature published from the postwar planning paradigm – object-oriented period. Only peer-reviewed journal articles and scientific books were considered in the literature review since this enables us to include high quality research. A total of 253 scientific publications on the role of ICT in supporting planning were identified in the first phase but after reading the details of the articles only 47 key publications were used in this paper.

Besides, expert views of ICT in supporting planning have also been compiled via an interview survey. Through face-to-face and online interviews, 12 experts working in the urban planning / governance field were correspondingly invited to participate over the course of four months, from June to October 2019. These experts are from Australia, USA, China, the Netherlands, Brazil, UK and Japan, respectively. The expert interviews were analyzed as a cross-validation of the results obtained from the genealogical investigation of the planning-support ICT literature.

5.3 Evolving roles of ICT in supporting planning

The conceptual framework of Figure 5.1 is positioned and comprehended in a set time frame, even though this should be accounted as merely a rough track. Geertman (2006) claims that the associated time frame in reality is different from place to place, from one planning field to another (e.g., transportation vs. urban design), between different planning professions (e.g., data analyzer vs. designer), etcetera. Thus, previous understanding of the role of ICT will have an evolutionary influence on comprehension of the next stage. Following the scrutiny of planning literature, this section conducts a genealogical investigation of the evolving roles of ICT in supporting planning in the following four areas: challenges in urban context, planning complexity and ICT functions, planning rationality and ICT development / application, and ICT implementation problems.

5.3.1 The role of ICT in supporting object-oriented planning

The idea of information technology was first introduced in the late 19th to deal with troubling urban challenges such as overcrowding, slums, unhealthiness and deterioration of cities (Huxhold, 1991). Up till 1951 when the first computer for commercial use was introduced to the public sectors, planners started to embrace reluctantly computer-based information technologies to support their planning activities (Shiode, 2000; Brail, 1987). The reason for planners to use computer-based information technologies in this period was due to the intensive urban renewal and reconstruction in western countries after World War II. With a deepening of the division of labor caused by the large-scale urban development, planning was developed into a multitude of specialties (e.g., transportation planning, environmental planning, health planning, land use planning, regional planning, and social planning) requiring specific skills and professional knowledge (Beauregard, 1986, 1987). The *complexity* faced by planners in this period was how to employ multiple theories and tools from different disciplines to preview, specialize, generalize and explain specific urban problems and combine these understandings to formulate a final picture of the future state, *blueprint planning* (Faludi, 1973). In these sectoral planning domains, planners are assumed as *rational-comprehensive* (also known as instrumental, substantive, unbounded, or synoptic rationalities), indicating that planners have all the knowledge about past, present, and future events, items, or performances and the knowledge required in the whole process of plan-making and coordination (Kiernan, 1983).

Influenced by this, computer-based information technologies were mainly required to facilitate planners to collect, process and analyze information and data and make intrinsically value-free plans that would be appropriate for everyone who lived in the city. A remarkable feature of planning-supportive ICT in this period was its task orientation. Some large-scale systems models were developed (e.g., urban transportation models, large-scale metropolitan land use, and integrated municipal information systems) to deal with some of the large and urgent urban issues (Chadwick, 1971; Klosterman, 1994; Lee Jr, 1973). In the process, the city was treated as a complex dynamic system, comprised of various interconnected components in a hierarchical order. Technology developers and specialists hoped that these systems models could collect and store the required data, and define problems, identify goals, generate alternatives and select the best plan. Underlying this was the influence of the rational comprehensive model on the value of technology, postulating that technology's usefulness is judged in terms of achievement of the ends (i.e., instrumental value).

However, it should be noted that the use of large-scale systems models, despite being deemed as a rational behavior, failed to optimize the overall urban system. According to Lee Jr (1973), seven shortcomings blocked the potential of earlier computer innovations in supporting and revolutionizing tools like large-scale models in a policy environment. According to him, these models were designated to replicate too complex a system in a single shot and serve too many purposes at the time. Then, simple algorithms and low computing capabilities did not match the needs of complex urban issues. In general, factual support needs of planners and planning practices were far ahead from what computer-based information technologies could provide. As a result, a key challenge facing with the application of computer-based information technologies at this period of time was the undersupply problem of ICT (Webster, 1993).

Accompanied with the intensive criticism of the rational comprehensive model, planning processes were never treated as politically neutral but were inevitably linked with power relations and political contestation (Hudson et al., 1979). Large-scale systems models, once presumed to offer value-free information and everyone satisfying plans, were no longer suitable for more open and participatory policy-making processes. Thus, the period following this saw more specialized information technologies that were developed to aid the factual planning process.

5.3.2 The role of ICT in supporting process-oriented planning

From the 1970s through the earlier 1990s, the general political and social evolution of the Western society challenged the conventional unitary public interest, which led to a so-called "paradigm breakdown" in planning (Alexander, 1984). Planning was no longer deemed as a closed system including only the state and its planner; instead, it was treated as a process-oriented open system to meet the need of engagement from non-state actors— *process-orientation in planning* (Faludi, 1973). The *complexity* faced by process-oriented planning is how the state/planner can build rich connections with different stakeholders to operate on the edge of social uncertainty and instability to articulate important urban problems and realize the pluralist interest in outcomes. Furthermore, due to the identified wickedness of many urban problems (Rittel and Webber 1973), *bounded rationality (incrementalism* and *mixed-scanning*), *advocacy*, *transactive* and *radical rationality* were respectively proposed (Lane, 2005), emphasizing the importance of politics and social interaction in collectively shaping the planning process. Knowledge, discourse, ideas and lived experience endowed with power among different stakeholders can all exert particular influence on the contents, strategic directions, and outcomes of certain plans (Friedmann, 1987). The changed perception of planning had largely altered the primary concern of technology in planning.

First, conflicting values and interests arising in the 1970s greatly increased the data and information input in the planning process (Klosterman, 1997). It was argued that better computer-based information systems would be useful for managing information and disclosing unrecognized controversies and faults in planning processes (Huxhold, 1991). When the minicomputer was developed and introduced, computer-based ICTs were mainly developed to deal with information management in planning. Except for traditional functions (such as data collection and input, data transmission, data storage, data processing and output), new information systems were considered to help planners to reasonably arrange the plans of each functional department. For instance, computer-based mapping was created to better craft representations of urban space, while relational database management systems (DBMS) were employed to transmit and share this mapping information within planning systems (Klosterman, 1997). However, it should be noted that the previous rational comprehensive model still had an enduring influence on the development of these systems. Although some techniques were deemed as useful for narrowly-defined technical problems, they could hardly offer the rigorously tested and empirically confirmed knowledge required to guide the policy making processes (Bernstein, 1976).

Then, in the 1980s the primary concern of computer-based ICTs shifted to facilitate the creation of knowledge and help planners make decisions (Geertman, 2006; Klosterman, 1997). This transition reflected the importance of knowledge in policy-making. Stimulated by the article of Gorry and Scott Morton (1971), the notion of decision support systems (DSS) was introduced to help managers to formulate decisions. According to them, DSS would allow decision-makers to systemically produce and assess a number of alternative solutions and help incorporate substantive knowledge along with quantitative data offered by the models. In the later 1980s, the underlying principles of DSS were incorporated into Spatial Decision Support Systems (SDSS) (Densham and Rushton, 1988). However, a key problem for SDSS was that it limited its capability to exclusively support short-term decision-making by isolated organizations or individuals and not stretched to longer-term planning (Geertman, et al., 2013).

In the earlier 1990s, earlier views of planning as a conflicting process were replaced by a perspective on planning as an ongoing process of interactive dialogue and debate in which different stakeholders can collaborate with each other to identify and solve collectively concerned issues (Healey, 1997). Innes (1995) summarized this new approach as 'communicative planning', even it was also called 'planning through debate', 'argumentative turn', 'communicative turn', 'collaborative planning' or 'deliberative planning' (see Healey, 1997). With this had come the realization that the development of computer-based ICTs should facilitate interpersonal communication and collective design and focus more on long-term urban challenges and strategic planning issues. To do so, the notion of planning support systems (PSS) were put forward to offer participatory and integrative procedures for tackling poorly structured decisions (Harris, 1989; Harris and Batty, 1993). According to Geertman (2008: 217), PSS are "the geoinformation technology-based instruments that incorporate a suite of components that collectively support some specific parts of a unique professional planning task". It intends to integrate various computer-based ICTs useful for planning and provide the information infrastructure for planners and planning practices.

However, attitudes towards the development of PSS seemed to be unsatisfactory (Geertman, 2006). Although a lot of PSS were developed and supplied, the application of PSS was primarily dominated by an apparent mismatch between the supply of available planning-support instruments and the time-bound demand for support by planning practice—the PSS implementation gap (Geertman, 2006; Vonk, 2006; Silva et al., 2017; Brömmelstroet and Schrijnen, 2010). It indicated that various PSS developed by experts in the laboratory with a traditional systems engineering approach can hardly meet the real needs of users (planners) and planning practices (Vonk and Ligtenberg, 2010). For instance, the lack of sufficiently attuned communicating functionalities had made it difficult to facilitate interpersonal communication and community-based debate in participatory planning. Focusing too much on strict rationality, some computer-based ICTs were too complex, incompatible and inflexible with real planning tasks (Vonk, 2006). Therefore, strong recommendations were made that future PSS developments should move beyond the demonstrated collaboration amongst PSS experts and step towards a user-centered PSS-development approach (Pelzer, 2015; Geertman, 2006; Vonk and Ligtenberg, 2010).

5.3.3 The role of ICT in supporting context-oriented planning

Since the late 1990s, the capitalist expansion has integrated local and national economies into a global, unregulated market economy (Fainstein, 2010). Cities worldwide are becoming more exposed to the challenges or tensions between the increasing significance of globalization and the escalating salience of local communities (Newman and Thornley, 2011). For a proper working of planning, arguments are made that planning should focus more on the context-specificities (Alexander, 2017; Fainstein, 2010, 2000). Hartmann and Geertman (2016) identify this as *context-orientation in planning*—focusing on the specific role of the planning object in its wider environment, reflecting on the political dimension of the planning process and theorizing on the specificities of the planning context. The *complexity* faced by planning in this period is how to produce more open and inclusive processes and better outcomes in specific urban contexts as its legitimacy claim (Fainstein, 2010, 2000). Then, *communicative rationality* and *pragmatic rationality* were correspondingly proposed to frame planning behavior and practice (Holgersen, 2015; Healey, 2009, 1997; Alexander, 2017, 2000). It emphasizes the importance of different planning methods and paradigms associated with the situations to be interpreted through either personal and individual deliberation or collective communicative action (Alexander, 2000).

Consequently, the enquiry of the supportive role of ICT in planning is recently advanced to embrace such a question: what kinds of ICT are or should be implemented by what kinds of stakeholders in which types of planning situations, contexts or circumstances? (Russo et al., 2018; Pelzer, 2015; Biermann, 2011; Vonk, 2006). Rather than taking a normative view, these questions help to embrace a more pragmatic attitude toward the role of ICT: to what extent can the implementation of ICT in planning become more effective and useful? (Deal et al., 2017; te Brömmelstroet, 2017b). This perspective indicates that: 1) the design of one typical functionality should first be related to its application situation—real needs of users and planning practices—rather than to the technology itself (Pan and Deal, 2019; Pelzer, 2017); 2) rather than being complex, objective or value-neutral, ICT should be more flexible, integrated and user-friendly (Russo et al., 2018; te Brömmelstroet, 2017a); and 3) all available ICT instruments suitable for serving the specific needs of planning should be employed—providing the “information infrastructure” for planning (Pelzer, 2015; Klosterman, 1997).

Summarily, rather than following a traditional systems engineering method, a much more human-induced socio-technical approach should be employed which is sensitive to the specific characteristics of the context to facilitate and optimize ICT’s potential role in planning practice (Geertman, 2006; Vonk and Lightenberg, 2010; Pelzer, 2017). Such a transformative approach assumes that a system is only optimal for dealing with a particular planning task when it is attuned to the specific characteristics of that specific planning context. To do so, a range of authors have urged that thorough research into the potential added value or usefulness of ICT for planning in specific contexts will facilitate this socio-technical transformation and unblock the bottlenecks that block widespread usage of ICT in planning (Geertman, 2006; McEvoy et al., 2019; Russo et al., 2018; Pelzer, 2017; Silva et al., 2017; te Brömmelstroet, 2017a; Vonk and Ligtenberg, 2010).

Table 5.1 Evolving roles of ICT in supporting planning

Dimensions	**Object-orientation in planning: 1950s to 1960s**	**Process-orientation in planning: 1970s to earlier 1990s**	**Context-orientation in planning: later 1990s to now**
Challenges in urban context	●Urban renewal and urban sprawl; population growth and various urban problems	●Government crisis; plurality of actors; urban inequality	●Tensions between globalization and localization; aggravated socio-spatial inequality; the information revolution and technological society
Planning complexity and ICT functions	●Blue-print; survey-analysis-	●Wicked problem and uncertainty; participatory planning	●New urbanism; the just city; communicative planning; smart urbanism

	implementation; master planning		
	●Electronic data processing and large-scale systems models to improve task operation	●MIS to improve management ability; DMS and SDMS for policy-making process; PSS for interpersonal communication and collective design	●Various techniques, methods, and tools focusing on real added value they can generate to users and planning practices ●Planning Support Science (PSScience)
Planning rationality and ICT development & application	●Rational comprehensive; instrumental rationality	●Transition from rational comprehensive to bounded rationality, advocacy, transactive and radical rationality	●Communicative rationality; pragmatic rationality
	●Task-oriented ICT development ●Very limited application	● Expert-led development ●Supply-oriented application	●Towards a user-oriented, sociotechnical approach for ICT innovation ●Demand-induced application
ICT implementation problems	●Strong support needs but immature ICT; undersupply of ICT	●Technological determinism; a discrepancy between ICT supply and ICT demand	●Transition challenges from technology-driven, supply-pushed to sociotechnical, demand-induced practices; context awareness

5.3.4 Findings

Table 5.1 summarizes the evolutionary perceptions of planning along with the evolving roles of ICT in supporting planning in the three main planning periods. It indicates that challenges in urban context have become more extensive while the complexity of planning has been consistently increasing. In succession, the way planning is performed turns to be more collaborative and pragmatic. However, it should be noted that although the acceptance and use ICT in planning practice are increasingly widespread, there is still a long way for them to be fully effectively incorporated into supporting planning. Implementation problems consistently appear in each period (e.g., undersupply of ICT in object-oriented period; a discrepancy between ICT supply and ICT demand in process-oriented period; and transition challenges in context-oriented period) (analyzing Row 5). Nevertheless, some insightful findings are meanwhile revealed to be operative and useful. First, challenges in urban context influence the perceptions of planning (i.e., planning complexity and planning rationality) and ultimately affect the choice of ICT-support functions and the way ICT is applied (analyzing Row 2-4). Secondly, there is a trend for transforming the current expert-led ICT innovation into more user-oriented, demand-induced ICT developments in order to offer high-quality ICT that can meet the factual needs of users and planning practices (analyzing Column 5 and Row 5). Thirdly, context has been paying increasing attention because of its influential role on the effective integration of ICT into planning practice (analyzing Column 5).

5.4 Towards an up-to-date and factual planning support

Geertman (2006: 870) argue that "[previous views of planning-support ICT] do not end with the arrival of the next one (no Kuhnian paradigm shifts); instead, equally-as-worthy indicated elements of previous traditions continue alongside and/or intermingled with, and/or adapted to following [views of ICT in supporting planning]". Taking this point into consideration, this section aims to link the findings obtained from the previous genealogical investigation to the expert interviews and distils those dimensions which are at the present overlooked and undeveloped but could significantly contributes to an up-to-date and factual planning support.

First, analyzing expert interviews indicates that ICT development to support planning should focus more on the sustainable urban challenges – the acknowledgement that the 'urban' as the object that planning support is intended to. As previously argued, while smart city technologies can become directly operational in planning practice, critiques show that the direct deployment of advanced ICTs into practice often fails due to an inadequate link between ICT developments and planning issues. When we turned to expert views, almost all the 13 experts emphasized the importance of changing urban problems in stimulating technological innovations. Experts claimed: "*in the past few decades, urban issues have been an important driving force for technological innovations in urban planning"* (Expert 3); "*It is not just about developing so-called PSS and implementing them, but more about the problems to be solved and the positive outcomes to be produced to cities"* (Expert 9).

However, the experts were not quite satisfied with the supportive role of ICT in handling the planning issues. As critiques shown: "*the main urban issues currently are pretty much the same as they were 20 years ago…[that is], affordable housing, transportation issues and public education, etc."* (Expert 3)*;* "*Many of these tools, techniques, and models* *didn't work well enough…they were not really oriented to what [users] are looking at*" (Expert 8). As experts commented: "*planning support techniques were only used to solve some urban transportation and land use problems and do some simple analysis such as traffic flow analysis, land use evaluation, mapping and visualization…it was hard to confront social issues like segregation, inequality and slums"* (Expert 6). Further comments indicated*: "Planning support tools has changed relatively fast over the past few decades, but our understanding of the city itself is quite inadequate; thus, the role of planning support tools is vague"* (Expert 9). As a response, experts highlighted that we should deliberate accurately what kinds of transitions cities are encountering and what kinds of planning modes are needed. As one expert concluded:

"*...I personally do not care much about the smart city technologies…the important thing is about cities and providing education, good roads and things like that… for the supportive role of technologies to be effective, you should ask: who does what, how, when, and to what effect?... I would start with planning and then think about what technologies can best support planning*" (Expert 10).

Second, interviews with experts confirmed that ICT advancements in supporting planning should be well attuned to the planning process, highlighting a shift from an expert-led, supply-pushed strategy to a user-centered, demand-induced innovation. At present, while basic ICT can become directly operational in planning practice, the direct deployment of advanced ICTs into practice often fails because the support functions do not fit the characteristics of planning processes as well as the demands and skills of users (Pelzer, 2015; Vonk, 2006). ICT developments over-rely on the ability of the private sector and experts to design, launch, and implement technologies; however, the extent to which the functions and capabilities of various ICTs are properly attuned to and can be applied to real-world issues are not adequately examined (Pelzer, 2017).

When we turn to the expert interviews, it was stated that linking ICT developments to planning processes (or users) is insufficient in practice. As experts disputed: "*Over the last decade, more tools were developed and created by [private] companies…but it is just a 'dark chamber'… it's too complex*" (Expert 9); "*Urban technologies are largely provided by private [companies]…but it's better to have technology that is easy-to-operate and user-friendly*" (Expert 1). Despite the technology push, expert views indicated that there has been a burst of recent scholarly attention on cooperation between technology developers and users on ICT development. For instance, experts highlighted that "*instead of focusing on the expert-led development of technologies, it's better to* *engage the public and make them smarter…focusing on the political process*" (Expert 10); "*The best thing for us is to understand the need and demand of [practitioners]*" (Expert 2). In brief, experts viewed that successful implementation of ICTs into supporting planning requires user involvements and increased communication to practice as it helps to develop ICT into tailor-made instruments for the relevant planning practices.

Third, interviews with experts revealed that the importance of context in analyzing the supportive role of ICT in planning should be considered particularly. Fainstein (2010: 2) argues that "much of planning theory dwells on planning processes and the role of the planner without analyzing the socio-spatial constraints under which planners operate". Hence, it is recommended to center on the practical realities of urban planning and urban policy within cities' local and global contexts. Analyzing the comments of experts indicated that contextual factors have been consistently influencing the way ICT is developed and integrated into planning practices. It should be noted that context was interpreted multidimensional by expert to include technological advancements, political institution, planning styles, user characteristics or even the planning issue itself.

For instance, political systems played a crucial role in the ICT diffusion and adoption in planning organizations. As one Chinese expert illustrated: "*the government threatened the planning institutions…if the computer-based plotting rate doesn't reach 50%, their institutions will be degraded to a lower level*" (Expert 7). Experts from the U.S. also demonstrated the influence of government on technology spread: "*the census bureau since 1970s has done a lot to promote the standardization of data…like time file, TIGER file, and street network file…so planners can make use of it*" (Expert 3). Then, contextual factors were argued to influence the organization and usefulness of ICT in practice. One Australian expert claimed: "*in Australia, certain councils and state government agencies mandate that the planning of smart cities projects should be more proactive…then, open dashboards like CITY VIEWS are used to provoke community engagement*" (Expert 2). In another participatory project, it was complained: "*the tool in the project is not quite helpful…not much people know it…the participation rate is low*" (Expert 7).

Besides the above context factors, the technology itself was also argued as an important contextual factor: "*during the past decade, the rapid development of digital technology has enabled us to build more than 2000 GIS [Geographic Information Systems] layers of Wuhan city [China]. These layers largely enhance our capabilities to plan and solve the urban issues in our city*" (Expert 7); "*The high cost and relatively low penetration rate of minicomputers hindered the adoption and use of planning support ICT in the past several* *decades*" (Expert 9). Finally, experts highlighted that some other contextual factors such as skills, training and education could significantly influence the future use of ICT in planning. From expert views, it can be seen that valid and convincing familiarity, awareness, or understanding of the specific contexts is strongly needed to help identify the complexity faced by planners, select the relevant planning rationality, and decide on the form of ICT to be used.

5.5 Conclusion

In the era of smart city, although many big data infrastructures (accrued through sensors) and associated Information and Communication Technologies (ICTs) have been developed and proclaimed to provide potential to support planning, their potential role in practice has been obstructed by fundamental and structural factors. This paper tried to get insights into the evolving roles of ICT in supporting planning to gain factual planning support. The genealogical investigation indicates that the increasingly popular topic of new smart ICTs in support planning will continue the trend to a broader concern with added value that technology can generate. From this, lessons learned from the genealogical investigation, cross-validated by expert interviews, are recommended for future planning support.

The outcomes imply that for an up-to-date and factual planning support role: 1) there should be a strong focus on the planning (urban) issue at hand since it determines the planning mode and the relevant ICT choice; 2) a user-centered, demand-induced approach towards ICT developments in planning is recommended, aiming at better serving the real needs of ICT users and planning practices; 3) ICT development in supporting planning calls for sensitivity towards the context specificity, since the specific contextual characteristics help to identify the complexity faced by planners, select the relevant planning rationality, and decide on the specific ICT to be applied.

By proposing these implications, this paper acknowledges that ICT-enabled planning support must go beyond the technology-driven approaches and move towards the development, implementation and use of planning support ICT in urban sociotechnical processes. It requires an understanding of how planning support tools should best be integrated in larger urban contexts and planning frameworks and what this means for planning support innovations. As Stratigea et al. (2015:1) urge, we should "match different types of 'smartness' (technologies, tools, and applications) with different types of urban functions and contexts". As such, this paper highlights the importance of considering planning support as a sociotechnical innovation of transformation shaped through contingent challenges in urban contexts and the relevant planning approaches applied for handling these challenges.

Future studies are further suggested to demonstrate the robustness of the arguments and implications made in this paper. Firstly, studies could investigate the extent to which a sociotechnical ICT development could facilitate an improved usefulness of ICT in supporting planning and contribute to the actual handling of the planning issues at hand. Secondly, a thorough study of the influence of different contextual factors could give us all sorts of insights into the effective integration of ICT into factually supporting planning. In fact, this has been pointed out already by Geertman (2006) in 2006. In sum, such studies will help to discern the successes and failures of the proposed implications for improving the supportive potential of ICT in planning.

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Chapter 6

Avoiding the Planning Support System Pitfalls? What Smart Governance can Learn from the Planning Support System Implementation Gap

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Abstract: The implementation of smart governance in government policies and practices is criticised for its dominant focus on technology investments, which leads to a rather technocratic and corporate way of 'smartly' governing cities and less consideration of actual user needs. To help prevent a mismatch between the demand for and the supply of technology, this paper explores what smart governance can learn from efforts in debates on planning support systems (PSS) to close the 'PSS implementation gap'. This gap refers to a long-standing discrepancy between the availability of PSS systems (supply) and the time-bound support needs of planning practice (demand). By exploring both the academic field of smart governance and the debates on the PSS implementation gap, this paper contributes to the further development of smart governance by learning from the experiences in the PSS debates. Two particular lessons are distilled: 1) for technology to be of added value to practice, it should be attuned to the wishes and capabilities of the intended users and to the specifics of the tasks to be accomplished, given the particularities of the context in which the technology is applied; and 2) closing the PSS implementation gap reveals that knowledge on the context specificities is of utmost importance and will also be of importance to the smart governance developments. In conclusion, smart governance can and should become more aware of the role of contextual factors in collaboration with users and urban issues. This is expected to shift the emphasis from today's technology-focused, supply-driven smart governance development, to a socio-technical, application-pulled and demand-driven smart governance development.

6.1 Introduction

The notion of smart city has received much attention regarding its potential to deal with problems brought about by rapid urbanisation. Caragliu et al. (2011) state that a city is smart when investments in traditional infrastructure, modern information and communication technologies (ICTs), and human and social capital fuel sustainable urban development through participatory action and engagement. Present-day scientific smart city research criticises the practices of many smart cities that are primarily dedicated to implementing digital technologies, often provided by just one firm ('lock-in') (Trindade et al., 2017; Roche, 2014; Shelton et al., 2015; Söderström et al., 2014). Another criticism is that smart cities are promoting a set of uniform technological solutions for city problems worldwide while grossly neglecting the particularities of the local socio-political processes (Verrest and Pfeffer, 2019). As a consequence, in academic literature, scepticism arises about how smart cities are planned, who plans them and for whom they are planned (Jiang et al., 2019a; Kitchin, 2019; Hollands, 2015; Sennett, 2012). As Barns (2018:6) argues: "The ideals of the smart city in seeking to leverage the benefits of digital services to improve the way a city works, can't simply be realized by investing in distributed sensors and technology solutions alone, but necessitate a 'reinvention of governance' that involves transforming the way they work internally and together with outside partners and citizens".

The recent rise in the exploration of the concept of smart governance is one such effort to better achieve the governance of smart cities. Smart governance emerges mainly due to the growing role of technology in the functioning of cities, which has made governmental agencies rethink their role in such data-rich cities (Bolívar and Meijer, 2016). In literature, the potential provided by smart governance varies. Some argue that smart governance can harness the power of increasingly abundant sources of data (e.g. data published by private data providers and real-time data contributed by ordinary people) to support smart decision-making (Barns et al., 2017; Mellouli et al., 2014; Goldsmith and Crawford, 2014). Others highlight that by using smart ICTs, smart governance is expected to promote more proactive, open-minded governance structures that can "open up the machinery of government to its people, letting them collaborate to create solutions" (Goldsmith and Crawford, 2014). More recently, it has been asserted that smart governance can support community- and individual-centred decision making, and achieve objectives for sustainable urban development in different urban contexts (Angelidou et al., 2018).

Nevertheless, the development of smart governance in practice has so far been unsatisfying (Jiang et al., 2020, 2019b; Ruhlandt, 2018; Meijer and Bolívar, 2016; Stratigea et al., 2015; Ferro et al., 2013). Practice shows that many technologies are implemented via government policies – 'policy implementation of smart governance' – in which governments consider 'smart' ways of governing cities as just a management issue that can be handled in technological and technocratic ways. The assumption underlying this view is that the acceptance and adoption of technology will automatically smarten the process of city governance and thus result in better city governance processes and/or outcomes. However, in practice, no straightforward relationship between technological innovation and improved governance processes and/or outcomes has been shown. According to some authors, while the widespread use of ICTs ranging from urban data analytics to mobile media, the internet and information management systems provides governmental organisations or ordinary people with even greater convenience, this well-funded private-led approach with a focus on technological supply often results in a failure to account for the mundane demands of citizens (Goldsmith and Crawford, 2014), discrimination against 'non-smart' people (Vanolo, 2014) or the prioritisation of ICT infrastructure over other imminent needs on the policy agenda (Jiang et al., 2019a).

However, the innovative development of new technologies and their implementation in a field of practice is not something unique and solely associated with the field of the smart city and its subfield of smart governance. Many examples can be provided in which governance processes are supported by innovative technology, such as the technology development of planning support systems (PSS) within the discipline of spatial planning. Here, PSS are dedicated to supporting the proper design, development and use of the spatial constellation of a city or rural area, as well as the increasing involvement of participants and stakeholders in their decision-making processes. In the context of the growing complexity of the processes and outcomes of planning problems (cf. Rittel and Webber, 1973), it can be expected that there is a growing need for assistance, also in a technological sense, to be able to better cope with these complexities, in particular by PSS. PSS are computer-based technologies with a focus on the support of different aspects of spatial planning, such as "problem diagnosis, data collection, mining and extraction, spatial and temporal analysis, data modelling, visualization, etc." (Geertman and Stillwell, 2004:292). Despite many technological innovations in this field of research and the growing recognition of the need for technological support due to growing spatial complexities, this field has been dominated by the 'PSS implementation gap', namely the fact that the implementation in spatial planning practice of a wide range of PSS – which were first developed in academia and later in the private sector – lagged far behind the supply of tools (Geertman, 2006, 2017; Te Brömmelstroet, 2017). Among the solutions proposed to close this gap were propositions that PSS should be put into embedded contexts and developed according to the needs of the users and existing practices. It was also proposed to see PSS more strictly as a means rather than a goal in itself and for its application to put the specifics of the context much more at the forefront (Geertman, 2006).

This paper discusses what the policy implementation of smart governance can learn from efforts in spatial planning practice to close the PSS implementation gap. The underlying idea is that spatial planning practice should possess a lot of experience in closing this gap based on 15 years of study of the phenomenon and the fact that the newly emerging smart governance developments need to learn from these experiences and should be able to do so. To establish our contribution to the smart governance debate, we depart from existing theoretical and conceptual approaches within PSS literature to close the implementation gap and link these to the critiques within smart governance. First, a literature review on the concept of smart governance is presented in Section 2. Section 3 reviews the debates concerning the PSS implementation gap and the solutions proposed to close this gap. In Section 4, a comparison of the two developments is made to explore the extent to which they do or do not relate to each other. Section 5 distils those dimensions that are currently underdeveloped or even significantly overlooked but are useful to improve smart governance developments.

6.2 Smart governance

6.2.1 The concept of smart governance

Around the world, rapid advances in smart cities and smart ICT (e.g., Internet of Things, artificial intelligence, social media, sensor networks and platforms) have created opportunities to transform urban developments and city governance (Batty et al., 2012; Hollands, 2008, 2015; Scholl and Scholl, 2014). As a component of smart cities, the smart governance concept is increasingly employed by governments, urban managers, private sectors and political elites to create a smarter city by using key terms such as 'intelligent', 'smart people', 'smart decision-making', 'smart administration' and 'smart urban collaboration' (Ruhlandt, 2018; Chourabi et al., 2012). However, the meaning of smart governance in the realm of cities varies.

First, literature shows that smart governance is about making the right policy choices and implementing them in an effective and efficient manner (Alkandari et al., 2012). Nam and Pardo (2011) stress that smart governance includes the definition and implementation of the policies intended to make cities smarter, and requires the sharing of visions and strategies with the relevant stakeholders. Chourabi et al. (2012) argue that smart governance includes the management of the implementation of smart city initiatives targeted at making the various city dimensions/components smarter. As Barrionuevo et al. (2012) maintain, smart cities need to develop smart governance. For them, smart governance includes a three-step process: diagnosing the situation, developing a strategic plan and then taking action.

Second, smart governance is about developing innovative governance structures through the use of newly emerging technologies and new channels of communication to make cities smarter (Meijer, 2016; Giuffrè et al., 2012; Giffinger et al., 2007). For instance, UNESCAP (2007) states that smart governance revolves around "the process of decision-making and the process by which decisions are implemented (or not implemented)". Pereira et al. (2018) assert that smart governance is the ability of governments to make smarter decisions through a combination of ICT-based tools. Other authors argue that smart governance is the advanced vision of e-government, focusing on a transformed relationship between government and non-state actors (Giffinger et al., 2007; Giuffrè et al., 2012). For those authors, smart governance goes beyond the traditional institution – the 'compliance model' – in dominating the management of city services at the local or municipal level, and creates opportunities for "technologically-mediated citizen co-production of service-delivery and decision-making" (Webster and Leleux, 2018:95). As AlAwadhi and Scholl (2016) contend, smart governance is only smart when it can reshape administrative structures and processes across multiple local government departments and agencies and promote stakeholder involvement and collaboration in governance.

Besides these views, smart governance in the field of urban planning (which is also called 'smart city governance') focuses more on a desired outcome, namely on how it can handle the substantive urban challenges (Ruhlandt, 2018; Hollands, 2015; Roche, 2014). For instance, Meijer (2016) claims that smart governance should be closely linked to the urban problem domain, since situational characteristics (e.g., the physical environment, the economic production, and democratic institutions and culture) can be either conducive to or limit the effectiveness of smart governance. Kourtit et al. (2012) emphasise that smart governance requires coping with negative externalities and maximising the socioeconomic and ecological performance of cities. In the same vein, Stratigea et al. (2015) state that smart governance must start with the 'city' and not with the 'smart', emphasising an application-pulled smart city governance approach. In this sense, central to smart governance is how the applied technology is dedicated and can be applied to solve the city's issues.

The above analysis shows that the meaning of smart governance is manifold and fragmented. However, as Ruhlandt (2018) argues, such incoherent perspectives on smart governance inevitably produce semantic ambiguity and discontinuity. Meijer and Bolívar (2016) conducted an extensive literature review and summarised four ideal-typical conceptualisations of smart governance: (1) government of a smart city, (2) smart decision-making, (3) smart administration and (4) smart urban collaboration. From this, they argue that smart governance "is about crafting new forms of human collaboration through the use of ICTs to obtain better outcomes and more open governance processes"

(Meijer and Bolívar, 2016: 392). This definition highlights that the complex interactions between technology and urban social processes need to be analysed to develop a theoretical understanding of techno-governance. For the purpose of clarity in this paper, we adopt this definition to further explore the implementation of smart governance in practice.

6.2.2 The implementation of smart governance in practice

In general, smart governance is usually in the early stage of development and still faces a range of challenges in practice. Given the lack of empirical studies on smart governance and its factual benefits and drawbacks, in the following we can only refer to the potential benefits and drawbacks of smart governance.

As some authors indicate, smart governance not only creates appropriate infrastructures to promote the smooth functioning of cities, but also helps to build a collaborative and communication-based environment for citizen participation and engagement (Scholl and AlAwadhi, 2016; Webster and Leleux, 2018; Scholl and Scholl, 2014). In this process, various policies and decisions concerning the delivery of public services and urban developments are co-created or co-produced by interactions between different stakeholders, including governments, private sectors, citizens, and international organisations and regimes. Further to this, citizens are able to assess the quality of services via smart ICTs and consume those services in an informed and accountable way. For instance, Urban Living Labs in Amsterdam provide a co-innovative setting in which multiple stakeholders jointly test, develop and create metropolitan solutions to complex urban challenges[7].

Smart governance also supports the creation of innovative learning and new knowledge in seeking solutions to urban problems. According to Ferro et al. (2013), ubiquitous computing technologies in smart governance eliminate different kinds of restrictions and reduce the costs of and the time spent on understanding urban issues by employing context-aware big data and visualisation approaches for the exploration of communities and cities. For instance, the Aalto Built Environment Laboratory at Aalto University, Finland, offers the space and technology for interactive human-centred co-creation of the built environment. Via immersive modelling and simulation technologies, process

[7] Please see: https://www.ams-institute.org/how-we-work/living-labs/

modelling and data visualisations, new ideas, knowledge and visions can be produced as a new source for 'smart' decision-making[8].

Despite the argued advantages of smart governance for smart city developments and the opportunities it offers, critical voices note that smart governance developments and implementations are, in practice, not realizing their potentials (Jiang et al., 2020, 2019b; Barns, 2018; Ruhlandt, 2018). The implementation strategies of smart governance are largely based on a commitment to government-led policymaking and well-funded private-led technology solutions, overemphasising the adoption of technology as smart solutions. This development has several consequences (Jiang et al., 2020, 2019b; Pfeffer and Verrest, 2016; Hollands, 2015; Shelton et al., 2015).

First, by way of smart governance, governmental organisations are over reliant on the ability of the private sector to design, develop and implement technologies in accordance with their needs (Vanolo, 2014). In that, due to their technological advantage, big high-tech companies are able to show their strengths in defining and building solutions to the range of problems in the city. However, instead of exploring the particularities of the problem situation at hand, more often than not developers design, build and/or maintain new technologies with a view to their technical capabilities and the feasibility of their application to a range of problems and customers, ignoring the demands of the particular user. Several authors consider these supply-oriented, self-designated smart governance initiatives as 'the corporatization, entrepreneurial form of urban governance' (Kitchin, 2019; Hollands, 2015, 2008; Söderström et al., 2014). Or, as expressed by Hollands (2015:68), what we observe is "a trend whereby our cities are increasingly becoming a backdrop to corporate advertising and the privatization of public space". And related to this, it is noted that little room has been left for other potential stakeholders, such as ordinary people, to participate in the smart governance of a city (Kummitha and Crutzen, 2017; Hollands, 2015, 2008).

Second, governmental organisations that adopt smart governance limit themselves to 'the technocratic way of governing cities' in which decision-making is made on the basis of technical knowledge (Verrest and Pfeffer, 2019). New ICT and data-driven approaches (data science and informatics) often cover a wide range of functionalities dedicated to supporting those involved in smart governance in exploring, analysing, visualising, implementing and monitoring issues (Sarker et al., 2018). By transforming the characteristics of urban places (e.g., site, function, land-use and growth process, either

[8] ease see https://www.aalto.fi/en/aalto-built-environment-laboratory.

planned or spontaneous) into maps, interactive tables, graphs, webpages, external programs or a single screen, city governments hope that the produced scientific knowledge will help them to realise the good governance of cities (Batty et al., 2012). According to Verrest and Pfeffer (2019), the assumption underlying this technocratic approach is that technology is capable of producing objective, value-free and unbiased knowledge that provides an account of urban futures and processes, by which the stakeholders can recognise and handle 'all urban problems'. However, as some authors argue, this 'top down, technocratic vision' of smart governance can be considered problematic if matters such as the active engagement of all the stakeholders involved in designing, operating and controlling these computing algorithms are not properly addressed (Mattern, 2016). Furthermore, as Viale Pereira et al. (2018) criticise, the technocratic smart governance in practice mainly reflects an enhanced government capacity for administrative decision-making based on the analysis of data, while the shaping role of context specificities (e.g., political, social, cultural and historical contexts) in functionality design and application is grossly neglected. Such criticism indicates the failure of many urban data analytics, cloud computing and information management platforms to explicitly articulate their functional scope or be conscious of the way of knowledge production in an enabling or collaborative environment (McFarlane and Söderström, 2017). According to Roche (2014), smart city governance builds too much on the new technological functionalities rather than on the common elements of socio-spatial development processes such as actors, activities and issues.

As a result, there is growing interest in a more context-dependent contribution of ICT-enabled participatory and collaborative smart governance (Jiang et al., 2019b). This view emphasises that "we should understand how particular technologies and interfaces associated with smart city investments emerge and continue to act within wider operating conditions of the city, in helping to more intensively unbundle and rebundle users, space, services and networks" (Barns, 2018:5). However, at present, technology is primarily treated as an end rather than a means, which results in the adoption, dissemination and use of technology in governance becoming a goal in itself (Jiang et al., 2020; Scholl and AlAwadhi, 2016). Meijer and Thaens (2018) argue that for the innovative use of technologies to achieve smart cities, it is vital to focus on the long-term dynamics of ICT-enabled institutionalised collaboration and value production. Rather than allowing for urban cybernetics, local innovation and stakeholder participation are badly needed in handling wicked problems (Goodspeed, 2015). As some authors urge, a socio-technical approach to smart governance is needed in practice (Jiang et al., 2019a, 2019b; Meijer and Bolívar, 2016). Given that this discussion of and focus on the socio-technical development has been going on for a long time within the earlier-mentioned debate on the PSS implementation gap, we now turn to that field of research.

6.3 PSS implementation gap and its solutions

6.3.1 PSS implementation gap

In recent decades, a plethora of PSS tools have been developed by research laboratories and private companies to help those involved in planning (e.g., planners, designers and researchers) handle knowledge. As a subset of geo-information technologies dedicated to supporting planning, PSS have long been used to explore, analyse, design, visualise, implement and monitor the spatial issues associated with the need to plan (Batty, 1995; Vonk and Geertman, 2008). According to Klosterman, PSS function as ‘information frameworks’ that combine the full range of ICTs that are useful for supporting the planning process; as a result, PSS are argued to offer planners not only the power of reasoning effectively as a guide to behaviour, but also the ability to handle new situations and novel problems (Klosterman, 1997; Pelzer, 2015). For an up-to-date review of the current state of the field of PSS, we refer to Geertman and Stillwell (2020). However, despite its long history, the PSS technology was long trapped in a vicious circle created by the large mismatch between the supply of and the demand for PSS (Vonk and Geertman, 2008;153). In multiple studies, this PSS implementation gap was reflected in the difficulty in applying poorly funded, largely academic PSS to support an equally underfunded civic function of planning (e.g., participatory planning and collective design) (Pelzer, 2015; Vonk, 2006; Goodspeed, 2008). In general, the PSS implementation gap arose because for a long time the implementation in planning and policy practice of a wide range of PSS, which were first developed in academia and then in the private sector, lagged behind the supply of tools (Geertman, 2006, 2017). This gap was caused by three groups of bottlenecks (of the 74 identified by Vonk (2006)).

First, the instrumental quality of a considerable number of PSS appeared to be insufficient, which hindered the implementation of PSS in practice (Vonk and Geertman, 2008). This partly resulted from the poorly funded and largely academic, expert-led development of PSS (Geertman, 2006). As an outcome, PSS more often than not showed a lack of the requested utility and an insufficient user-friendliness (Russo et al., 2018). For instance, a discrepancy was often identified between the developers' supply of primarily advanced and overly complicated PSS, and the users' demand for PSS with easy to use, simple support utilities. Second, PSS often lacked several usability attributes (e.g., transparency, flexibility, ease of use and interactivity), which had a damaging effect on the reputation of PSS and "prevent[s] users from accessing PSS functionality" (Vonk and Ligtenberg, 2010:167). Third, numerous PSS acted as 'black boxes' (see Douglas Lee's Requiem of Large Scale Models from the early 1970s), in which the underlying models and variables of the PSS were invisible and not transparent to the user (Te Brömmelstroet et al., 2014). Fourth, for a long time there was little proof of the actual worth of PSS and, as a result, the usefulness or added value of PSS was often not proved conclusively (e.g., insufficient comparative evaluations made it hard to distinguish favourable systems from unfavourable systems) (Vonk and Geertman, 2008). These four outcomes show that the insufficient instrumental quality of many PSS contributed to the implementation gap. This all implied that despite the promises made about the supporting role of PSS in exploring, analysing, modelling, designing, visualising, implementing and monitoring planning issues, the factual supporting role of PSS for planning support could hardly be demonstrated to practitioners for quite a long time (Geertman and Stillwell, 2020).

A second group of bottlenecks that contributed to the implementation gap concerned the limited acceptance of PSS in planning organisations, not at least the hesitance of organisational management. In this process, managers in a planning organisation often tended not to adopt PSS since they generally lacked profound knowledge of PSS and thus feared the unpredictable and risky consequences (financial or organisational) of accepting and using PSS in the organisation. Furthermore, 'insufficient communication within the organization, especially between organizational management and innovative precursors' blocked the diffusion of PSS within planning organisations (Geertman, 2017:73). And, as Vonk and Geertman (2008:160) argue, "[technology developers and users] do not have a well-developed and shared communication network to exchange knowledge and experiences, and they lack a common vision of the role of PSS".

A third group of bottlenecks was composed of a diversity of user-related factors. For instance, many instruments were considered to be so complicated that their use could not be learned quickly and users often appeared to be unwilling to invest sufficient learning time in them ('steep learning curve'). Furthermore, as indicated by Goodspeed (2008:2), despite the increasing public participation in urban planning, "the use of the Internet-[based PSS] to engage citizens has been constrained by the limited availability of suitable technical tools and concerns about the digital inequality". And finally, failure to teach

PSS users the skills and knowledge required to use PSS properly led to users being unwilling and unable to make use of PSS in planning practice.

6.3.2 Solutions to the PSS implementation gap

A number of studies on closing the PSS implementation gap were conducted; most focused either on overcoming the lack of utility/functionality (from the systems' view) or on usability (from the users' view) (see Nielsen, 1993). The study by Pelzer (2015) found that PSS usefulness or added value was often conceived as the focal point, since questions permeating these studies not only reveal the value of PSS for planning practice, but also contribute to supporting planning in a better way. In general, better functionality and usability of a system improves its practical acceptance and added value (Pelzer, 2017). Thus, some authors argue that there is a need for PSS developments to take into account the real demands of users within planning practice (Russo et al., 2018; Deal et al., 2017; Geertman, 2017). To accomplish this, a socio-technical development of PSS should be applied in which the PSS technology is dedicated specifically to the particularities of the planning tasks and the specific users in planning practice. For instance, Te Brömmelstroet and Schrijnen (2010) show how PSS developers in interaction and dialogue with potential users helped refine and improve the acceptance and usefulness of existing tools, instruments and models for potential users. Pelzer (2015) also shows how the 'fit' with the support capabilities of PSS and planning tasks is crucial for improving the effectiveness of PSS in practice. And Goodspeed (2016) shows how linking the concept of PSS to broader theories of social learning would help develop better PSS infrastructures and improve their adoption and use.

Furthermore, the right mechanisms to enhance the institutionalised cooperation between the field of PSS development (PSS developers or researchers) and that of PSS application (planners or planning organisation managers) should be well built to allow PSS instruments to be effectively integrated into planning organisations (Vonk and Geertman, 2008; Te Brömmelstroet, 2017; Te Brömmelstroet and Schrijnen, 2010). For instance, it is often argued that research institutions and universities are a good platform for validity assessment and evaluating international developments in PSS. Scholars are therefore recommended to strengthen their communication with planning practice with a view to improving PSS instrument quality and encouraging PSS innovation, diffusion and adoption (Geertman, 2017). Therein, it is highlighted that involving different kinds of actors within the network of PSS innovation can help to promote a process of interactive learning and the sharing of knowledge about successful PSS applications (Goodspeed and

Hackel, 2019; Goodspeed, 2016). Close cooperation in a group of interconnected people can be instrumental in facilitating the diffusion of dedicated PSS instruments to potential users (Vonk and Geertman, 2008).

In addition, when addressing the role of planning support, contextual variables – such as the organisational environment, the planning issue at hand, user skills and the specific policy context – should also be explicitly taken into account (Geertman, 2006; Goodspeed and Hackel, 2019). According to some authors, the PSS implementation gap was largely caused by the insufficient uptake of these kinds of contextual factors in the construction and application of PSS (Pelzer, 2017; Deal et al., 2017). For instance, McEvoy et al. (2019) found that contextual factors like the style of tool use, the phase of planning and the local project setting greatly affected the added value of PSS in a participatory environment. Pelzer (2017) found that existing organisational hierarchies and the timing of the policy process could seriously hinder the usefulness of PSS in practice. Thus, statements were made that a better handling of the contextual factors would unblock and facilitate more widespread acceptance and usage of PSS in planning practice.

6.4 When Smart Governance Meets the PSS Implementation Gap

Taking the previous points into account, this section compares the smart governance debate with the developments in the field of PSS to explore the extent to which these do or do not relate to each other in a fruitful way. Table 6.1 shows three differences and three commonalities between these two developments.

Table 6.1 Comparing policy implementation of smart governance with ongoing PSS developments

	Differences		Commonalities	
	Smart governance	Planning support systems		
Source of innovation	●Public–private partnership with big firms	●Academics / researchers cooperate with small to medium-sized firms	*Origin*	●The origin of development is the innovation in ICT that drives the policy implementation of both smart governance and PSS
Stage of the research	●At an early stage of research, development, demonstration and deployment	●A long history of development and research (mature stage)	*Innovation process*	●Mismatch between technology supply and practice demands
The scope of implementation and impact	●Multiple aspects and multidimensional scales ●Support different stakeholders (e.g., local authorities, the private sector and citizens)	●The spatial planning field ●Support those involved in planning (e.g., planner, designer and researcher)	*Context consideration*	●Ignorance of the influence of contexts in the development, implementation and impact of smart governance and PSS

Differences

First, smart governance differs from PSS in terms of the *source of innovation*, namely individuals or legal entities engaged in innovation. In the case of individuals, public–private partnerships are often the main actors in smart governance, in which the private sector is usually comprised of big ICT firms. In contrast, in the case of legal entities, the initiation and development of PSS is mostly performed by academics/ researchers in cooperation with small or medium-sized private firms. As a consequence, lots of smart governance developments are primarily ICT-directed (steered by the potentials of available and up-to-date ICT), while quite a few of the PSS developments are steered primarily by the topic matter (the content-wise task that has to be supported).

Second, smart governance is at a different *stage of the research*, development, demonstration and deployment cycle compared to its PSS counterpart. In general, smart governance is usually in the early stage of development and still faces a range of unmet challenges. For instance, there is often a discrepancy between the ICT needs of the organisation (how to support which tasks?) and the supply of smart governance ICT (innovative, high-end technology). As a consequence, the needed support is sometimes difficult to offer because of a misfit between the high-end technology and the users' capabilities and/or the tasks to be performed. On the other hand, PSS have undergone a long period of development and research and their ability to support spatial planning tasks has been further improved. In the PSS field, despite some continuing problems in practice, many lessons have been learned, for example, it is important to analyse planning tasks and user needs, measure the benefits of PSS application, spread the news of PSS to increase awareness, be more aware of the influence of context, etc.

Third, *the scope of implementation and impact* of the two differs. PSS are mainly used by those involved in the planning process (e.g., planners, designers and researchers) to assist them in handling ill-structured or semi-structured problems (e.g., achieving sustainable urbanisation) and in producing knowledge that supports the proper handling of these kinds of planning issues (Russo et al., 2018; Geertman, 2017, 2006; Pelzer, 2017, 2015; Te Brömmelstroet, 2010). In contrast, smart governance has a much broader scope in the urban context, in the sense that it is not restricted to typical planning problems but is also applied to, for instance, organisational and management issues (e.g., managing traffic flows electronically). As Batty et al. (2012) argue, smart governance, as a much stronger intelligence function, should be implemented to coordinate the many different components that comprise the smart city (e.g., energy, buildings, mobility and infrastructure). Meijer and Bolivar (2016) state that in practice, smart governance is related to the technological support of organisational internal bureaucratic processes, organisational external processes (e-participation and collaboration), the management of the city (e.g., living labs, smart urban labs, citizens' dashboards, and crowdsourcing) and ICT-facilitated decision making. This all makes the scope of implementation and impact of the two differ substantially.

Commonalities

There are commonalities between smart governance and PSS. For both, technology and its innovation were at the heart of their inception. The rapid development of smart city technologies offers the potential to harness the power of urban big data, sensor networks and urban data analytics to govern cities. In practice, the technological value – "the acceptance, adoption, and use of technology in itself is seen as valuable" – has been prioritised in smart governance, whereas much less attention is paid to the extent to which technology can bring real added value to the city, facilitating information and knowledge exchange among stakeholders, and promoting the co-production of policies and decisions (Meijer and Thaens, 2018:368). As a consequence, technological innovation largely drives the implementation of smart governance. Many inventories reveal that for a long time this was also the case in the field of PSS (see Geertman and Stillwell, 2004, 2009). It shows that a technology-driven approach seems to have been the starting point of both developments, but the developments of PSS in planning practice show that this overemphasis on technological innovation in itself is insufficient to become successful in practice, as evidenced by the PSS implementation gap (Geertman and Stillwell 2020). It is only more recently that PSS have been considered a means to an end; that is, more focus is now put on what improvements and added values PSS can bring to the planning issues at stake and what this means for the development and application of the instruments.

Closely connected to the previous point, in smart governance and for a long time also in PSS developments, the *innovation process* was characterised by a serious mismatch between technology supply and practice demands. In the policy implementation of smart governance, high-end technology companies possess strong research and developmental capabilities, which gives them a great advantage over their customers in technological innovation and application. However, this usually results in neglect of the socio-political nature of knowledge production and technological innovation. Although it is often claimed that technology will produce objective, value-free knowledge to "decipher crisis, tendencies, contradiction and lines of conflict in contemporary cities" (Verrest and Pfeffer, 2019:1335), this should be seriously questioned. As McFarlane and Söderström (2017:325) argue, "instead of technology-push strategies of urban management, [alternative smart governance] should strive to shape technology to put it in the service of social improvement". In the same vein, the PSS debates concerning the implementation gap show that technological innovation needs to be complemented with an explicit user- and task-orientation to be successful in practice (Geertman and Stillwell, 2020). This implies that the technology should be attuned to the wishes and capabilities of the intended users and to the specifics of the tasks to be accomplished.

It can be concluded from the PSS debates that the ignorance of *contexts* has contributed significantly to the emergence of the PSS implementation gap (Geertman, 2006). The failure to consider the specificities of context in practice led to a situation in which instruments did not fit the characteristics of the specific planning tasks or the skills and demands of users (e.g., planners, designers and politicians). For instance, in a range of experimental cases, authors argue that the characteristics of the planning and policy process – for example time span (time pressures) and participation rate (resulting in diversity in educational background, experience, knowledge, occupation, etc.) – were hardly taken into account in the development and use of PSS (Geertman and Stillwell, 2009). Consequently, this often contributed to a shortfall or even a failure in PSS development and implementation. It is only recently that more explicit attention has been paid to contextual factors in PSS implementation and these factors have been proven to improve the implementation of PSS in planning practice (Geertman and Stillwell, 2020).

One can also identify this tendency for one-size-fits-all solutions in smart governance implementations, for instance in projects such as Songdo Ubiquitous City (South Korea) and Tianjin Smart Eco-city (China), in which the implementation of smart governance is standardised and not tailored to the real situations of cities, communities and individuals (e.g., real urban issues, the level of technological development, cultural preference and economic strength). As such, there have been criticisms that interventions must start with the place and not with the technology, since smart policies or smart approaches are socially constructed and are deeply embedded in specific socio-spatial contexts (McFarlane and Söderström, 2017). According to Meijer (2016:75), "an in-depth analysis of the smart solutions in their (political, institutional, societal, economic, and cultural) context is needed to assess the value of certain successful smart (city) governance approaches for other cities".

In short, and as an indispensable extension of previous points, the technology should be attuned to the wishes and capabilities of the intended users and to the specifics of the tasks to be accomplished, given the particularities of the context in which the technology is applied. It is only then that technology can be of added value to practice. Based on the above discussion of differences and commonalities, the extent to which dimensions of the policy implementation of smart governance do or do not relate to the PSS implementation gap were outlined. It is argued that the much more recent smart governance developments and implementations can learn from the already longer standing debates around the PSS implementation gap. It is to these contributions that we now turn our attention.

6.5 Discussion: What the PSS Debate Can Contribute to Smart Governance Developments

From the previous discussion, at least two lessons that smart governance research and practice can profit from can be learned from the debates concerning the PSS implementation gap. First, as indicated, for technology to be of added value to practice, it should be attuned to the wishes and capabilities of the intended users and to the specifics of the tasks to be accomplished, given the particularities of the context in which the technology is applied. The development of smart governance is currently largely driven by short-term policy-based investments and high-end technological innovations. Some studies have explicitly stated that this policy-driven treatment of smart governance is neither necessary nor satisfying, since the acceptance of ICTs and the 'intelligence' that such technologies are supposed to generate do not produce substantive value per se (Jiang et al., 2019a; Ruhlandt, 2018). In contrast, as for smart governance itself, more pragmatic questions are required; for example, to what extent can the implementation of smart governance in practice become more effective and valuable to the citizens? Rather than starting from the technological innovation, smart governance can and should move towards more application-dependent contributions to innovate governance processes and solve substantive urban challenges.

Furthermore, closing the PSS implementation gap shows that knowledge of the context specificities is of importance and will also be of importance to smart governance developments. Geertman (2006) argues that to close the PSS implementation gap, besides taking the supply–demand discrepancy into account, the technology should be explicitly attuned to the particularities of the specific context at hand. As regards smart governance, Meijer (2016:75) emphasises that "studying the effects of smart governance is complicated since the relations between governance arrangements, use of technologies, and effects on the quality of urban life are contextual". It means that "situations across cities vary widely, and the priorities for both analysis and interventions need to be grounded in the specificity of places" (McFarlane and Söderström, 2017:325). Several other studies also indicate that contextual factors have a considerable influence on smart governance (Jiang et al., 2019a, 2019b; Meijer, 2016). These studies cross-examine how context mediates the technological interaction with urban actors and produces the appropriate solutions to the concerned urban issues. From this arise questions regarding technological innovation and implementation: what sorts of smart ICTs are or should be implemented, by what kinds of urban actors, and in which types of governance situations or contexts?

To be able to answer these questions, the supply–demand discrepancy characteristic of the PSS implementation gap shows that there is a strong need to promote a socio-technical method. For smart governance developments, it means that one should include distinct (i.e., expert and lay) urban actors in the ICT development and implementation processes and attempt to develop more collaborative ways of working. In most current smart governance practices, the corporate-led version of urban governance leads to a situation in which broad political engagement and opinion expression are weak and the interests and real needs of ordinary people receive only minor attention (McFarlane and Söderström, 2017). As a consequence, it is unclear in what sense various smart technologies deliver what people actually expect or need, even though they can be considered the final users of the smart city. Furthermore, it should be noted that practical urban challenges are socially constructed (Verrest and Pfeffer, 2019), which can either limit or be conducive to the chosen smart governance approach (Meijer, 2016). For instance, distinct governance issues (e.g., congestion, pollution, housing, flooding and crime) to a large extent stipulate the functional support of hardware and software devices that governance processes need. A lack of understanding or consideration of the specific governance issues leads to improper smart governance arrangements and the misuse of technology. Hence, smart governance should integrate knowledge from diverse actors into ICT development and implementation and as such 'support city- and citizen-specific decision making, capable of dealing with objectives for urban sustainability' (Stratigea et al., 2015:1). To do so, this paper urges a shift from an expert-led, supply-pushed strategy to a user-centred, demand-induced approach of smart governance innovation.

Before concluding this paper, a main limitation of this research should be acknowledged: since smart governance is a relatively new field of study, the definition and discussions of smart governance were primarily based on reviewing and mapping the existing conceptual literature rather than on solid empirical studies.

Nevertheless, this paper shows how discussions around the PSS implementation gap can provide some meaningful insights into how to overcome the policy implementation voids of smart governance and change this into a more socio-technical oriented approach. It highlights the interactions and mutual shaping processes between technological advances and governance practices. This means that a technology should be implemented only when it can add value to governance practices. But whether the latter is the case largely depends on our understanding of the mediating role of contextual factors. Based on this, the conclusion is that relating the PSS implementation gap to smart governance means that smart governance can become more aware of the role of contextual factors in collaboration with users and urban issues. This is expected to shift the emphasis from today’s technology-focused, supply-driven governance development to a socio-technical, application-pulled and demand-driven smart governance development.

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Chapter 7

Smartening Urban Governance: An Evidence-based Perspective

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Abstract: This paper presents a framework that provides guidelines on how information and communication technology (ICT) can create added value to smarten urban governance. Furthermore, the framework was applied to measure and interpret the added value of ICT functionalities for governance practice, based on an international questionnaire (268 respondents) and in-depth expert interviews (12 experts). For improving governance processes and handling related urban problems, the results suggest that differentiated strategies should be employed. In this way, the use of ICT in smart planning can realize its full potential—and 'smartening' urban governance can be achieved in specific contexts.

7.1 Introduction

Over the past decade, the rapid development of newly emerging information and communication technologies (ICTs) (e.g., big data, Internet of Things, social media, cloud computing) in the realm of smart cities has been proclaimed as having the potential to transform traditional urban governance into "smart" governance (Jiang et al., 2020, 2019a, 2019b; Ruhlandt, 2018; Webster and Leleux, 2018). As discussed in the literature, this can be accomplished in at least two ways. First, advances in ICTs facilitate the collection, processing, and storage of big data in forms like sensor data and public and private records. The increased amount of data can provide valuable information and evidence for policymaking (Kitchen, 2014). Second, smart ICTs open up the governance process and enable different stakeholders to access the public policymaking cycle (Webster and Leleux, 2018; Scholl and Scholl, 2014). Through ICT-enabled interactive dialogues, communications, debates, and social networking, it is expected that urban problems and the real needs of individuals and communities can be better clarified and defined (Verrest and Pfeffer, 2019). According to Janssen and Helbig (2018), by continually expanding data sources and enlarging political participation, technological innovations will, in the long run, both help to alter the way that policymakers and citizens engage with each other and promote new and innovative forms of urban governance.

Despite the potentials, the full capabilities of newly emerging smart technologies to generate a transformative governance praxis or enable constructive problem-solving activities have not been realized (Ferro et al., 2017). Thus, the value of technological innovations in improving urban governance has been largely restricted. Critics contend that the smart approach to solving profound urban problems is primarily supported by large high-tech companies that have substantial technical capabilities and financial resources (Hollands, 2015). ICT investments and applications in many smart city initiatives appear to be intricately linked to the promotion of big business interests (Shelton et al., 2015). In that, local governments often treat the acceptance and adoption of ICTs as applying smartness to urban problem-solving. However, such corporate-led and policy-driven digital infrastructure developments often lead to a discrepancy between the support capabilities and the demand from users and governance practices (Jiang et al., 2019a). Whether the implemented ICTs are actually useful and effective in handling urban challenges needs to be carefully examined (Verrest and Pfeffer, 2019). In fact, it appears that the application of ICTs is not well suited to facilitate an effective shift of power, institutions, and improved relations between government and non-state actors (Cardullo and Kitchin, 2019).

Hollands (2015) criticizes this corporate-led, technology-driven approach to smart cities, referring to it as a "one-size-fits-all" strategy that emphasizes the uniformity of the solution rather than relating it to specific, tailored functional support. A range of authors argue that the improved role of ICTs in governing smart cities requires input and contributions from various groups of people, as well as an increased awareness of the value of technology as a means to an end (Webster and Leleux, 2018; Ruhlandt, 2018). This implies that it is more important to focus on "the long-term dynamics of institutionalized collaboration and instrumental value" (Meijer and Thaens, 2018:363). As Ferro et al. (2013) assert, technological innovations are considered valuable only to the extent to which they can achieve a set of goals that are recognized as being of intrinsic value for either society or a specific group of stakeholders. Therefore, Meijer and Bolívar (2016) argue that the potential of ICTs to improve urban governance should be part of a complex process of institutional change and the acknowledgement of the political nature of appealing visions of socio-technical governance.

Other authors also emphasize that tools and technologies for governing smart cities must start with the "city," matching different types of "smartness" (technologies, tools, and applications) with different types of urban functions in specific contexts (Verrest and Pfeffer, 2019; Stratigea et al., 2015). In other words, a redefined role of technology "should be grounded in places—actually existing cities—with their specific populations, resources and problems" (McFarlane and Söderström, 2017:313). Rather than leaving technologies, tools, and applications to the corporate and political elites, taking the "urban" into consideration indicates an urban social process of technological innovation in improving urban governance. More recently, Jiang et al. (2019b) proposed an urban planning perspective on smartness to improve ICTs' capabilities for smartening urban governance in the realm of smart cities. They argue that smart urban governance should integrate technology with explicit reference to the particularities of the urban challenges at stake and the specifics of the embedding governance processes. Still, studies on how to transform urban governance into smart governance and its resulting added value are mostly lacking.

This paper combines multidisciplinary knowledge of smart urban governance and planning support science to make the key argument that technological innovations (i.e., the supply of smart ICTs) should be embedded in governance processes and attuned to urban problems to achieve their added value in smartening urban governance. To help explain the argument, the following research question was formulated: *"How can smart ICTs be transformed into added value in smartening urban governance?"* Here, added value means the usefulness of an ICT tool to help the participants to achieve their specific urban governance objectives. It offers urban governance problem-solvers a new dimension, enabling them—with the help of ICT—to innovate decision-making processes and find action-oriented solutions.

7.2 Smartening urban governance: a conceptual framework

7.2.1 ICTs in smart cities: opportunities for urban governance

The smart city concept has been adopted as a policy priority in many countries. It is argued that by integrating smart ICTs and various physical devices connected to the IoT network into urban functions, it provides creative solutions to the challenges of economic growth, social justice and environmental problems in cities (Haarstad and Wathne, 2019). It should be noted that there is no commonly agreed upon definition of "smart" cities. For instance, Hollands (2015) points out the self-gratulatory nature of the smart city label and asserts that smart cities are too dependent on big data and ICT applications. Kourtit et al. (2012) argue that smart cities should focus on developing productive interactions between networks of urban actors (McFarlane and Söderström, 2017; Meijer and Bolívar, 2016). More recently, Wolf et al. (2019) showed that the achievement of a smarter city relies more on the ability to increase the flexibility and transparency of urban decision-making and promote place-based initiatives. Although many definitions of "smart city" have been identified (Albino et al., 2015), we adopted the comprehensive definition by Caragliu et al. (2011:70) to help us understand the changing and fuzzy concept: “A city can be defined as smart when investments in human and social capital and traditional transport and modern ICT infrastructure fuel sustainable economic growth and a high quality of life, with a wise management of natural resources, through participatory governance.”

The rapid development of smart cities and smart ICTs has provided various new opportunities for smartening traditional urban governance (Barns et al., 2017). According to Nam and Pardo (2011), urban governance is increasingly being connected to disciplines that focus on technology and innovation (e.g., e-government and innovation studies). Here, “urban governance involves a range of actors and institutions; the relationships among them determine what happens in the city” (Avis, 2016:5). It shows that the integration of various ICTs and digital devices into local urban government systems helps to improve the operational efficiency of urban governments and transform the role the government can play in creating a smart city. Such approaches indicate that smart city technologies can transform government from institutional conservation (i.e., traditional governance of a smart city) into more open-minded institutional structures (i.e., smart urban collaboration) (Meijer & Bolivar, 2016). According to Barns et al. (2017), it is crucial to transform and enhance the relationships between various stakeholders via smart city technologies to change how cities are governed.

In addition to the ability of smart ICTs to reshape urban governance processes, new big data can also be generated from technology-facilitated citizens to help policymakers to analyze, model, and understand urgent urban problems (Barns et al., 2017). For instance, the rapid development of big data contributes to the emergence of big data analytics. Through the co-creation and exploration of new-found data, innovative ideas and knowledge can be produced to understand the nature of specific urban issues (Kitchen, 2014). Besides, various urban data and data platforms provide trustworthy, valid, and reliable data, which enables individuals and communities to develop and implement their own solutions to daily life problems (Jiang et al., 2019a).

Although smart ICTs can be used to support governance processes and deal with different urban problems, their potentials have not been fully realized due to the lack of an effective framework to understand and put into practice the previously argued added value of smart ICTs, namely producing new data, innovating urban governance processes, and gaining knowledge of urban issues (Jiang et al., 2020; Ferro et al., 2013). According to some literature, the smartness of ICTs is represented by the technology itself; big-tech companies around the world demonstrate their smartness by implementing a network of technological functionalities (e.g., digital devices, modules, machines, subsystems, and platforms) (Datta, 2015). However, whether the capabilities of smart ICTs can satisfy the needs of urban governance practices is only limitedly considered in most academic literature.

7.2.2 A framework for smartening urban governance

To construct a framework for smartening urban governance, one has to integrate technology with explicit reference to the particularities of the urban challenges at stake and the specifics of the embedding governance processes (Jiang et al. 2019b). First, technology is envisioned as the capabilities a functionality has for supporting governance practices. Based on Vonk (2006) and Geertman (2014), three types of ICT capabilities are identified, namely *informing & communicating*, *analyzing & modeling*, and *designing & visualization*. Here, informing & communicating (e.g., social media and government information management systems) is about information exchange between different persons and devices (Vonk, 2006); analyzing & modeling is concerned with, usually quantitative, calculation and information production to improve our understanding of the object (Pelzer, 2017); and designing & visualization is about the perception, production, and presentation of design ideas (Geertman, 2014). Second, the urban challenges refer to urban problems that significantly influence people's wellbeing and quality of life. Campbell (1996) highlights that economic, social, and environmental problems in general constitute the core of urban sustainability challenges. Besides the general sustainability notions of social, economic, and environmental, we also identify transportation & mobility and housing as separate categories, due to their importance (Benevolo et al., 2016; Grigsby, 2017). Third, governance processes describe the different urban governance modes shaped by actor interactions (Pierre, 2011). Two categories of governance modes are considered: Centralized processes—in which the government acts as the only or by far dominant stakeholder in urban governance—and interactive processes, in which besides government, non-state actors (i.e., market and civil society) are important and are involved too.

Table 7.1 Different kinds of added value (source: Pelzer, 2017:86)

Kind of usefulness	Definition
Learning about the object	Gaining insight into the nature of the planning object
Learning about other stakeholders	Gaining insight into the perspectives of other stakeholders in planning
Collaboration	Interaction and cooperation among the stakeholders involved

Communication	Sharing information and knowledge among the stakeholders involved
Consensus	Agreement on problems, solutions, knowledge claims, and indicators
Efficiency	The same or more tasks can be performed with smaller investments
Better informed plans or decisions	A decision or outcome is based on better information and/or a better consideration of the information

Furthermore, integrating functionalities into urban governance processes can be seen as an outcome (Jiang et al., 2019b). According to Pelzer (2015), the outcome can also be regarded as the perceived added value of technology. Here, the added value depends on "how well the instruments are capable of carrying out the task" (Vonk, 2006:75). When functionalities are implemented to solve different problems and support the policymaking process, seven major added values can be identified to measure the outcome (Table 7.1). Additionally, it should be noted that contextual factors are also deemed critical for influencing the usefulness of technology (Jiang et al., 2019a; Meijer, 2016). Here, context is the situation and circumstance in which the application of ICT in improving urban governance is embedded. Geertman (2006) identifies six major contextual factors that influence the role of technology in supporting policymaking and planning, namely: the content of planning issues; the specific characteristics of information, knowledge, and instruments; user characteristics; the characteristics of the planning and policy process; the planning and policy style; and the political context.

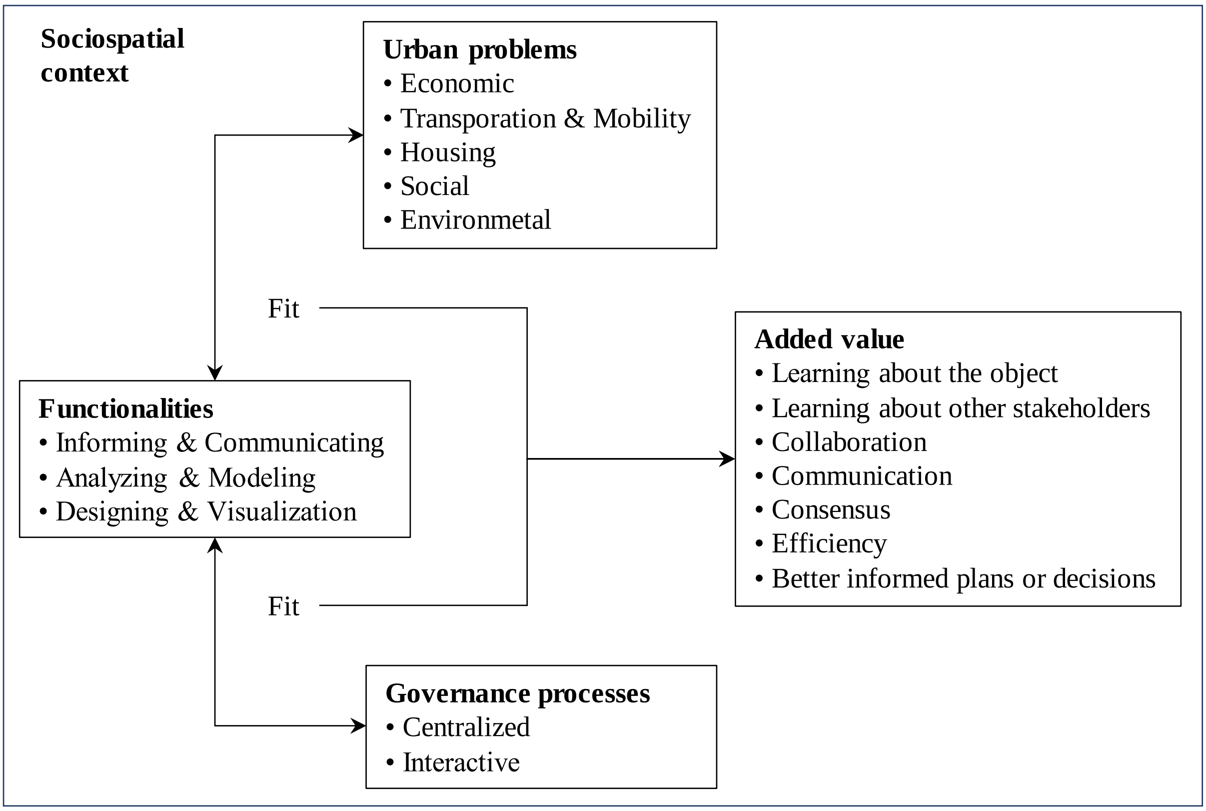

Figure 7.1 A framework for effective ICT practices in smartening urban governance

Based on these ideas, a conceptual framework was developed to provide guidelines on how ICT can create added value to smarten urban governance (Figure 7.1). Here, the functionality linkage with urban problems and governance processes is based on the task–technology fit model, which asks "the question of whether the functionality of the system in principle can do what is needed" (Nielsen, 1993:24). Then, the figure shows that functionalities are incorporated into urban problems and governance processes to produce perceived added value. This whole process of application of functionalities to create added value is regarded as smartening. However, it should be noted that the level of added value produced by functionalities is related to the functionalities' linkages with urban problems and governance processes; that is, how well functionalities can solve urban problems and support governance processes. In our research, we assumed that the linkages between functionalities, urban problems, and governance processes are positively related to the added value produced by the functionalities. As some authors argue, higher adoption and use of functionalities suggest that functionalities have higher maturity levels (e.g., flexibility, simplicity, user-friendliness) (Pelzer, 2015; Vonk, 2006). Figure 7.1 also shows that contextual factors play an important role in influencing the role of technological functionalities in smartening urban governance.

7.3 Methodology

7.3.1 Data collection

In-depth information about the application of ICT in smartening urban governance was gathered through an international questionnaire and expert interviews. The questionnaire was mainly distributed to the Computers in Urban Planning and Urban Management (CUPUM) research community. Using electronic and regular mailing lists, between May and September 2019, about 1,300 people worldwide were invited to complete the questionnaire. The main part of the questionnaire comprised 45 statements categorized into types of technological functionalities, urban challenges identified, involvement of stakeholders, added values, and contextual factors. Questions concerning the survey population (e.g., gender, age, profession, origin, expertise) were also asked. The respondents could respond on a 7-point scale (1=low, 7=high), allowing them to determine the extent to which they agreed or disagreed with each statement in the questionnaire.

Twelve internationally recognized experts were then interviewed to gain insights and opinions in terms of technological applications in smartening urban governance. The experts were from Australia, the USA, China, the Netherlands, Brazil, the UK, and Japan, and all of them had worked in the field for at least 20 years. The interviews were held between June and October 2019. After the interviews, the records were manually transcribed. By using qualitative data analysis software NVivo©, the texts were further coded and analyzed to generate themes to address the research question. The analysis of the interviewed data was based on Figure 7.1, in order to obtain the conceptual and visionary opinions and comments of the experts on how ICT can produce added value to smarten urban governance.

7.3.2 Data analysis

The analysis of the questionnaire data was based on the theoretical framework presented in Figure 7.1. Some of the respondents were involved in smart city projects, and this allowed them to evaluate the role of ICT in practice. As shown in Figure 7.2(a), a total of 268 questionnaires were returned, implying a response rate of 20.6%. Of the respondents, 175 had participated in smart city projects in which ICTs played an important role and were therefore used in our analysis. Figure 7.2(b) shows these 175 respondents divided into four subgroups, namely: respondents from China (53%); respondents from NAEJA (North America, Europe, Japan, or Australia) (33%); respondents from BRICS (Brazil, Russia, India, or South Africa; excluding China) (approx. 10%) and respondents from other countries (approx. 4%). The BRICS (without China) and Others subgroups were not analyzed due to insufficient sampling quality. Thus, only the China and NAEJA subgroups were included in the analysis.

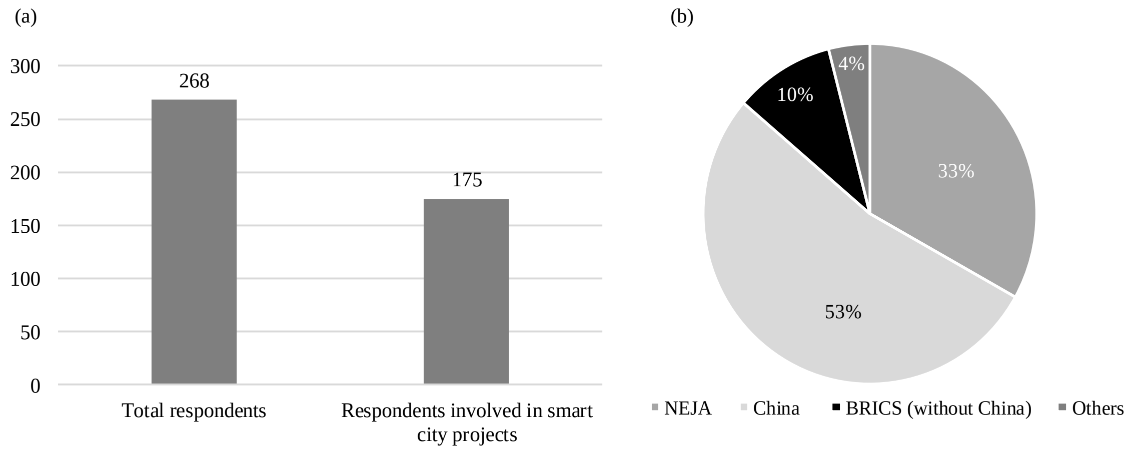

Figure 7.2 (a) Total number of respondents and number of respondents involved in smart city projects; (b) geographical origin of the respondents involved in smart city projects.

In terms of the data analysis, Figure 7.1 shows that there exist five types of 'urban problems', three types of 'functionalities', and two types of 'governance processes'. It should be noted that one smart city project can include more than one type of urban problem (not mutually exclusive) and more than one type of functionality (not mutually exclusive). However, one smart city project only includes one type of governance process (centralized or interactive, mutual exclusive). The combinations (30) of functionalities (three types), urban problems (five types) and governance processes (two types) constitute the basic unit of analysis (see Figure 7.3). In that we measure the frequency of occurrences of combinations of these three dimensions to describe their linkages.

Second, the indicated added value of each type of functionality in a combination of functionalities, urban problems, and governance processes was calculated by obtaining an average score. The average added value score of each type of functionality was then compared with the frequency of occurrences of combinations (the linkages) to identify their possible relationship. Additionally, a simple linear regression model was applied to statistically test the relationship. The purpose of this step was to see whether a higher frequency of linkages between functionalities, urban problems, and governance processes would result in a higher added value of functionalities.

Third, to further validate the results, the respondents were divided into two subgroups: respondents from China and respondents from NAEJA. This was done because China and NAEJA have large regional differences (e.g., level of urbanization rate, level of local development, political systems, and policymaking styles) and distinctive policy priorities. Therefore, research on the application of technology in China and NAEJA would help understand the different development trends of technology in smartening urban governance.

Finally, in-depth interviews with 12 experts from the field of urban governance/planning were used to interpret and validate the general findings. This helped us to build up a comprehensive picture of the application of smart ICTs in improving urban governance.

7.4 Results

7.4.1 Functionalities to smarten urban governance

7.4.1.1 Frequency of linkages

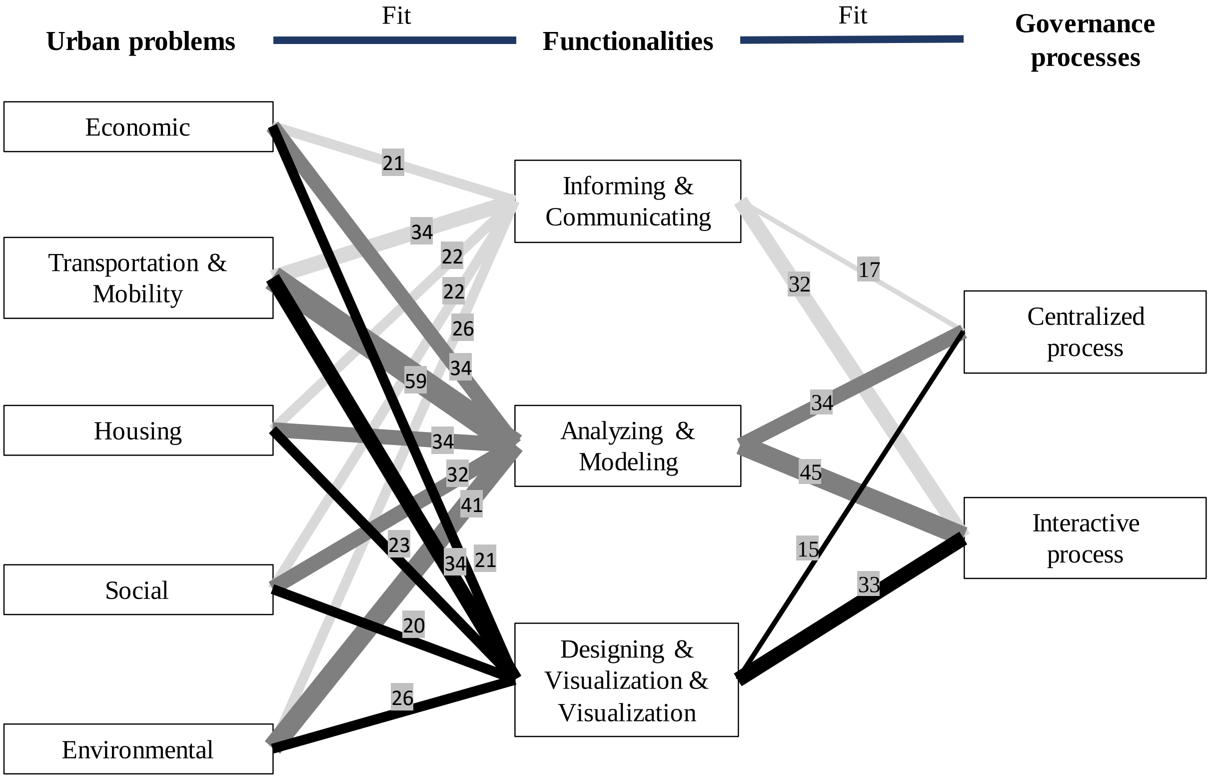

Figure 7.3 Linkages (represented by the frequency of occurrences of combinations) between functionalities, urban problems, and governance processes

The average occurrence frequency of the 30 combinations of functionalities, urban problems, and governance processes was first calculated to be able to analyze the separate frequencies of specific linkages between functionalities, urban problems, and governance processes.

The left-hand side of Figure 7.3 shows the frequency of the linkages between functionalities and urban problems. It shows that analyzing & modeling was the most frequently mentioned functionality, which is furthermore highly related to transportation & mobility problems (59), followed by environmental problems (41), and to a lesser extent housing (34) and economic (34) problems. For the two other functionalities—namely informing & communicating and designing & visualization—the urban challenge of transportation & mobility is also the best connected to (34). All other combinations have much lower frequencies of the linkages. The dominance of transport & mobility reflects the huge impact it has on the urban environment (Benevolo et al., 2016).

The right-hand side of Figure 7.3 shows the average frequency of the linkages between functionalities and governance processes. All three types of functionalities are much more dedicated to supporting interactive processes than centralized processes. Among the linkages, the frequency between analyzing & modeling and interactive process receives the highest score (45). Conversely, informing & communicating and designing are seldom applied to support centralized processes, respectively (17) and (15). The results confirm the finding that the identified technological functionalities focus more on supporting participatory forms of governance with non-state actors, than on supporting centralized processes (Vonk, 2006).

7.4.1.2 Relation between frequency of the linkages and added value of functionalities

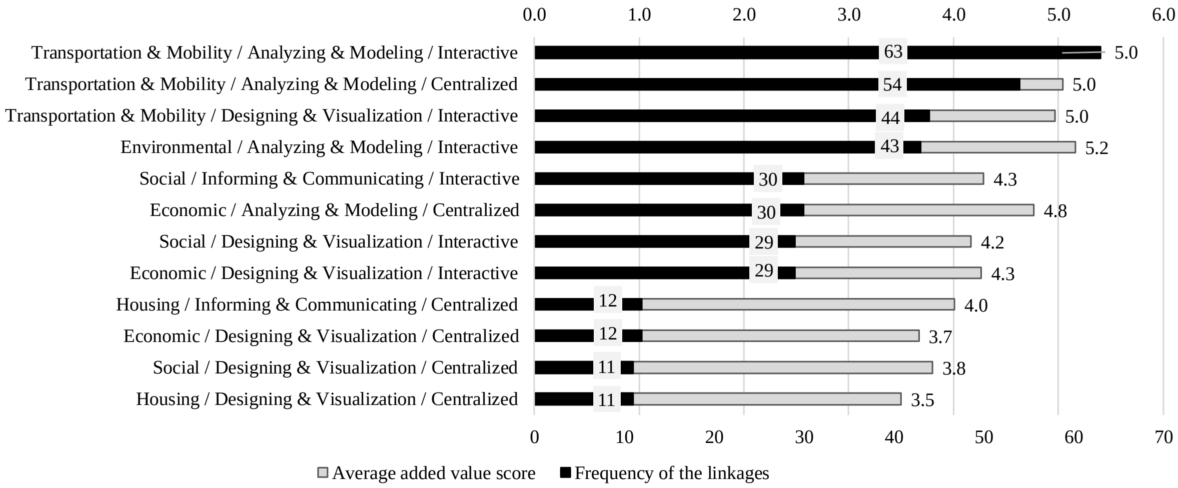

Figure 7.4 Possible relations between frequency of the linkages and average added value score

To find the relation between frequency of the linkages and added value created by functionalities, three subgroups (high, moderate, and low, based on their frequency of the linkages) of the 30 combinations were further identified for analysis. Figure 7.4 presents the possible relationship between frequency of the linkages and average added value score. It shows that the functionalities with high added value are mainly analyzing & modeling and designing & visualization, dedicated to supporting transportation & mobility and interactive processes, whereas functionalities with low added value are mainly informing

& communicating and designing & visualization, dedicated to supporting problems related to people’s daily lives (e.g., housing, social, and environmental problems) and supporting centralized processes.

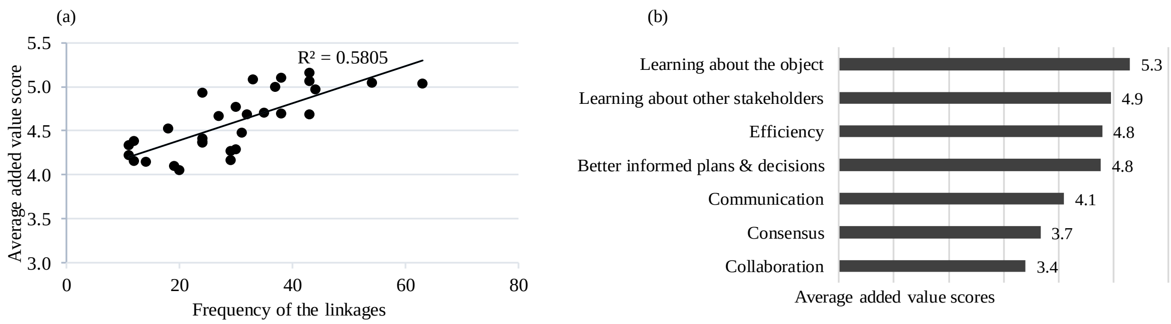

Figure 7.5 (a) Relations between frequency of the linkages and average added value score and (b) average scores of different kinds of added value

To find dependence patterns in the variable concerning frequency of the linkages and average added value score, a regression analysis was made. Figure 7.5(a) shows that the higher the frequency of the linkages, the higher the added value scores of the functionalities. The average scores of different added value indicators were also analyzed (Figure 7.5(b)). The figure shows that “learning about the object” scored 5.3, whereas “collaboration,” “consensus,” and “communication” scored only 3.4–4.1. A possible explanation is that the support capabilities of technologies are more focused on disentangling complex problems like analyzing and modelling transportation and mobility problems, whereas the functional support to facilitate user’s capabilities for participation, dialogue, and interpersonal communication is lacking in quality and/or regarded as much less complex. The results fit well with the high frequency of the linkages between analyzing & modeling, urban problems, and governance processes, and the relatively low frequency of the linkages between informing & communicating, urban problems, and governance processes (i.e., the higher the frequency of the linkages, the higher the added value scores of the functionalities).

7.4.2 ICT to smarten urban governance in subgroups

7.4.2.1 Frequency of the linkages and its relation with the added value of functionalities

Subgroups of respondents were used for further analysis. Of the respondents, 58 were from NAEJA and 93 were from China. The analysis first shows that the patterns of the linkages between functionalities, urban problems, and governance processes in NAEJA and China are more or less similar to the pattern of the total group.

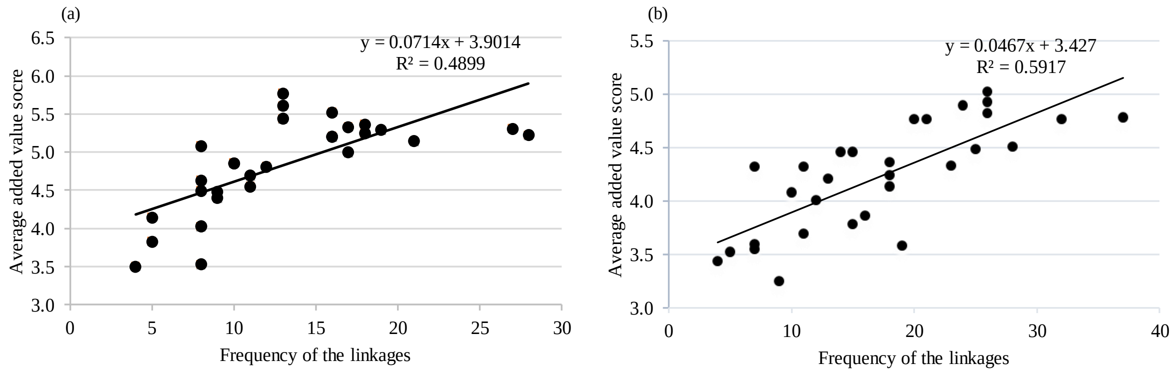

Figure 7.6 Relations between frequency of the linkages and average added value score (a) in NAEJA and (b) in China

Regression analysis also confirmed the general result that the higher the frequency of the linkages, the higher the added value scores gained by the functionalities (Figure 7.6). However, it should be noted that the regression coefficient (0.0714) in NAEJA is greater than in China (0.0467), which indicates that the marginal effect of the frequency of the linkages on added value in NAEJA is larger than the effect in China. To identify the possible reason for this, the average scores of different contextual factors in NAEJA and China were compared (see Figure 7.7(a)). Figure 7.7(a) shows that the effects of contextual factors on the role of functionalities in China are mostly bigger than they are in NAEJA, indicating that the role of functionalities in China is under greater constraints. This finding thus explains the difference in marginal effects of the frequency of the linkages on added value between NAEJA and China.

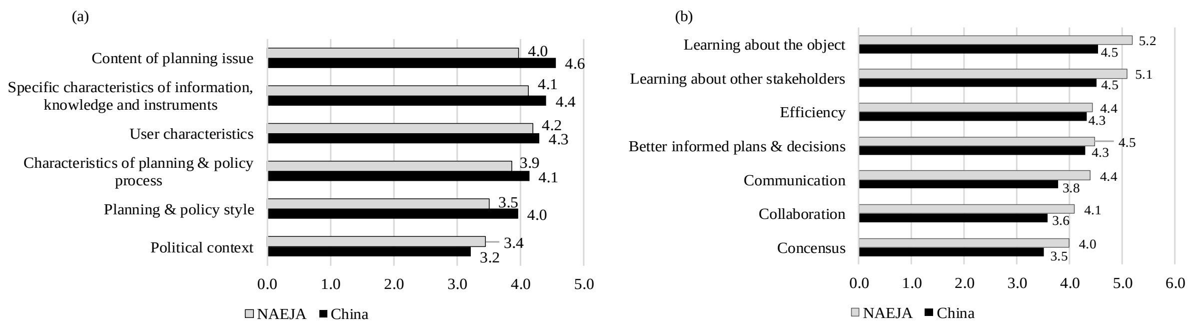

Figure 7.7 Average scores of contextual indicators (left) and average scores of different kinds of added value (right) in NAEJA and China

Figure 7.7(b) shows the average scores of added value indicators in NAEJA and China. The results accord with the finding obtained earlier for all respondents that high-quality analyzing and modeling tools are more preferred, whereas there is a lack of functional support, or quality thereof, in facilitating user's capabilities for participation, dialogue, and interpersonal communication. However, comparing the scores of different kinds of added value in NAEJA with their China counterparts, reveals that the average scores of the seven added value indicators in NAEJA are slightly higher than the average scores in China. As shown earlier, the frequency of the linkages of different combinations of functionalities, urban problems, and governance processes in NAEJA is, on the whole, higher than in China. Thus, the higher scores of different added value indicators in NAEJA agreed with the general results; that is, that functionalities within higher linkage combinations result in higher added value scores, and vice versa. Besides, the different average scores of added value indicators also accord with the finding that the effects of contextual factors on the role of functionalities in China is stronger than in NAEJA.

7.5 Interpretation of the results

To better understand the results, the 12 expert interviews were further analyzed to cross-validate the survey results. First, it is noteworthy that the dominance of analyzing & modeling and transport & mobility was verified by the expert interviews. Of the 12 experts interviewed, 10 were involved in smart projects related to transportation and mobility problems. As one expert said, "*Mobility problems are an important area for smart cities because of mobility's huge environmental, economic and social impact*" (Expert 3). In addition, the majority of the technological functionalities in their smart projects were linked with analyzing & modeling. For instance, some functionalities offer digital tools to provide an informative picture of spatial travel behavior in Beijing, China; others are involved in the evaluation, assessment, design, and siting of cycling lanes in São Paulo, Brazil; and yet others are used to support the analysis and visualization of unaffordable properties in Sydney, Australia. One key reason for the widespread adoption of analyzing & modeling tools is due to the opportunities provided by new big data and new ICTs. Experts highlighted, for instance, that "*for the past ten years, big data has been evolving into a very important area…it provides new 'oil' for previous modeling or visualization tools, so the use of big data analytics in current smart city projects is prevailing*" (Expert 6). Besides, "[universities] *try to skill people up and they will know how to work with big data and open data … hence, they become aware of using modeling* *simulation and urban data analytics*" (Expert 2). In addition to the rise of big data and data-related education, "*a lot of companies try to improve algorithms, from carpooling to simulation capacity…* [the algorithm] *improves the capacity of computing technologies and enhances the performance of some complex behavioral models*" (Expert 3). This indicates that the emerging big data and data-related digital technologies provide new momentum to the development and application of analyzing & modeling tools in the smart era, not at least in the complex urban field of transportation and mobility.

Then, in terms of the weak combinations of functionality, urban problems, and governance processes (mainly designing & visualization is less used to support housing, social, and environmental problems in centralized processes), experts claimed that "*in the last twenty years, it's always been the idea that you want to make a lot of plans more visible to the public* [i.e., citizens] *earlier on and get their input with respect to design and land use*" (Expert 3). Almost all the experts stated that it is important to realize that smart urban governance is more about using ICTs to transform institutional conservation (centralized) into institutional transformation (interactive). Here, the perspectives of two Chinese experts are cited, since "one would not expect open governance in an authoritarian state" (Meijer et al., 2019:6): "*From 2005 to 2015, urban planning in China entered a new stage, called the digital planning stage. The digital planning stage includes more networks, participation and communications to improve the efficiency and quality of plans*" (Expert 7); and "*the current technologies used in our project are mainly intended to the analysis and visualization of traffic flows and networks of cities, but the application of the outcome is restrained … we have therefore begun to focus more on digital enhancement design by engaging people who have interests*" (Expert 9). Based on their views, the low frequency of the linkages can be understood from the perspective of a transformation going on in urban governance with more focus on participatory planning processes and a need for tools to support this active participation, including designing & visualization functionalities.

Second, the results reveal that functionalities in higher linkage combinations result in higher added value scores, and vice versa. This might indicate that to improve the added value of technological functionalities, more efforts focused on implementing technologies to solve urban problems and support governance processes are needed. However, the subgroup results show that contextual factors influence the role of functionalities. When we turn to the expert interviews, the relation between the frequency of the linkages and the added value produced by technological functionalities was vague; however, the expert interviews did confirm the strong effects of contextual factors. To better interpret the meaning of this finding, some distinct combinations of functionality, urban problems, and governance processes were selected (see Figure 7.8).

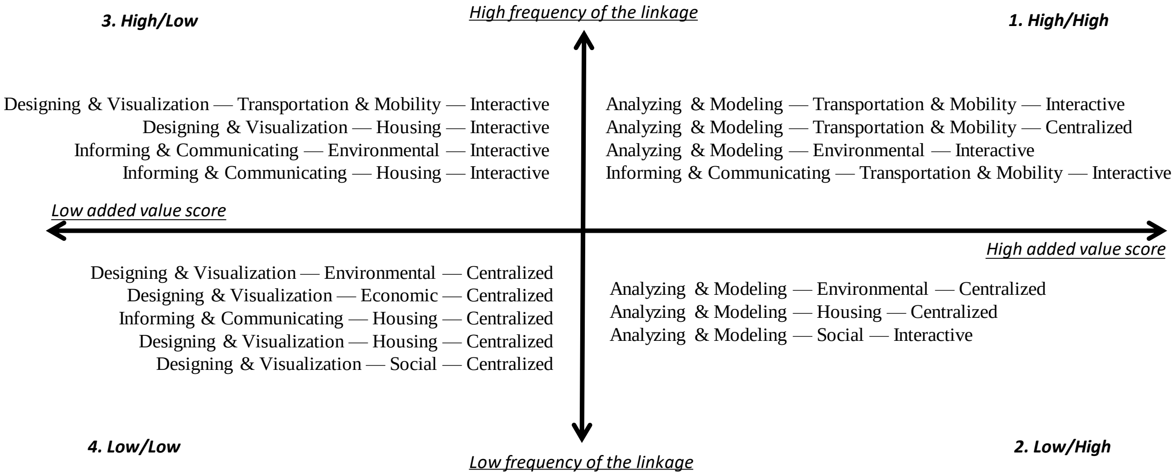

Figure 7.8 Some distinct combinations of functionality, urban problems, and governance processes, based on their frequencies of the linkages and average added value scores

The four quadrants in Figure 7.8 represent the different patterns of the implementation of technological functionalities. The first and second quadrants indicate that the analyzing & modeling functionality is relatively mature and stable in handling different urban problems and supporting both kinds of governance processes. Both quadrants indicate a high level of frequency of the linkages and added value. In that, "we should look at the success stories (successful or best practices) and try to learn from them" (Geertman, 2017:75). However, compared with the first quadrant, the second quadrant indicates the underutilization of some analyzing & modeling in specific areas (i.e., housing, social, and environmental problems), despite high support capabilities. As experts highlighted: "*although some GIS, camera systems, and big data analytics are frequently used to deal with some urban problems and produce high value, the technical skills, knowledge, and unawareness of users could impede the use of technologies in urban planning*" (Expert 2); besides, "*the complex and wicked nature of urban problems makes it hard for computer-aided tools to work in reality*" (Expert 8). This implies that implementing analyzing & modeling tools to tackle housing, social, and environmental problems should be more sensitive to the main bottlenecks (i.e., user characteristics, content of governance issues) to their usage (Pelzer, 2015). The third quadrant indicates that informing & communicating and designing & visualization are lacking in quality, although they are widely adopted. This can be perceived from one of the expert interviews: "*ultimately* *while our tools were more accurate, more up to date, visually appealing, and fast…, practice really needs software that everyone can understand and use*" (Expert 10). This finding implies that technological innovations that can improve support functions of participation, interpersonal communication, visualization, and collective design should primarily be improved in quality (Klosterman, 1997). Finally, the fourth quadrant represents some technological functionalities (mainly designing & visualization) that are not much implemented in centralized governance processes (low added value scores). As experts highlighted, the recent wider context (e.g., the political environment of urban governance/planning) places more emphasis on incorporating smart functionalities to support interactive processes.

Finally, some methodological remarks are in place. First, it is not surprising that the most used combinations are also the most valued ones (because they are the most used). It is worth noting that this relationship was measured through a simplified reporting process, which means a range of other factors—such as user expertise level, characteristics of the urban issue, political attitude, and time pressure—were not considered as a part of the added value determinants. This could be part of a very nice follow-up research. Nevertheless, the present analysis helps to understand the possible mechanisms of transforming technological innovations into added value. Second, due to unavoidable limitations of the questionnaire design, we were unable to calculate the different kinds of added value referring to one particular combination of functionalities, governance processes and urban problems in one smart city project. Despite, the general overview helps us to understand the general performance of ICT in smart cities. Third, our respondents were mainly scholars and practitioners; no citizens were included in our analysis. However, since citizens' perceptions provide important insights into and much-needed knowledge on improving the supportive role of ICTs (Meijer and Thaens, 2018), it would be meaningful for further research to capture the perspectives of citizens who have participated in ICT-facilitated urban governance.

7.6 Conclusion

Literature suggests that various smart ICTs and big data are being connected to urban governance to develop approaches that can make cities smarter. This paper presented a framework that provides guidelines on how ICT can produce added value to smarten urban governance. An international questionnaire and expert interviews were used to examine the practical application of technological functionalities in smartening urban governance and to measure the relevant added value produced by technological functionalities.

Based on the interpretation of the results, this paper revealed that: 1) The added value of ICT tools is best illustrated by analytical tools to tackle transportation and mobility problems, whereas some communicating and designing functionalities are less used; 2) higher frequency of linkage between functionalities, urban problems, and governance processes results in the higher added value of these functionalities, and vice versa; and 3) contextual factors have a significant influence on the process of transforming technological functionalities into added value. These findings lead to the following strategies to enhance the support capabilities of technological functionalities in smartening urban governance.

First, we could take a better look at the lessons learned from the more successful application of analyzing and modeling tools, especially in the field of transportation and mobility, and see whether they are applicable to the less successful urban governance practices, namely housing, social, and environmental issues. Second, we should be more sensitive to the main bottlenecks (i.e., users' characteristics and the content of governance issues) to the widespread usage of some technological functionalities that have high support potentials (e.g., analyzing & modeling and informing & communicating in tackling housing, social, and environmental problems). Third, technological innovations that can contribute to the creation of an enabling environment for citizen engagement and voluntary action require qualitative improvement. In particular, those informing, communicating, and designing tools should improve the quality of interpersonal communication, mutual learning, visualization, and collective design. Finally, although both the frequency of linkages and added value of functionalities in centralized governance are relatively low, this does not mean that there is no room for single entity, centralized innovations that are tailored to very specific needs (e.g., centralized highway management, city-wide traffic control system). We still need to contextualize the implementation of ICT in practice.

All in all, for improving governance processes and handling related urban problems, the results suggest that differentiated strategies should be employed. In this way, the use of ICT in smart planning can realize its full potential—and 'smartening' urban governance can be achieved in specific contexts.

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Chapter 8

Ignorance is Bliss? An Empirical Analysis of the Determinants of PSS Usefulness in Practice

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Abstract: Planning support systems (PSS) enabled by smart city technologies (big data and information and communication technologies (ICTs)) are becoming more widespread in their availability, but have not yet been fully recognized as being useful in planning practice. Thus, a better understanding of the determinants of PSS usefulness in practice helps to improve the functional support of PSS for smart cities. This study is based on a recent international questionnaire (268 respondents) designed to evaluate the perceptions of scholars and practitioners in the smart city planning field. Based on the empirical evidence, this paper recommends that it is imperative for PSS developers and users to be more responsive to the fit for task-technology and user-technology (i.e., utility and usability, respectively) since they positively contribute to PSS usefulness in practice and to be more sensitive to the potential negative effects of contextual factors on PSS usefulness in smart cities. The empirical analyses further suggest that rather than merely striving for integrating smart city technologies into advancing PSS, the way that innovative PSS are integrated into the planning framework (i.e., how well PSS can satisfy the needs of planning tasks and users by considering context-specificities) is of great significance in promoting PSS's actual usefulness.

8.1 Introduction

The rapid development of new digital information and communication technologies (ICTs) (e.g., Internet of Things sensors, artificial intelligence, networks) and big data in the realm of smart cities has opened up new opportunities for the development and application of planning support systems (PSS) (Geertman and Stillwell, 2020; Barns, 2018; Vallicelli, 2018). According to Pettit et al. (2018), PSS—as enabled through big data, city analytics, and modelling—provide potential benefits for smarter city planning that should be given consideration. Here, PSS can be understood as geo-information technology-based instruments that are dedicated to supporting those involved in planning in the performance of their specific planning tasks (Geertman 2006). Studies show that the potential benefits arising from new ICTs and big data to PSS are multidimensional. For instance, real-time and personalized (big) data concerning built environment (e.g., traffic flow, energy usage, public safety, and environmental protection) can be captured, analyzed, and integrated into various types of PSS because of the rapid development of electronic data sensors in augmenting city functions (Geertman and Stillwell, 2020; Thakuriah et al., 2017; Bettencourt, 2014). Urban planning-relevant spatial analyses are substantially increased with the advent of urban data analytics and ubiquitous computing

(Babar and Arif, 2017; Rathore et al., 2016). Besides, various smart ICTs (e.g., web-based platforms, online social networking, blogs, electronic voting, internet petitions) can also broaden and deepen political participation and collaboration in the planning field by enabling ordinary people to have access to the planning process (Stratigea et al., 2015; Khan et al., 2014).

Although new PSS, as enabled through big data, and new smart ICTs offer the potential for smarter city planning and are becoming more widely available, it should be noted that planning practitioners have never fully embraced the much wider diversity of available methods, techniques, and models developed in research laboratories and private companies (Pettit et al., 2018; Geertman, 2017; Geertman, 2006). For quite some time, there exists an implementation gap for PSS—that is, an apparent mismatch in planning practice between supply, demand, and applications of PSS and their outcomes (dedicated information and knowledge) (Geertman et al., 2015; Brömmelstroet and Schrijnen, 2010; Vonk, 2006). To shed light on the reasons for the PSS implementation gap, Vonk et al. (2005) conducted systematic research and identified a wide range of bottleneck indicators, including human, organizational, and institutional, as well as technical factors, that have blocked widespread usage and adoption of PSS in planning practice. Based on their recommendations, research has been conducted to investigate the usefulness (or added value) of PSS in practice (Pelzer, 2015; Te Brömmelstroet, 2013). It is highlighted that thorough research into the potential benefits of PSS can help arouse awareness among planners of the existence of PSS and of the purposes for which PSS can be used in a supportive way (Vonk, 2006).

However, studies indicate that in the actual application of PSS, a range of factors influence the usefulness of PSS. For instance, some authors argue that the quality of PSS functional support for planning tasks is decisive for PSS success (Geertman and Stillwell, 2009; Klosterman, 1997; Harris and Batty, 1993). Other authors claim that the perceived user-friendliness is positively related to the success of PSS (Pan and Deal, 2019; Russo et al., 2015; Vonk, 2006). More recently, it has been widely accepted that PSS need to be enhanced to align the instruments more with the dynamic characteristics of planning processes since the specific situations or contexts in which PSS are embedded have a significant influence on how PSS work in actual planning practice (Champlin et al., 2019; Geertman, 2017; Geertman 2006). From this, it can be seen that increasing attention is being paid to the factors influencing PSS usefulness. However, there is a lack of comprehensive conceptual frameworks and empirical studies to systematically investigate the determinants (i.e., important success and failure factors) of the usefulness of PSS, even though Vonk et al. (2005) emphasized the necessity of such an effort in 2005. Fifteen years later, such elaborations seem to be much needed, since PSS are now being confronted with implementation challenges in the realm of smart cities (Pettit et al., 2018).

To improve the usefulness of PSS in actual planning practice, this paper aims at utilizing the knowledge of PSS as a benchmark to investigate the important success and failure factors determining the usefulness of PSS in the realm of smart cities. This study can be seen as an extension to the study of Vonk et al. (2005). Different from Vonk's study, which focused on bottlenecks blocking widespread acceptance of PSS, this paper examines the factors determining the actual use of PSS in planning practice. Consequently, the key argument made here is that unlike fifteen years ago when applications of PSS in practice were primarily experimental and tended to be less accepted, in recent years PSS enabled by smart city technologies have been more easily accepted and widely implemented into different planning practices, such as environmental planning, tourism planning, public health service, disaster management, etc. (see also Geertman and Stillwell, 2020). Thus, a better understanding of the factors influencing PSS's actual usefulness in practice enables us to provide effective and holistic solutions to the implementation gap of PSS and improve the support function of dedicated PSS in smart cities.

The next section describes the state of the literature with respect to PSS usefulness and then develops a conceptual framework, including the most important factors determining PSS usefulness as observed in the literature. The third section describes the research methodology. Section 4 elaborates on the empirical results and describes the important success and failure factors determining PSS usefulness. Section 5 reflects on the conceptual framework and empirical results, followed by the conclusion in Section 6.

8.2 Determinants of PSS usefulness: a conceptual framework

8.2.1 Usefulness of PSS in smart cities

Cities are full of ubiquitous information technologies and they are increasingly understood as smart and connected urban areas (Batty, 2013). To turn the omnipresence of urban technological innovations into benefits for planners and citizens, they could be used within PSS which help make the planning process more efficient and handle complexity better (Geertman and Stillwell, 2020; Pettit et al., 2015). Recently, a growing body of research seeks to better understand how PSS can make use of these new ICTs and data sources to support the planning, management, and implementation of a smart city.

First, some authors argue that the rise of a smart city leads to an exponential increase in data by several orders of magnitude; consequently, such enormous volumes of data or big data act as valuable input for PSS (Babar and Arif, 2017; Bettencourt, 2014). By exploring the ways in which this considerable amount of real-time and very up-to-date data collected through various sources are linked using data-driven analytic PSS, valuable information and knowledge can be produced for service and administration purposes (e.g., crowd sensing-based traffic measurements) (Barns, 2018).

Second, the emergence of big data and new ICTs generates sophisticated data analytics and geospatial modeling, which further helps expand the scale and scope of PSS applications (Thakuriah et al., 2017; Rathore et al., 2016; Khan et al., 2015). Traditionally, PSS are mainly accepted in limited fields like transportation planning and expertimental research. However, recent studies indicate that PSS enhanced by real-time data and new ICTs are increasingly implemented to address a wide spectrum of urban issues such as resource and environmental management, basic farmland protection, tourism planning, housing planning, etc. (Geertman and Stillwell, 2020).

Third, PSS can also be used to facilitate technology-mediated interaction between the civil society sphere and the formal political sphere and broaden access to smart city planning processes (Lock et al., 2019; Zhang et al., 2018; Panagiotopoulou and Stratigea, 2017; Saad-Sulonen and Horelli, 2010). By offering new opportunities for more direct and convenient citizen access to the planning process of smart cities and including a broader range of new perspectives, ideas, opinions, and knowledge, it helps governments and its agent planners to gain insight into the views of other stakeholders and avoid pitfalls caused by unawareness of the specificities of individuals and communities (Geertman et al., 2019; Panagiotopoulou and Stratigea, 2017).

As Geertman et al. (2015) highlight, the integration of new big data and ICTs into PSS in the era of smart cities not only have the capability for collecting, managing, analyzing, and storing information about cities more efficiently than before, they also present planners and managers with opportunities to draw on this information to improve city life. It is proclaimed that this trend will continue over the coming years, particularly given the rapid development of ICTs (Barns, 2018; Vallicelli, 2018). However, it should be noted that although PSS offer the potential to harness the power of urban big data and new ICTs and digital tools to support smart city planning, the usefulness of PSS for smart cities is weakened due to restraints related to PSS implementation (Pettit et al., 2018). A lot of PSS are developed by academic researchers, but the tools are ultimately not responsible for planning decisions (Brömmelstroet and Schrijnen, 2010). In practice, low PSS education and training and low technical skill are highlighted to influence PSS usefulness (Pelzer, 2015). Besides, some of the PSS cannot achieve a balance of complexity and simplicity due to a lack of flexibility and transparency (te Brömmelstroet, 2012). As Geertman (2017) criticizes, although PSS application studies actually apply PSS, most intended PSS applications are not realized. Based on this, we argue that to strengthen and optimize the transformative potential of PSS in smart cities, factors determining PSS usefulness should be systematically investigated.

8.2.2 Factors influencing PSS usefulness

The usefulness of PSS refers to the positive influence a PSS can have on practice (Pelzer, 2015). Te Brömmelstroet (2013) highlights that PSS usefulness can be measured at the process or outcome level. In several empirical cases studies, PSS have been identified as useful for planning practice by helping the public to express their needs, promoting interpersonal dialogue and debate, producing information in a form which can be understood and used by the 'non-specialists', and visualizing and interpreting keyword data (Zhang et al., 2018; Goodspeed, 2015; Pelzer et al., 2014; te Brömmelstroet, 2013).

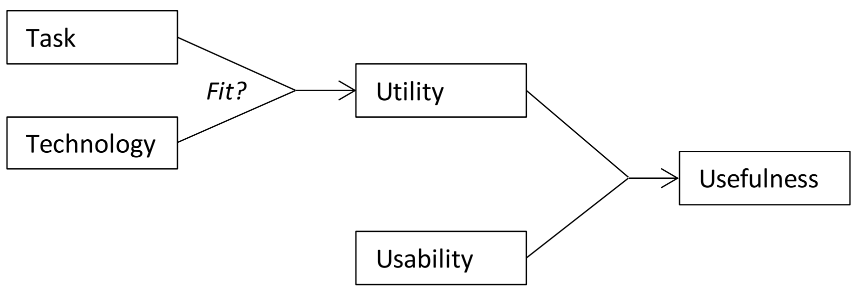

Figure 8.1 Factors determining PSS usefulness, based on Nielsen (1993) (Source: Pelzer, 2017)

Based on Nielsen (1993), Pelzer (2017) reveals that two main factors—utility and usability—can be identified to determine the usefulness of PSS (Figure 8.1). Here, "utility is the question of whether the functionality of the system in principle can do what is needed" (Nielsen, 1993:24). According to Pelzer (2017), "'do what is needed' refers to the effect on the planning tasks a PSS is intended to support in the context of PSS". The concept of 'task–technology fit' is applied to make sense of utility (Pelzer et al., 2015; Goodhue and Thompson, 1995). It assumes that only if the characteristics of the PSS fit the planning task, can the utility of PSS be fulfilled. Table 8.1 indicates the commonly used utility indicators that have a significant influence on PSS usefulness.

Table 8.1 Different kinds of utility indicators influencing PSS usefulness, based on Geertman et al. (2015), Pelzer (2015) and Vonk (2006)

Utility indicators	Description
Geo-data gathering	Functional support for geo-data collection
Geo-data storage	Functional support for geo-data storage
Visualization	Functional support for creating images, diagrams, or animations
One-way informing	Functional support for transferring information in one direction only
Two-way communicating	Functional support for facilitating communication and discussion between those involved in planning through supporting flow of planning related information between them (e.g., Touch Table)
Spatial analysis	Functional support for examining spatial patterns of human behavior
Spatial modelling	Functional support for simulating spatial objects or phenomena
Spatial designing	Functional support for idea design and drawing
Scenario building	Functional support for identifying possible "realities" of the future
Impact analysis	Functional support for determining the potential consequences of a plan

Usability, then, is about 'how well users can use that [utility] functionality' (Nielsen, 1993:25). 'How well' indicates the user experience of using a PSS. According to Russo et al. (2015), usability is widely acknowledged within the Human–Computer Interaction literature as user-technology fit (Vonk 2006), which focuses on the effectiveness and efficiency of the interaction between user and system (PSS), the user engagement and the derived satisfaction. Normally, a higher level of usability of a PSS tool can improve the acceptance of a PSS in practice. Table 8.2 indicates the commonly used usability indicators that have a significant influence on PSS usefulness.

Table 8.2 Different kinds of usability indicators influencing PSS usefulness, adapted from Pelzer (2017:88)

Usability indicators	Description
Transparency	The extent to which the underlying models and variables of the PSS are visible to users

User friendliness	The extent to which participants are able to use the tool themselves
Interactivity	The extent to which the tool can directly respond to the users' questions and suggestions
Flexibility	The extent to which the tool can be applied to different planning tasks
Calculation time	The time participants have to wait before an analysis is completed
Data quality	The extent to which the input data is considered valid
Reliability	The extent to which the outcomes of the tool are considered reliable

Te Brömmelstroet (2010) finds that a technical focus is insufficient to improve the PSS added value, since key bottlenecks of the use of PSS are actually centered on 'soft issues' like poor connections to the planning process. Hence, he argues that usability of PSS should be improved to link the instruments more with the dynamic features of users and planning issues. According to Vonk and Ligtenberg (2010), since social activity is often dynamic and nuanced, knowledge often needs to be contextualized to be useful in planning. This means the actual use of PSS should not be reduced to a rational and linear process or one-size-fit-all approach; instead, PSS should become more aware of situational specificities in which a PSS is embedded. A systematic review of contextual factors influencing the usefulness of PSS was conducted by Geertman (2006). In his elaborations, six contextual variables were identified to influence the potential planning support roles of PSS. Table 8.3 shows the different kinds of contextual variables and explanatory indicators in the PSS research. However, to the best of our knowledge, no systematic empirical study has been conducted to examine the importance of these contextual variables in shaping PSS usefulness.

Table 8.3 Different kinds of contextual indicators influencing PSS usefulness, based on Geertman (2006), Pelzer (2015) and Vonk (2006)

Contextual variables	Explanatory indicators
The planning issue	content of planning issue
Specific characteristics of information, knowledge & instruments	adaptability to user needs; adaptability to new setting
User characteristics	technical skill; user attitude; active uptaker
Characteristics of planning & policy process	time pressure; planning phases
Planning and policy style	planning & policy style
Political context	political pressure; political system

8.2.3 Towards a conceptual framework

According to Pelzer (2017:93), "the best way to understand usefulness is to integrate the frameworks of Geertman (2006) and Nielsen (1993)". Based on his work, this paper makes such an attempt by integrating the context dimension into the usefulness model to be able to better understand the factors determining PSS usefulness (Figure 8.2). Therein, the task-technology fit indicates to the appropriateness of the technology to handle the task at hand; while the user-technology fit indicates to the goodness of fit between the capabilities of the user and the functionalities offered by the technology.

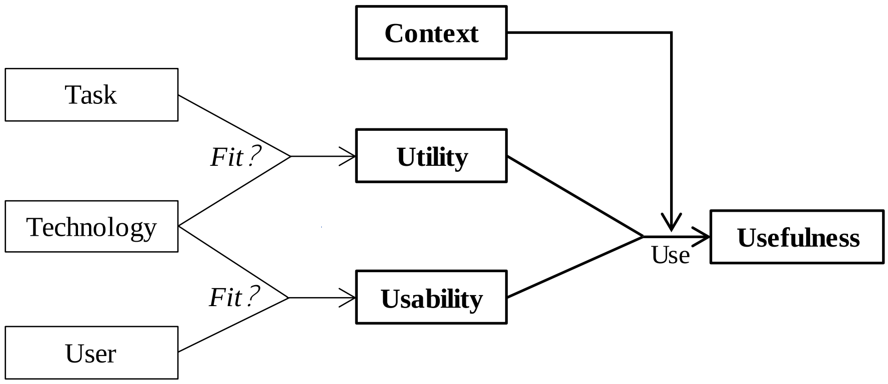

Figure 8.2 A conceptual framework of factors influencing PSS usefulness

This adapted model illustrates that PSS usefulness is mainly explained and influenced by the utility and usability factors. When being implemented into practice, context then plays a crucial role in affecting the usefulness of PSS. It should be noted that the task-technology fit and the user-technology fit are also highlighted as part of the framework to help us understand better the meaning of utility and usability. In the following sections, the elaborated utility indicators, usability indicators and contextual indicators were applied to thoroughly investigate the determinants (i.e., important success and failure factors) of PSS usefulness in practical smart city projects.

8.3 Methodology

8.3.1 Data collection

This study is mainly based on an international questionnaire which was undertaken over the course of three months, from May to July 2019. The aim of the survey was to collect in-depth information about the application of PSS in practical smart city projects. The questionnaire was mainly headed to the research community of Computers in Urban Planning and Urban Management (CUPUM). The reason for selecting the CUPUM community as survey respondents is that CUPUM has been one of the major international academic platforms to discuss the latest ideas and applications of computing technology, aiming to address a diverse range of social and environmental issues that would affect urban planning and development based on computing technology[9]. Thus, CUPUM members are normally considered to be equipped with comprehensive and detailed knowledge and specialized skills in terms of PSS, which enables them to understand the central goal of the survey: to gain knowledge to better understand the opportunities and threats of planning support technology in computational urban planning for smart cities. By using electronic and regular mailing lists, approximately 1,300 people around the world were invited to participate in the survey.

In the web-based survey, forty-five statements constitute the main part of the questionnaire, categorized for types of urban problems, stakeholders, utility, usability, added value, and context. Except for the statements linked with this study, questions to decide the features of the survey population (e.g., gender, age, profession, origin, expertise with planning support ICTs) were also attached. The statements were based on the previously identified PSS literature. For each of the statements, a seven-point scale (from 1 (low) to 7 (high)) was offered to the respondents. Respondents were specifically asked whether or not they have been—academically and/or professionally—involved in smart city projects over the past years. The follow-up questions specifically addressed their involvement in such projects. In this paper, the 28 statements concerning utility, usability, and context were applied to do the analysis.

8.3.2 Data analysis

The questionnaire data was analyzed based on Figure 8.2. First, the analysis only included respondents who were involved or are currently involved in smart city projects, because this real-life experience gives them the actual possibility to evaluate the statements. Furthermore, in the questionnaire we asked the respondents about their level of expertise in planning support technology and if they have practical experience in working with this technology in real-world projects. Second, the scores of utility variables, usability variables, and contextual variables were calculated to explore the success and failure

[9] http://www.cupum2019.org/

factors. More specifically, for both the utility and usability statements the success factors were calculated by combining the frequency scores of the answer categories 'successful' and 'very successful'; and for the context statements by combining the frequency scores of the answer categories 'positive' and 'very positive'. Likewise, for both the utility and usability statements the failure factors were calculated by combining the frequency scores of the answer categories 'unsuccessful' and 'extremely unsuccessful'; and for the context statements by combining the frequency scores of the answer categories 'negative' and 'extremely negative'. For clarification reasons, the frequency scores show in absolute or relative sense how many participants select a specific seven-point category. For instance, among the 268 respondents, 155 respondents selected the category 'successful' or 'very successful' in the 'spatial analysis' indicator; as a result, the frequency score is 155 in absolute sense and 58% in relative sense (absolute score / total population of respondents = percentage; 155/268=58%).

Third, to further validate the results, sub-groups of respondents were examined and compared with the results from all respondents. Subgroups were distinguished on the basis of geographical origin/economic development level and profession. First, all respondents were categorized as respondents from China or as respondents from North America, Europe, Japan, and Australia (abbreviated as NEJA). This classification is mainly due to three major reasons: 1) more than half of the questionnaire respondents appeared to be from China, which is foremost attributed to the fact that the 2019 CUPUM conference was organised in Wuhan, China (see Figure 8.3a); 2) according to some authors, China, North America and Europe have the largest group of smart cities projects (Jiang et al., 2019; Zubizarreta et al., 2016); thus, research on the application of PSS in China and NEJA would help understand the strengths and limitations of PSS in the workplace; 3) China and NEJA countries are at different levels of economic and societal development, thus posing different challenges for PSS usefulness in practice. Second, all respondents were categorized based on their professions: respondents from academia on the one side and respondents from practice on the other. Respondents from academia include academic researcher/scholar and doctoral students, while respondents from practice consist of planners, designers, and politicians (see Figure 8.3(b)).

Finally, the variables were interpreted in relation to the conceptual framework, thus providing insight into the important factors that contribute to the success and failure of PSS usefulness in practice. The average frequency score per group of important success and failure factors was measured, which helps to derive the relative importance of the different factors in the conceptual framework. From this measurement, an overall picture of determinants of the usefulness of PSS in the realm of smart cities can be clearly illustrated.

8.4 Results from data analysis

8.4.1 Exploration of responses

Analysis shows that 268 respondents have filled out the questionnaire, which is estimated as approximately a 20.6% response rate, which is a good result for a web-based international inquiry. Among the 268 respondents, 175 respondents are involved in smart city projects in which PSS have played an important role. Figure 8.3(a) reveals that 93 out of the 175 respondents (53%) are from China, 58 of the respondents (33%) are from NEJA (North America, Europe, Japan and Australia) and 24 (14%) are from other countries (mainly Russia, South Africa, Brazil, and India). Figure 8.3(b) indicates the profession of the respondents. It illustrates that the majority of the respondents are academic researcher/scholars (72 respondents; 41%) or planners (58 respondents; 33%) whereas only 9 respondents (5%) are designers or politicians. Besides, 37 doctoral students account for 21% of the total respondents. As mentioned in the previous section, designers, politicians and planners are combined and categorized as the practitioner group and academic researcher/scholars and doctoral students are treated as the academic group.

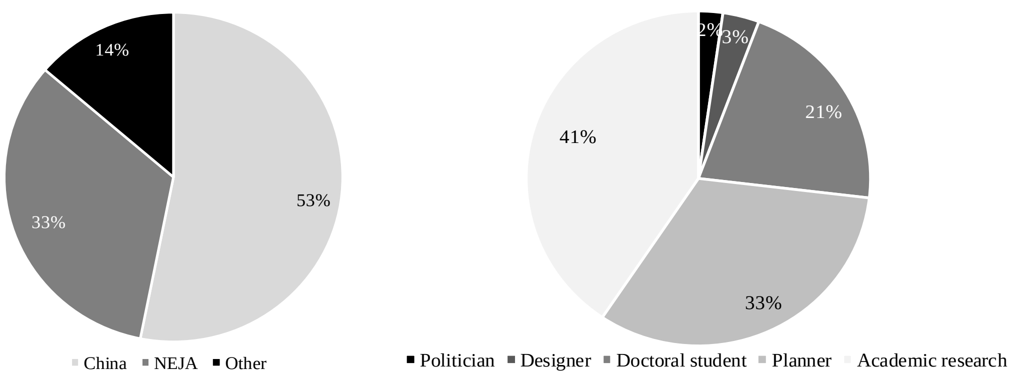

Figure 8.3 (a) Respondents based on geographical origin/economic development level and (b) profession

8.4.2 Analyzing success and failure factors

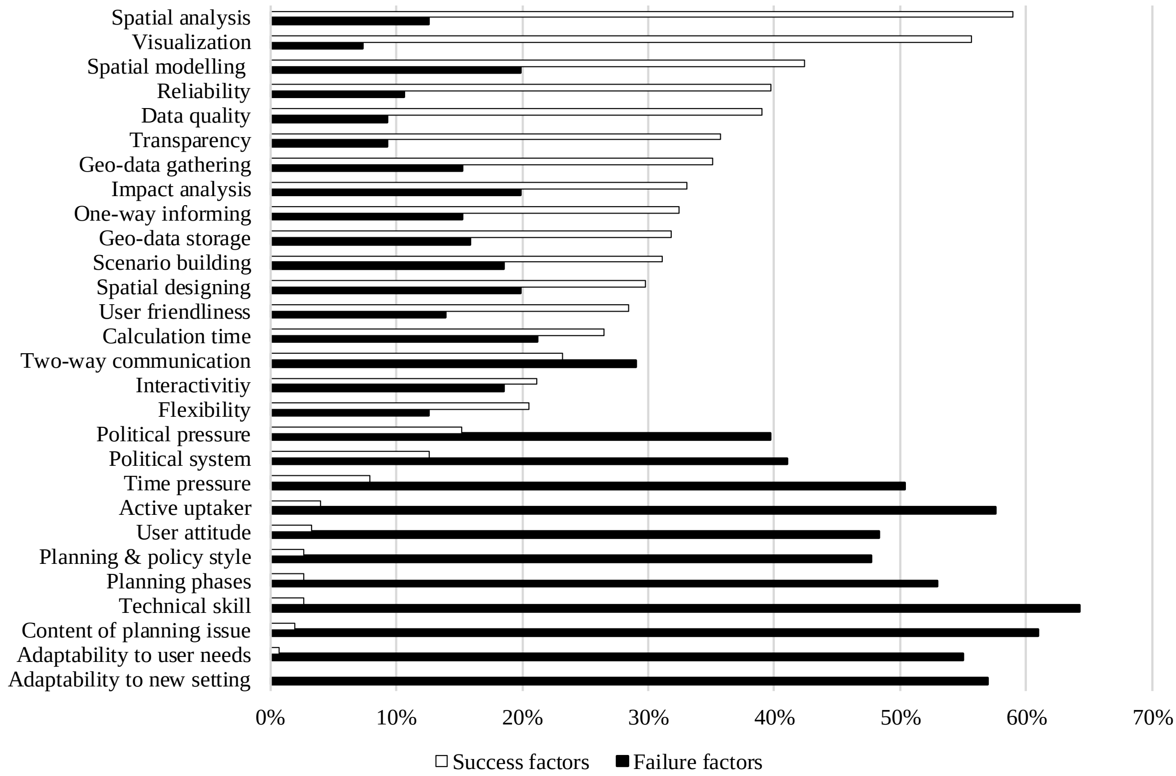

Figure 8.4 Percentage of success and failure indicators

Figure 8.4 (white bars) shows the success indicators with their importance scores (percentage of 'successful' and 'very successful' in the utility and usability statements and percentage of 'positive' and 'very positive' in the context statements) derived from the 28 statements. A wide range of indicators are significant. Illustrative in this respect is that 12 out of the 28 indicators gain scores of more than 30%. The three most important success indicators are 'spatial analysis', 'visualization' and 'spatial modeling', which are all related to PSS utility. Following these three utility indicators are three usability indicators—'transparency', 'data quality' and 'reliability'. Besides, six other indicators representing PSS utility are mentioned as important indicators—'geo-data gathering', 'impact analysis', 'one-way information', 'geo-data storage', 'scenario building', 'spatial designing'. As noted, nine out of the 12 important success indicators are related to PSS utility and three are related to usability. This confirms the finding that the quality of support functions along with its user experience are decisive for PSS usefulness (Vonk and Ligtenberg, 2010). Additionally, it should also be noted that no contextual indicators are considered to be important success indicators.

Figure 8.4 (black bars) shows the failure indicators with their importance scores (percentage of 'unsuccessful' and 'very unsuccessful' in the utility and usability statements and percentage of 'negative' and 'very negative' in the context statements) derived from the 28 statements. It is worth noting that the majority of the important failure indicators (scores over 30%) are contextual indicators. The two most important failure indicators are 'technical skill' and 'content of planning issue', having a 64% and 61% response rate respectively. This confirms the finding by Pelzer et al. (2014) that user technical skill and knowledge on planning issues are crucial for PSS implementation. Besides these contextual indicators, the utility indicator 'two-way communication' stands out in the failure indicators. Although the score of this indicator is below 30% (around 28%), we still regard it as an important failure indicator due to its crucial role in participatory urban planning (Flacke et al., 2020; Zhang et al., 2018).

8.4.3 Success and failure factors for subgroups of respondents

8.4.3.1 Respondents from China and NEJA

Analysis of respondents from China and NEJA shows that the importance scores of success and failure indicators are consistent with the scores of the total. Thus, the 12 important success indicators and the 12 important failure indicators in China and NEJA are further analyzed and compared with the total. As mentioned by Vonk et al. (2005), a small difference between the results for subgroups and the general results would indicate unanimity, which would contribute to the validity of the general results, whereas larger differences would indicate the opposite. In our study we have applied Chi-Square tests to determine whether there is a statistically significant difference between subgroups in terms of success and failure factors.

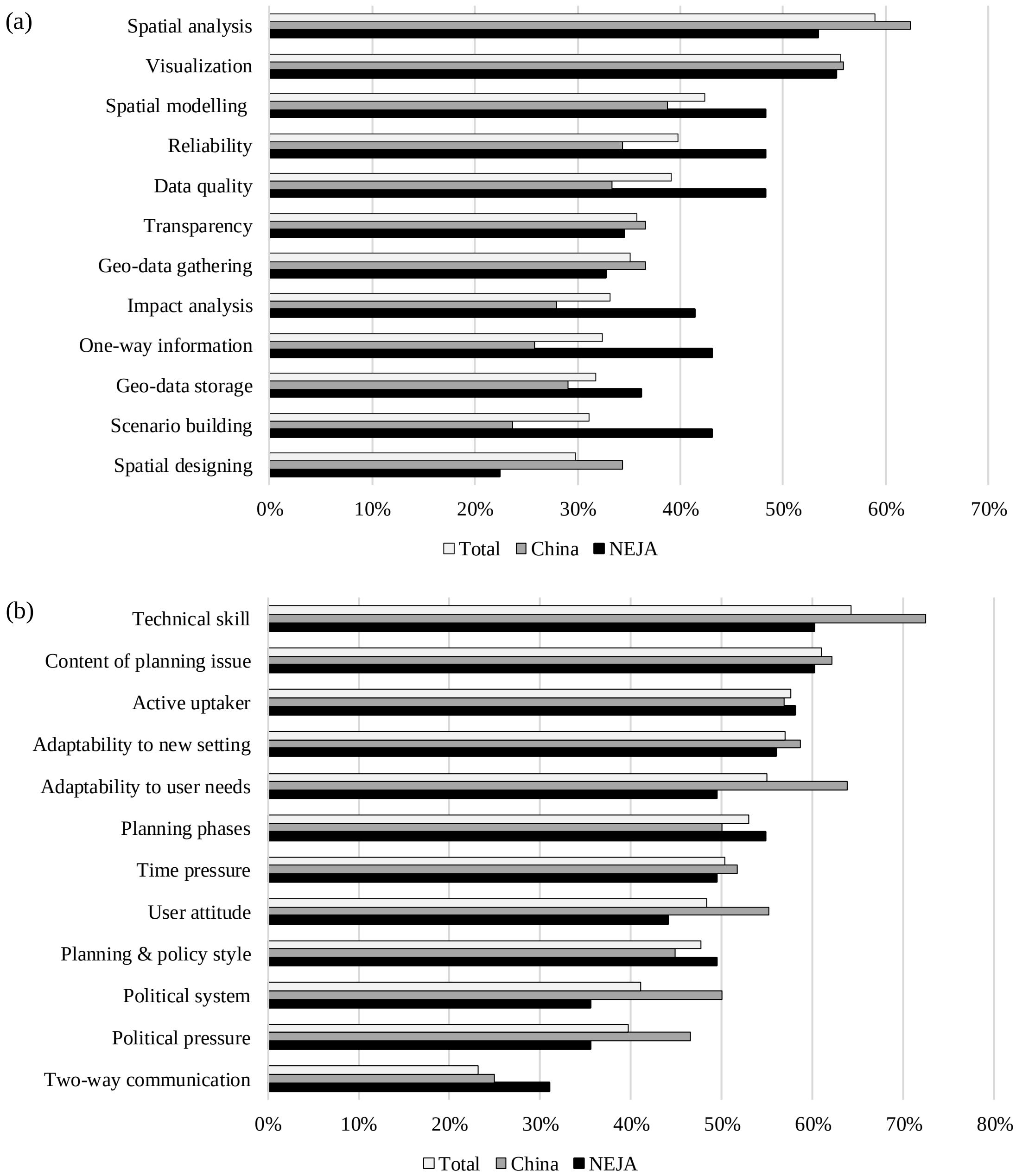

Figure 8.5 (a) Important success factors in China and NEJA and (b) important failure factors in China and NEJA

Figure 8.5 (a) indicates the scores of the 12 important success indicators distinguished earlier which scored high on importance in total (over 30%), compared with the scores from subgroups of respondents based on geographical origin / economic development level. The subgroups consist of 93 respondents from China and 58 respondents from NEJA. It shows that the difference in some indicators between China and NEJA are marginal (namely ‘visualization’, ‘geo-data gathering’, ‘transparency’); for all other indicators the outcomes differ substantially. Further analysis shows that indicators gaining higher scores in NEJA include two usability indicators (‘reliability’ and ‘data quality’) and four utility indicators (‘spatial modeling’, ‘impact analysis’, ‘one-way informing’ and ‘scenario building’). Only the scores of ‘spatial designing’ and ‘spatial analysis’ in China is distinguished much higher. This could indicate that utility and usability indicators in NEJA are more conducive to the success of PSS implementation than their China counterparts. However, in statistical hypothesis testing (Chi-Square test), p-value (=0.0854) was reported larger than 0.05, indicating that the difference between China and NEJA in terms of success factors is not statistically significant.

Figure 8.5 (b) illustrates the scores of the 12 important failure indicators distinguished earlier which scored highest on importance in total (over 30%), compared with the scores from China and NEJA. In accordance with the total respondents, failure indicators are also chiefly linked with contextual indicators in both China and NEJA. Then, some indicators (i.e., ‘technical skill’, ‘adaptability to user need’, ‘user attitude’, ‘political system’ and ‘political pressure’) in China distinguish themselves from their NEJA counterparts by quite a margin, indicating the stronger negative effects of context on PSS usefulness in China. Despite the observed difference between China and NEJA in terms of failure factors, the significance was not determined by the Chi-Square test as p-value (=0.3270) was reported larger than 0.05.

8.4.3.2 Academic respondents and practitioners

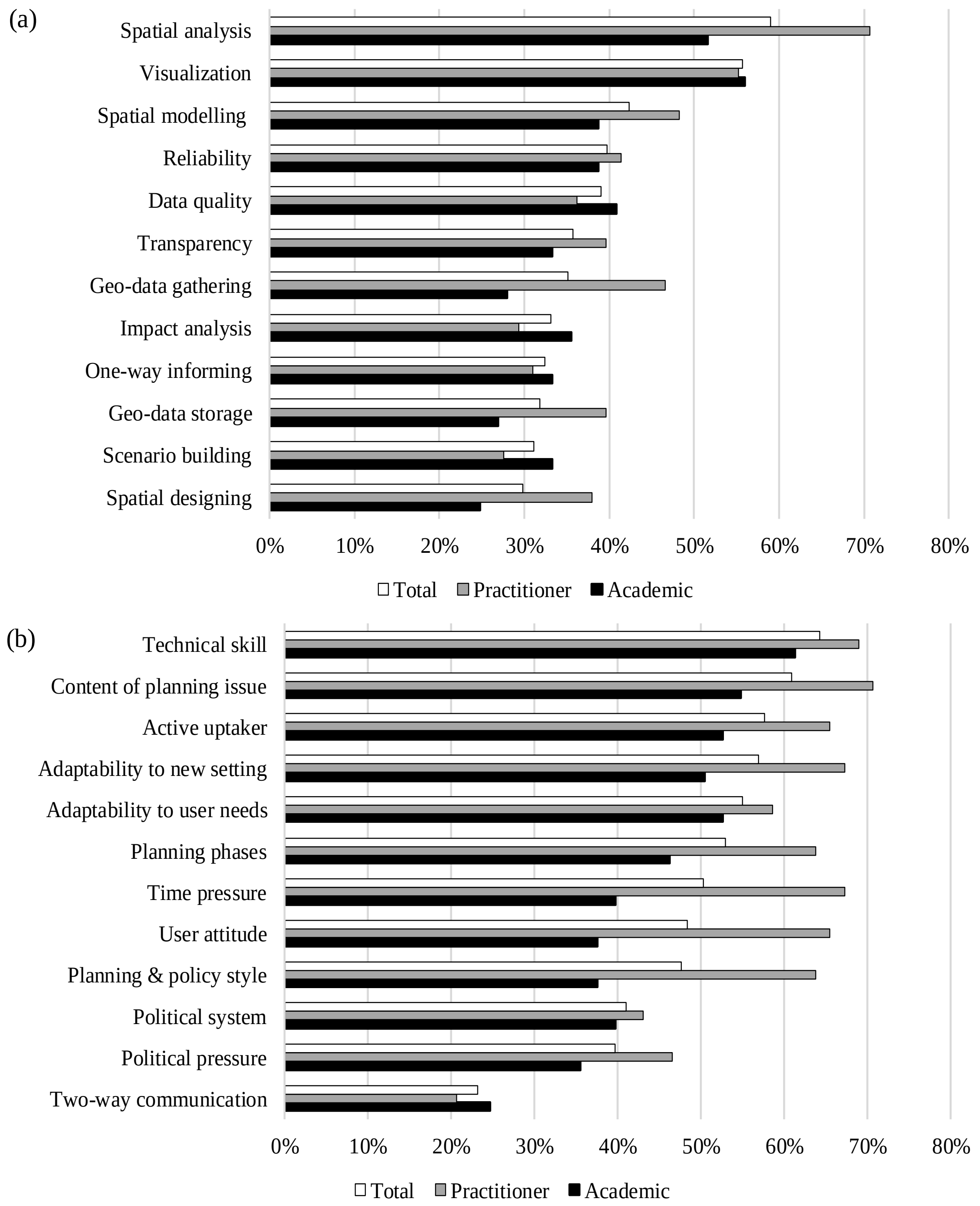

Figure 8.6 (a) Important success factors in the academic group and the practitioner group (b) important failure factors in the academic group and the practitioner group

Figure 8.6 (a) indicates the scores of the 12 success indicators distinguished earlier which scored high on importance in total (over 30%), compared with the scores from subgroups of respondents based on profession. The subgroups are made up of 108 academic respondents and 67 practitioners. Comparative analysis reveals that the scores of some utility indicators—'spatial analysis', 'spatial modelling', 'geo-data gathering' and 'spatial design' and 'geo-data storage'—are distinguished much higher in the practitioner group than their academic counterparts whereas other indicators between the two groups differ little from each other. Then, both groups see 'visualization' and 'spatial analysis' as the most important success factors. This indicates the high satisfaction of both subgroup respondents in using PSS for analysis and visualization. In statistical hypothesis testing, p-value was reported much larger than 0.05 (p-value=0.8412), showing that the difference between practitioners and academic respondents in terms of success factors is not significant. It also means that success factors between practitioners and academic respondents show a high consistency.

Figure 8.6 (b) illustrates the scores of the 12 important failure indicators distinguished earlier which scored highest on importance in total (over 30%), compared with the scores from academic respondents and practitioners. In general, the scores of the 12 important failure indicators in the practitioner group are much higher than their academic counterparts. This indicates that while practitioners are more sensitive to failure factors than for instance academia, this can negatively contribute to the PSS-implementation gap. Besides, it should also be noted that the only failure indicator that had a higher score for academic experts than for practitioners is 'two-way communication', showing that academic experts are more affected by the quality of communicating functionality. In statistical hypothesis testing, the p-value (=0.0010, less than 0.05) shows that the difference between practitioners and academic respondents in terms of failure factors is statistically significant. Average score analysis has revealed that the influence of failure factors in the group of practitioners is much stronger than its academic counterpart.

Therefrom, further analysis was made to compare the scores of the success and failure indicators from subgroups of practitioners with different levels of experience in using PSS—experienced practitioners and less-experienced practitioners. Firstly, in terms of success factors, the scores of the majority of utility and usability indicators are much higher for the group of experienced practitioners than for its less-experienced practitioner counterparts, while both have low scores for contextual indicators. In statistical hypothesis testing, the p-value (<0.0001, much smaller than 0.05) determined this difference significant. Secondly, in terms of failure factors, both groups gave high scores for contextual indicators, however, the scores of experienced practitioners are relatively higher than of its less-experienced practitioner counterparts. The Chi-Square test has also determined the statistically significant difference between these two groups (p-value<0.0001, much smaller than 0.05), which verifies the obtained results.

8.4.4 Interpretation of results

The ranking of success and failure factors in previous analyses indicates that a wide diversity of factors is considered to be important. But the relations among those factors are not explicit from such a list. Therefore, our theoretical framework on determinants of PSS usefulness is used to interpret these relations and help to understand the added value of the results. Figure 8.7 shows the theoretical framework, with the important success and failure factors and their scores incorporated within the three key factors (utility, usability, and context) in total, compared with two subgroups based on geographical origin/economic development level and profession. The percentages were calculated as an average from the relative frequency scores of the success or failure indicators, as shown in Figures 8.4 to 8.6. For instance, the percentage of 'utility success factors in NEJA' was obtained by calculating the average of the scores of the nine utility indicators in Figure 8.5a.

The earlier notion that there is not a single success and failure factor influencing the usefulness of PSS for smart cities, but quite a diversity, is clearly conveyed by previous analyses. Figure 8.7 (black bars) shows that factors related to utility, usability, and context can either be success factors or failure factors. In general, the scores of the utility and usability success factors (39% and 38%, respectively) are higher than their failure factor counterparts (23% and 0%, respectively). This means the positive effects of utility and usability factors on PSS usefulness outweigh their negative effects. More detailed analysis shows that except for 'two-way communication', almost every utility indicator is among the important success factors, indicating that PSS utility constitutes the main determinant of success for PSS usefulness. However, the support function related to communication and discussion between those involved in planning (i.e., low score of 'two-way communication') lacks a particular quality, especially for practitioners in China as compared to practitioners in NEJA countries. This confirms the work by Zhang et al. (2018) that PSS have potential to be applied in the Chinese context but the usefulness differs from West European and North American countries. Due to top-down institutions and dominant government-led approaches, PSS (especially communicating PSS) in China might not necessarily be well developed and employed to encourage technology-facilitated participation and collaboration between different stakeholders in the planning process.

Then, usability success factors are mainly linked to the quality or characteristics of PSS in transforming input into output information production (i.e., high scores of 'reliability' and 'data quality' and 'transparency') whereas other usability success indicators gain moderate scores. Besides, no important usability failure indicators were identified. This confirms the statement by Pelzer (2017) that "usability has increased significantly over the last decade" and is widely treated as a necessary condition but not a sufficient condition for the success of a PSS tool. Third, it should be noted that all th e contextual indicators were identified as important failure indicators. Thus, a declaratory judgment is made that context constitutes the main determinant of failure of PSS usefulness in practice for contemporary smart cities.

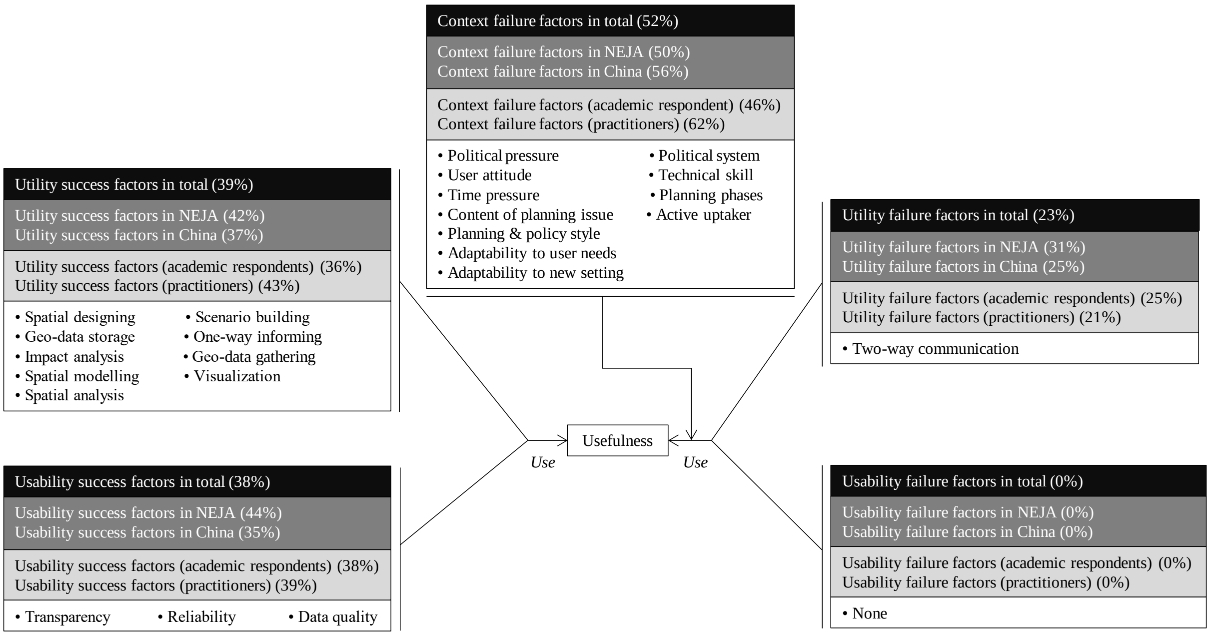

Figure 8.7 Important success and failure factors influencing PSS usefulness in total (in black), between subgroups of respondents based on geographical origin/economic development level (in dark grey) and profession (in light grey)

Figure 8.7 also shows the important success and failure factors in subgroups of respondents based on geographical origin/economic development level (dark grey) and profession (light grey). Some similarities and differences exist between the subgroups. Figure 8.7 (dark grey) reveals that in terms of the total average scores of success factors, the NEJA group in general is more outspoken than its China counterparts, whereas concerning the total average scores of failure factors, China shows more vulnerability. However, previous analyses indicate that the difference between China and NEJA is not statistically significant, which indicates that key factors for success and failure between

China and NEJA show a high consistency. Then, Figure 8.7 (light grey) reveals that the total average score of success factors in the practitioner group is much higher than for its academic counterpart. The practitioner group shows a higher average score of failure factors than its academic counterparts, negatively influenced by contextual factors. In statistical hypothesis testing, between practitioners and academic respondents only the difference in terms of failure factors was determined significant.

In brief, similarities and differences exist between subgroups but results for the subgroups agreed, in general, with the results obtained earlier for the total respondents for both the important success and failure factors. This confirms the general validity of the results.

8.5 Reflections

This section further reflects on the conceptual framework built in Section 2 and discusses the extent to which the empirical results obtained in the realm of smart cities agreed with and/or differed from PSS studies in the literature.

8.5.1 Reflection on the conceptual framework

The results show that the theoretical framework proposed in Section 2 is helpful to examine the success and failure factors determining the usefulness of PSS in the realm of smart cities. Different from previous studies (Pelzer, 2017; Pelzer et al., 2014; Brömmelstroet, 2013), our conceptual framework treats the contextual factor as an integral part of influencing the usefulness of PSS. As Pelzer (2015) argues, although task-technology fit (utility) and usability are valuable to understand PSS usefulness, the complexity of the task itself and a user's experience of a task could influence the evaluation of PSS usefulness. By building a more comprehensive and integrated framework, it indicates that the usefulness of PSS in the planning of smart cities is not achieved just by the PSS themselves but depends more on the different kinds of factors influencing the use of PSS in practice.

Despite the advantages the framework offers, there are some issues still being debated. For instance, in the conceptual framework, some usability indicators such as communicative value, integrality, and level of detail are not considered because of some overlap between utility and usability (e.g., communicative value as a usability indicator and communicative support capabilities as part of utility) (Pelzer, 2017) and inexplicable semantics. In addition, Bressers (2007) shows that contextual variables consist of two main levels—wider context (e.g., problem context, political context, economic context, cultural context, technological context) and structural context (e.g., policy style, networks & actors, strategies & instruments). It should be noted that not all contextual variables of these two levels are considered in this paper since we considered some contextual variables (e.g., economic, cultural) to merely influence the widespread acceptance of PSS (see Vonk et al., 2006). Despite the identified limitations of the framework, this framework arguably contributes to integrating the frameworks of Geertman (2006) and Nielsen (1993), as strongly recommended by Pelzer (2017), to build an effective model for studying the determinants of the usefulness of PSS in the realm of smart cities.

8.5.2 Reflection on the empirical results

The results obtained based on a large-scale survey make a good response to the current PSS research, but meanwhile goes beyond these research inputs. In the literature, PSS are found successful in exhibiting information in forms that are easy to understand by non-specialist users, facilitating interpersonal communication, displaying relevant scenarios, and helping the public to express their interests (Champlin et al., 2019; Zhang et al., 2018; Pelzer et al., 2014). In this paper, the results confirm that PSS utility (or functionalities) are the major success factors contributing to PSS usefulness. Some studies reveal that poor user-friendliness and interactivity have a negative impact on PSS usefulness (Pan and Deal, 2019; Russo et al., 2015). Results in this paper, however, show that usability in general is not considered an important failure factor.

Besides the aforementioned results, the authors have also found that the usefulness of PSS is associated with the types of urban problems that the users attempt to solve[10]. It shows that utility indicators concerning 'analyzing' and 'data processing' (e.g., 'spatial analysis', 'visualization', 'geo-data gathering', and 'geo-data storage') gain high scores in dealing with 'transportation & mobility' problems. Conversely, the scores of utility indicators concerning 'informing & communicating' and 'designing' (e.g., 'two-way communication' and 'spatial designing') are low in dealing with 'environmental', 'housing' and 'economic' problems. The different success and failure factors determining PSS usefulness within different urban problems are mainly caused by the interaction

[10] Note: these results are based on an extensive analysis of research data concerning the appropriateness of PSS dealing with diverse kind of urban issues, which was examined in Chapter 7. Over here, I only conclude some of the key findings out of that article, because these are closely related to this chapter.

strength between functionalities and urban problems—that is, the extent to which PSS functionality fits to the task.

Still, the authors recognized the limitations of the results. Because of our selection procedure, the opinions and attitude from the group of citizens are not considered in this paper. According to some authors, however, ideas and knowledge from civil society can effectively promote the advancements of PSS and accelerate growth in participatory urban planning (Geertman and Stillwell, 2020; Zhang et al., 2018; Pelzer, 2015). Notwithstanding this limitation, the paper does not consider this to be detrimental to the validity of the obtained results since the perspectives from scholars and practitioners still provide a professional overview of determinants of success and failure of PSS in practices of contemporary smart cities.

8.6 Conclusions

Planning support systems (PSS) enabled by smart city technologies are becoming more widespread in their availability, but have not yet been fully recognized as being useful in planning practice. This paper extends and updates the work by Vonk et al. (2005) and aims to investigate and analyze the factors influencing PSS usefulness during the process of PSS being actually used in the realm of smart cities. Based on an international questionnaire, empirical evidence shows that 1) utility (explained by 10 indicators) constituted the primary reason for the success of PSS usefulness in practice; 2) context (explained by 11 indicators) primarily acted as a failure factor for PSS usefulness; and 3) usability (explained by 7 indicators) were identified as a necessary but not sufficient factor to achieve PSS usefulness.

In general, this study offers a comprehensive picture of the important success and failure factors determining the usefulness of PSS in the realm of smart cities. What can be deduced is that the factors that contribute to the success of PSS usefulness are not necessarily the same as the factors that contribute to its failure. This points to the idea that the implementation of PSS should take into account both sets of factors of avoiding failure and on ensuring success. Thus, this paper recommends that it is imperative for PSS developers and users to 1) be more responsive to the fit of task-technology and user-technology (i.e., utlity and usability, respectively) since they positively contribute to PSS usefulness in practice; and 2) be more sensitive to the potential negative effects of contextual factors on PSS usefulness in smart cities.

Finally, Vonk and Ligtenberg (2010) argue that intense cooperation with users to improve the analysis of planning tasks and user needs in specific contexts is promising as a means to enhance PSS use in planning practice. Therefore, the results obtained in this paper further suggest that rather than merely striving for integrating smart city technologies into advancing PSS, the way the innovative PSS are integrated into the planning framework (i.e., how well PSS can satisfy the needs of planning tasks and users by considering context-specificities) is of great significance in promoting PSS's actual usefulness. The large-scale survey and empirical evidence acquired in this paper have provided valuable insights into realizing the full benefits of available PSS in smart cities. Future research could address these topics based on detailed case studies. Such a study helps discern context-aware determinants of the usefulness of PSS in specific smart city projects.

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Chapter 9

The Effects of Contextual Factors on PSS Usefulness: An International Questionnaire Survey

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Abstract: Contextual factors have been consistently argued as influencing the usefulness of planning support systems (PSS). Whereas previous studies were mostly conducted within a single planning project or based on experimental workshops, the present study looked at the application of PSS in smart city projects worldwide, and investigated the extent to which subjectively measured contextual factors contribute to PSS usefulness in smart cities. Based on a recent international questionnaire (268 respondents) designed to gather the perceptions of scholars and practitioners in the smart city realm, an ordinal regression model was fitted to assess the associations between the argued contextual factors and PSS usefulness. The results show that, in general, four contextual factors—namely the characteristics of the technology itself, user characteristics, characteristics of the planning process, and political context—have a significant influence on the usefulness of PSS, and that their impacts vary significantly. This paper emphasizes that only when PSS users can identify the critical contextual factors that are favorable and unfavorable, will the potential benefits of PSS for spatial planning be fully achieved.

9.1 Introduction

Recent years have seen a plethora of discussions and studies on how big data infrastructure, accrued through sensors, and associated information and communication technologies (ICTs) can help achieve sustainable development goals and improve the management of cities (Geertman and Stillwell, 2020; Pan et al., 2019; Thakuriah et al., 2017; Khan et al., 2015; Caragliu al. 2011). In planning, planning support systems (PSS) have been imagined and conceptualized to make use of big data and interactive interfaces to achieve smart goals (Babar and Arif, 2017; Deal et al., 2017a; Allwinkle and Cruickshank, 2011). Defined as geo-information technology-based instruments, PSS are dedicated to supporting those involved in planning in the performance of their specific planning tasks (Geertman, 2006, 2017). More recently, studies have shown that with the advent of urban sensing and ubiquitous computing, and the gradual standardization of embedded location information within administrative datasets on urban activities, the promise of a smart city has led to an exponential increase in data by several orders of magnitude (Geertman and Stillwell, 2020). Consequently, such enormous volumes of data, or big data, act as valuable input for PSS. By capturing, analyzing, and integrating this real-time and up-to-date data into various types of PSS, spatial analyses related to the realm of urban planning in the city (e.g., energy consumption, land use, traffic congestion, energy usage, and air quality) are improved substantially (Rathore et al., 2016; Khan et al., 2015). Besides, ICTs and big data can also be used to enhance PSS's capabilities for extending and transforming somewhat conventional citizens' participation practices, and for facilitating technology-facilitated communication and interplay between the formal political sphere (government) and the civil society sphere (citizens) (Jiang et al., 2019, 2020a; Khan et al., 2014). For instance, Pan et al. (2020) show that urban informatics augmented by new smart data enhance the sharing of information to the general public and make planning processes more participatory and democratic, especially for disadvantaged groups. Geertman and Stillwell (2020) indicate that web-based PSS enable more non-state actors (i.e., individuals and organizations that are not affiliated to the government, such as private sector entities, academic institutions, and non-governmental organizations) to build solutions that enable the delivery of content, services, and even applications over the HTTP protocol. Briefly, PSS enabled by smart ICTs help enhance reach and range by enabling information to be shared across different stakeholders and contribute to aspects of the planning process, including data collection and storage, data analysis and presentation, plan- and policy-making, interpersonal dialogue and debate, and policy implementation and administration (Jiang et al., 2020b; Pettit et al., 2018; Zhang et al., 2019; Thakuriah et al., 2017).

It should be noted, however, that in practice PSS have not fully achieved their potential, since their usefulness depends not only on the characteristics and capabilities of the tools themselves (Pan and Deal, 2020; Geertman, 2017; Russo et al., 2017; Pelzer, 2015). It has been widely accepted that PSS need to be enhanced to better align the instruments with user requirements and the planning tasks and problems at hand, since the specific situations or contexts in which PSS are embedded have a significant influence on how PSS work in actual planning practice (Champlin et al., 2019; Geertman, 2017; Geertman 2006). Here, context indicates the real circumstance or situation in which a PSS tool is embedded in planning practices. Empirical studies have demonstrated the influence of contextual factors on PSS usefulness. For instance, Pelzer (2017) found that existing organizational hierarchies, the timing of the policy process, and the users' characteristics (disciplinary background, existing habits, etc.) affect how the role of a PSS is perceived, implemented, and evaluated. Zhang et al. (2019) point out that digital literacy has prevented many ordinary people from engaging in web-based participatory planning. As Jiang et al. (2020c), Geertman (2017, 2006), and te Brömmelstroet (2010) argue, what can be achieved with a PSS, and the meaning of those achievements, largely depend on how the planning context is treated.

However, despite the importance of contextual factors in influencing PSS usefulness in practice, research on PSS has concentrated more on aspects of the tools than on understanding the interactions between the tools and the contexts in which they are used (McEvoy et al., 2019; Champlin et al., 2019). This shortcoming is well recognized in the field of PSS, which calls for tools to be studied in the "real world, context-rich environment" (te Brömmelstroet, 2013:306). Rather than taking a normative view, it embraces a more pragmatic attitude toward the role of ICT: To what extent can the implementation of ICT in planning become more effective and useful? (Deal et al., 2017b; Geertman, 2017). Consequently, research into the supportive role of PSS in the realm of smart cities has recently been advanced to embrace such a question: What kinds of ICT are, or should be, implemented by what kinds of stakeholders in which types of planning situations, contexts, or circumstances? (Russo et al., 2018; Pelzer et al., 2015; Biermann, 2011; Vonk, 2006). It has to be noted, however, that the significance of the proposed guidelines for improving PSS usefulness in practice is still limited by a lack of studies on theorizing the different contextual factors and their effects in practice.

Thus, the aim of this paper is to draw attention to the critical influence of contextual factors on the usefulness of PSS in smart cities. An ordinal regression model was applied to data gathered through an international questionnaire, to quantify the impact of the identified contextual factors on PSS usefulness. It should be noted that this study was an extension to the work by Geertman (2006), te Brömmelstroet (2013), and Pelzer (2017), who argue that further study could systematically analyze the effects of the contextual factors on PSS usefulness in practice. Based on this, Section 2 operationalizes the key terms describing earlier research and the various indicators related to the role of context in PSS usefulness. Section 3 introduces the methodology. Section 4 describes the main findings from the questionnaire. This is followed by a discussion in Section 5. The paper ends with a conclusion.

9.2 Context and PSS usefulness

The study by Pelzer et al. (2014) found that the added value of PSS is often conceived as the focal point, since the questions permeating these studies not only reveal the value of PSS, but also contribute to supporting planning in a better way. From a general technological viewpoint, Nielsen (1993: 24) conceptualizes the added value of a system as "usefulness," which indicates "the issue of whether the system can be used to achieve some desired goal." As te Brömmelstroet (2013) argues, the usefulness of PSS can be measured at both the process level and the outcome level. And Pelzer et al. (2014) highlight that an evaluation of the usefulness of a PSS tool should focus on at least three dimensions, namely individual, group, and outcome. Based on this, they identify seven major types of usefulness that a PSS tool can provide.

In practice, scholars and professionals have developed a wide variety of applications to support all kinds of planning actions, ranging from highly strategic to operational actions (te Brömmelstroet, 2013). However, what is remarkable about PSS is its long-standing implementation gap, that is, a discrepancy between supply and demand: Despite the availability of a growing number and variety of potentially valuable PSS instruments, planning practitioners are rather hesitant to buy, implement, or apply them (Geertman, 2006, 2017). To find the main bottlenecks to increasing the usefulness of PSS in planning practice, numerous authors have identified that the support role of PSS is closely related to the context in which a PSS is applied (Luque-Martín and Pfeffer, 2020; McEvoy et al., 2019; Zhang et al., 2019; Vonk and Geertman, 2008; Vonk et al., 2005; Geertman, 2006). According to Pelzer (2017), context influences both the extent to which a PSS is useful and the kind of usefulness that is achieved. For instance, at an early stage of a policy process, learning about the object might be the prime usefulness (cf. Brömmelstroet, 2010; Goodspeed, 2013), whereas at a later stage efficiency might be more important. In addition, different planning styles affect how the technological intelligence is organized and operates; for example, the ICT-enabled centralized planning process in which the entire set of intelligent devices is arranged hierarchically and steered into one center, versus ICT-facilitated participatory planning processes in which new technologies enable various stakeholders to participate in urban issues. As Luque-Martín and Pfeffer (2020) summarize, local context specifics are one of the main factors that define the PSS-based potential solutions. Geertman (2006) provides a comprehensive conceptual discussion on the different contextual factors. In his framework, six major contextual factors are argued to influence the potential roles of PSS in planning practice, namely characteristics of the technology, content of the planning issue, user characteristics, characteristics of the planning process, planning style, and political context (see Fig. 1). The present study applied and operationalized these six contextual factors to further examine the effects of contextual factors on PSS usefulness in practice.

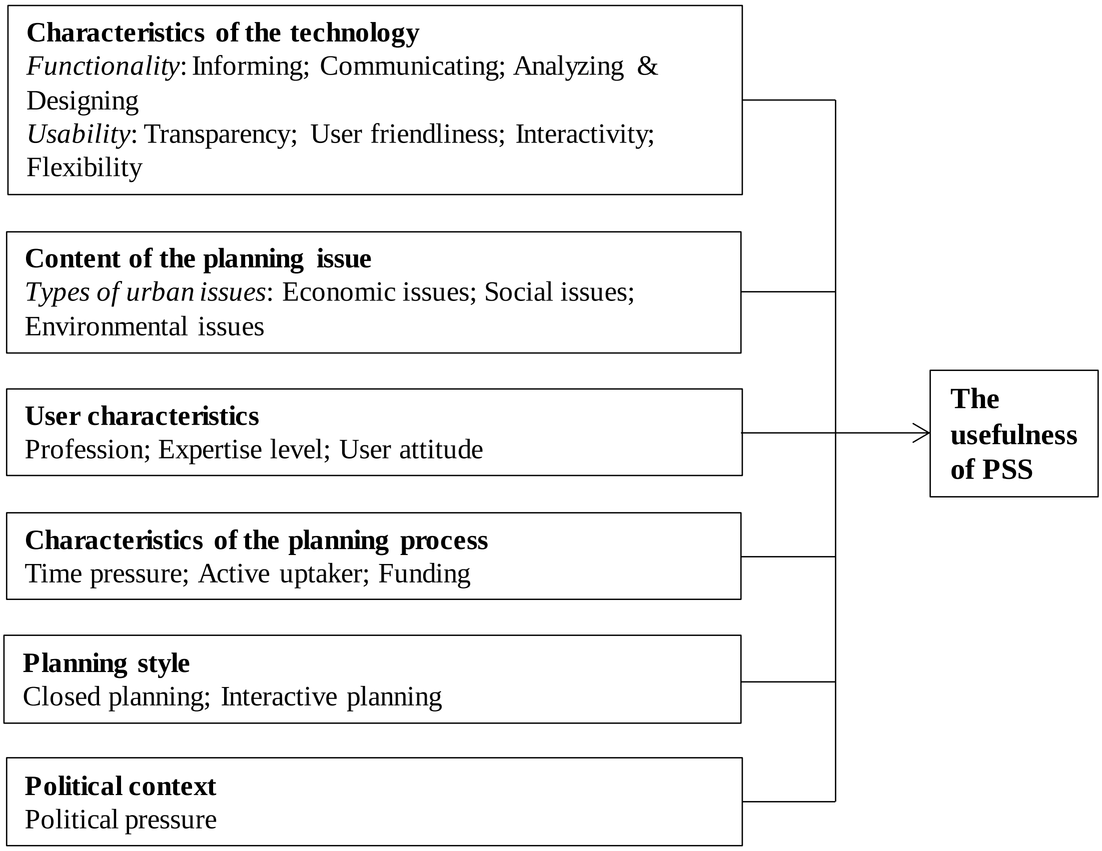

Fig. 1 Contextual factors influencing PSS usefulness (framework based on Geertman (2006: 867); the indicators describing each variable are explained in Section 2.1)

9.2.1 Contextual factors

Characteristics of the technology

Regarding the characteristics of the technology itself, Geertman (2006) argues that planning support tools are contextual in that the support role of PSS proves to be more evident in operational decision-making than at the level of strategic decision-making. From a technological innovation perspective, the technology itself as a contextual factor can be understood from two variables: functionality and usability. Functionality "is the question of whether [the information-handling capabilities] of the system in principle can do what is needed" (Nielsen, 1993:24). Since the planning tasks vary in different planning practices, a PSS tool in one specific project is unlikely to act in the same way in another project. Thus, an effective way to achieve planning support is to apply the information-handling capabilities of a PSS to support specific professional spatial-planning tasks (Luque-Martín and Pfeffer, 2020; McEvoy et al., 2019; Zhang et al., 2019). Several authors (e.g., Jiang et al., 2020a; Vonk, 2006) categorized these information-handling capabilities into three groups: informing, communicating, and analyzing & designing.

- Informing indicates the functional support for transferring information in one direction only.
- Communicating describes the functional support for facilitating communication and discussion between those involved in the governance process through supporting flows of information between them.
- Analyzing & designing indicates the functional support for examining spatial patterns of human behavior and facilitating the perception, production, and presentation of design ideas.

Usability refers to "how well users can use that [functionality]" (Nielsen, 1993:24). It indicates the goodness of fit between the capabilities of the user and the functionalities offered by the technology (Jiang et al., 2020a). In general, a high level of usability will lead to the more usefulness of a PSS. In literature, although a range of usability indicators have been identified (Pelzer, 2015), four key indicators are widely used to describe the usability of a PSS: transparency, user friendliness, interactivity, and flexibility (Pan and Deal, 2020; Champlin et al., 2019; te Brömmelstroet, 2017, 2012, 2010; Vonk et al., 2005).

- Transparency describes the extent to which the underlying models and variables of the PSS are visible to users.
- User friendliness is the extent to which participants are able to use the tool themselves.
- Interactivity refers to the extent to which the tool can directly respond to the users' questions and suggestions.
- Flexibility indicates the extent to which the tool can be applied to different planning tasks.

Together, these functionality and usability indicators delineate the specific characteristics of the technology (PSS) itself.

Content of the urban issue

According to Rittel and Webber (1984), a range of strategic, nonroutine planning issues can be said to be ill-structured or at best semi-structured. New PSS are primarily developed to provide new capabilities to gain insights into genuinely unique spatial issues.

However, it should be noted that many of the urban issues that PSS tools attempt to solve are typically ill-structured or ill-defined by nature (Klosterman, 1997; Cats-Baril and Huber, 1987). The consequence is that there is no clear procedural or predetermined way to solve a specific urban issue; instead, it requires diverse and innovative solutions. Because of this, the PSS—which usual promotes a false idea of value-free and objective knowledge of urban issues—exacerbates technocratic reductionism (Söderström et al., 2014) and masks those urban conflicts and issues that are not visible in the digital representations (e.g., congestion, unemployment, pollution, and diseases peculiar to the urban way of life) (Verrest and Pfeffer, 2019). Hence, to improve the appropriateness of dedicated PSS tools, it is vital to distinguish the different attributes of the urban issue. In this study, we applied the variable "types of urban issues" to operationalize the content of the urban issue. According to Campbell (1996), economic issues, social issues, and environmental issues are the three main types of urban issues.

User characteristics

User characteristics are contextual factors in that they are a useful source of information that helps designers to foster an understanding of target users and the product under development (Chesbrough, 2006; Geertman 2006). For each category of user, the demands and requirements regarding the content of the functionalities needed differ considerably. For instance, in the profession of planning practitioner, there is a significant difference between more design-oriented practitioners and research-oriented practitioners: The former need more functional support that can stimulate their imagination and lead to original and innovative ideas, whereas research-oriented practitioners are more concerned about how a PSS functionality can gather, store, analyze, model, and visualize data in a digital representation (Brail and Klosterman, 2001). As Geertman (2006: 868) argues, "professional protectionism plays a role of importance." In addition, attributes of users such as competency, skill, knowledge, qualification, and proficiency level also affect the performance of PSS in practice (Zhang et al., 2019; Pelzer, 2017; Holsapple et al., 2005). Without a doubt, an inexperienced newcomer (newbie) differs from a person who has comprehensive and authoritative knowledge or skill in terms of using PSS (expert) (Vonk et al., 2005). Finally, Vonk and Geertman (2008) argue that user attitude is also responsible for promoting the supportive role of PSS in their field. Users with a rational mindset and a positive attitude toward PSS will usually be early adopters and be more enthusiastic about PSS innovations and their added value. Therefore, a user-oriented approach in developing and implementing PSS requires a deeper understanding of user characteristics related to the expected and unexpected problems that users face when interacting with particular PSS tools. In this study, the three previously mentioned variables—profession, expertise level, and user attitude—were applied to operationalize the user characteristics.

Characteristics of the planning process

The characteristics of a planning process are the qualities or features that are regarded as inherent parts of a plan. For instance, plans are made for a period of, say, five, ten, or more years. Therefore, in composing a plan and getting it politically approved, PSS users may face time pressure or strict deadlines (Geertman, 2006; Vonk, 2006). Then, active uptakers are responsible for signaling promising supportive roles of PSS in their field and bringing these to the attention of other potential users (Vonk and Geertman, 2008). For instance, geo-information specialists have the important role of scanning the organization's external environment, signaling PSS developments, and evaluating their usefulness to the planning organization (Vonk, 2006). Besides, funding is also crucial for providing continuous support and maintenance of the PSS being used in practice (Ismail, 2008; Hutchison et al., 2006). Thus, three variables are used to describe the characteristics of the planning process: time pressure, active uptaker, and funding.

Planning style

A planning style is understood as the leading form of planning during a certain period of time (Pelzer, 2015). It represents time-bound normative opinions as to the way in which the planning job should be performed (Healey, 1997). However, it should be noted that the influence of planning style on PSS usefulness changes along with changes in time and place. For instance, the dominant rational comprehensive model in the 1960s led to the design and implementation of a range of large-scale computer-based systems (e.g., large-scale metropolitan land use, integrated municipal information systems, and urban transportation models) to solve some of the large and urgent urban issues (Chadwick, 1977). Thus, the usefulness of PSS at that time was mainly related to gaining insights into urban issues. Then, in the 1990s, PSS were used to facilitate interpersonal communication and community-based debates because of the rise of participatory and collaborative planning (Pelzer, 2015; Pettit, 2005). In the present study, planning styles were categorized as either "closed planning" or "interactive planning" (Jiang et al., 2020b; Healey, 1997).

- In closed planning, the government and its agent planner act as the prime stakeholders in the planning process.

- In interactive planning, also non-state actors—like citizens and the private sector—are important and involved in the planning process.

Political context

As a decision-making process, each planning process should be aware of the broader political context in which it is embedded (Jiang et al., 2019; Lin, 2018; Biermann, 2011). This context has specific mechanisms that influence how technology is organized in planning practice. For instance, in democratic Western countries, there is a general consensus that the increasing number of crowdsourcing platforms, social media, smartphones, portals, and planning support systems should be applied to facilitate e-participation, e-democracy, and wider collaboration for collective problem-solving (Geertman and Stillwell, 2020; Lin, 2018). In contrast, in some societies that are tightly controlled by the government, the use of innovative technologies in planning is more oriented toward improving the efficiency and effectiveness of the planning process, for example, to gain a better understanding of the urban issue and inform the public of the plan (Long et al., 2011). According to some authors, the influence of the political context can be described as "political pressure" (Stanilov, 2007), which reflects comprehensive persuasion by, the influence of, or even intimidation from members of the political planning systems.

9.2.2 PSS usefulness

As explained by Pelzer et al. (2014) and te Brömmelstroet (2013), the usefulness of PSS can be measured by different aspects or dimensions. However, it is worth mentioning that PSS usefulness is often demonstrated and asserted in PSS experimental case studies (Champlin et al., 2019; Pelzer et al., 2016; Pelzer, 2015). Results show that the benefits obtained in an experimental environment, to a large extent do not meet the actual needs of users and planning practices (Geertman, 2017; te Brömmelstroet, 2013; Vonk, 2006). Studies also tend to emphasize the importance of improving PSS functionalities and usability in optimizing PSS usefulness (Pan and Deal, 2020; Silva et al., 2017; Pelzer, 2017). Thus, there has been much argument that PSS validity and potential would benefit from being employed in a context-rich, real-world research scenario, as well as much lobbying for such employment (Jiang et al., 2020a, 2020c; Luque-Martín and Pfeffer, 2020; McEvoy et al., 2019; Zhang et al., 2019; Vonk and Geertman, 2008), since it would provide PSS with "a structure [to] constructively develop a coherent and comprehensive body of knowledge" (te Brömmelstroet, 2013: 306). In the present study, we conducted a survey to determine the multidimensional impact of contextual factors on the usefulness of PSS in smart city practices. Although PSS usefulness consists of different levels and dimensions, we applied the subjective perception of the overall satisfaction of the supportive role of PSS in practice—"overall usefulness"—to measure PSS usefulness (Jiang et al., 2020a).

9.3 Research Design

9.3.1 Data collection

In order to study the effects of contextual factors on the usefulness of PSS in smart cities, we used an international questionnaire to gather and consolidate in-depth data and information concerning the application of PSS in smart city practices and to track performance across 55 quantitative indicators. The questionnaire was distributed to approximately 1300 members of the Computers in Urban Planning and Urban Management (CUPUM) research community across a wide geographical area. The CUPUM community was selected for two reasons. First, CUPUM is a major international academic platform that offers a state-of-the-art overview of the availability and applications of PSS-based methods, tools, and techniques, and it provides valuable and meticulous insights into a diverse range of social and environmental issues in the context of smart cities, big data, and smart urban futures (Geertman et al., 2019). Second, the perspectives of scholars and practitioners reflect the empirical case of applying PSS in practice, which provides a highly professional overview of the influence of contextual factors on PSS usefulness in the context of smart cities. The questionnaire, which was delivered by regular and electronic mailing systems, was administered over a 3-month period (May–July 2019).

The questionnaire consisted of three main parts. The first part gathered the (anonymous) participants' basic information (e.g., gender, age, profession, origin, expertise with planning support ICTs), whereas the second part gathered in-depth information about their knowledge regarding the application of PSS in practical smart city projects. The respondents were specifically asked whether in recent years they had been academically and/or professionally involved in smart city projects. The follow-up questions chiefly assessed the performance level of five indicators—namely urban problems, functionalities, usability, added value, and context—perceived by researchers and PSS experts. The questions in the third part were related to specifics of the 2019 CUPUM conference and were not of relevance to this research.

Information about the influence of contextual factors on the usefulness of PSS in smart cities was obtained from the second part of the questionnaire. The development of the statements was based on previously recognized PSS literature. In order to effectively measure the strength of an individual's perception of the importance and attainment of contextual factors' roles, a 7-point rating system was used (1=low, 7=high). Respondents were not expected to respond to every statement.

9.3.2 Data processing

This study used only the 18 statements related to the indicators presented in Section 2 to analyze the effects of context on PSS usefulness. It should be noted that "overall usefulness" (measured on a scale from 0 to 100 in the questionnaire) was recategorized into ordinal scale (from 1 to 5) to fit the relationship between the effects of contextual factors and PSS usefulness. "Types of urban issues" was regrouped as "economic issues," "social–environmental issues," and "mixed urban issues." "Profession" was categorized as "academic researcher" and "practitioner." The "academic research" group included academic researchers/scholars and doctoral students, while the "practitioner" group consisted of designers, politicians, and planners. As mentioned, "planning style" was categorized as "closed planning" and "interactive planning." All other indicators were measured on a 7-point scale. The value assignment types for each indicator are shown in the second column of Table 9.1.

9.3.3 Statistical analysis

Of the approximately 1300 questionnaires that were distributed, 268 were completed (response rate of just over 20%). Of these, 175 were completed by respondents who had been involved in smart city projects in which the role of ICTs was significant, and we used their questionnaires in our analysis. In terms of geographical origin, more than half of the respondents were from China (53%); the other respondents were from Europe (15.4%), Asia (excluding China) (14.2%), North America (5.1%), South America (5.1%), Oceania (5.1%), and Africa (2.3%). Approximately 61.7% of the respondents were academic researchers/scholars (including doctoral students); the others (practitioners) were planners (32.6%), politicians (2.3%), or designers (3.4%).

Descriptive statistics were used to summarize the data (Table 9.1 and Appendix IV). Among all participants, the average score on “overall usefulness” was 2.90. Regarding “characteristics of the technology,” the average scores on “analyzing,” “designing,” and “transparency” are the top three indicators, whereas “communicating” had relatively lower scores (4.34). This indicates the different influences of the indicators of this variable. In terms of “characteristics of the urban issue,” the majority of the participants were involved in projects dealing with “mixed urban issues.” For the variable “user characteristics,” 61.7% of the participants were academic researchers, whereas 38.3% were practitioners, as mentioned. The average score on “expertise level” was much higher than the scores on “user attitude,” indicating the importance of “expertise level” in influencing PSS usefulness. Concerning “characteristics of the planning process,” the indicator “time pressure” received higher scores than “active uptaker” and “funding.” Further, 44.6% of the participants were engaged in “closed planning” and 55.4% in “interactive planning.” Finally, the average score on “political pressure” was 3.79, showing its relatively large influence.

Table 9.1 Variable measurement and descriptive statistics

		Descriptive Statistics				
Variables (indicators)	Measures	N	Minimum	Maximum	Mean	Std. Deviation
Overall usefulness	1=Low to 5=High	175	1	5	2.90	0.842
Characteristics of the technology itself						
Informing	1=Low to 7=High	152	1	7	4.78	1.452
Communicating	1=Low to 7=High	151	1	7	4.34	1.544
Analyzing	1=Low to 7=High	163	1	7	5.60	1.480
Designing	1=Low to 7=High	149	1	7	4.91	1.495
Transparency	1=Low to 7=High	172	1	7	5.05	1.352
User-friendliness	1=Low to 7=High	172	1	7	4.84	1.424
Interactivity	1=Low to 7=High	170	1	7	4.51	1.461
Flexibility	1=Low to 7=High	171	1	7	4.74	1.356
Characteristics of the urban issue	1=Economic 2=Non-economic 3=Mixed	174				
User characteristics						

Profession	1=Academic researcher 2=Practitioner	175				
User attitude	1=Low to 7=High	174	1	7	3.04	1.209
Expertise level	1=Low to 7=High	175	1	7	4.87	1.381
Characteristics of planning process						
Time pressure	1=Low to 7=High	166	1	7	3.20	1.526
Active uptaker	1=Low to 7=High	170	1	7	2.92	1.395
Funding	1=Low to 7=High	167	1	7	3.09	1.563
Planning style	1=State-led 2=Interactive	175				
Political context						
Political pressure	1=Low to 7=High	159	1	7	3.79	1.646

9.4 Results

9.4.1 Model fitting information

To determine whether the effects of the argued contextual factors are statistically significant, ordinal logistical regression was employed to determine their associations. Table 9.2 shows the strength of associations, the predicted ability of the model, and goodness-of-fit statistics. Regarding the overall model test of the null hypothesis, the results yield a significance level of 0.000. Thus, it can be concluded that this is an important test, because the change in the likelihood function has a chi-square distribution (Harrell Jr, 2015). The pseudo-R^2 statistics measures the success of the model in explaining the variations in the data, which is an indication of the strength of the association between the dependent (overall usefulness) and the independent variables (contextual factors). Since the results of Cox and Snell (0.878), Nagelkerke (0.955), and McFadden (0.834) are smaller than those for a linear model, the pseudo-R^2 can be regarded as very satisfactory (Harrell Jr, 2015). However, because the number of empty cells in the model is relatively large (there are 456 cells (80.0% of the total number) with zero frequencies), the goodness-of-fit measures of Pearson and Deviance are not reliable.

Table 9.2 Overall model-fitting information, strength of association, goodness-of-fit-statistics[a]

Model	-2 Log Likelihood	Chi-square	Df	Sig.
Intercept Only	287.267			

Final	47.660	239.608	86	0.000	
Pseudo R-square		Goodness-of-fit			
Statistics	Value	Statistics	Chi-square	df	Sig.
Cox & Snell	0.878				
Nagelkerke	0.955	Pearson	5614.123	366	0.000
McFadden	0.834	Deviance	97.872	366	1.000

[a] Link function: Logit.

9.4.2 Ordinal regression model to explain PSS usefulness

The detailed results of the calculations are summarized in Appendix V. All variables were simultaneously added to the model along with a statistically significant two-way interaction term. The test of the proportional odds assumption was non-significant for the two models, suggesting that effects were proportional across the categories of the outcome variables. The estimates indicate that several variables representing "characteristics of the technology," "user characteristics," "characteristics of the planning process," and "political context" have a strong influence on PSS usefulness. The variables that were determined as statistically significant are presented in Table 9.3.

Table 9.3 Parameter estimates determined as significant

	Estimate	Std. Error	Wald	df	Sig.
Overall usefulness					
[Overall usefulness = 1]	30.358*	12.029	6.369	1	0.012
[Overall usefulness = 2]	37.128*	12.362	9.02	1	0.003
[Overall usefulness = 3]	48.775*	14.839	10.804	1	0.001
[Overall usefulness = 4]	55.825*	15.66	12.708	1	0.000
Characteristics of the technology					
[Informing=2]	40.269*	12.256	10.796	1	0.001
[Communicating=4]	6.389*	2.828	5.102	1	0.024
[Communicating=5]	12.077*	3.704	10.628	1	0.001
[Analyzing=3]	-15.067*	6.2	5.905	1	0.015
[Analyzing=5]	-13.194*	4.212	9.812	1	0.002
[Designing=2]	-22.704*	7.975	8.106	1	0.004
[Designing=6]	-8.845*	2.878	9.447	1	0.002
[Transparency=1]	53.717*	17.164	9.795	1	0.002
[Transparency=3]	27.313*	7.692	12.609	1	0.000
[Transparency=4]	13.914*	4.724	8.674	1	0.003
[Transparency=5]	6.383*	2.887	4.887	1	0.027
[Transparency=6]	9.666*	3.176	9.265	1	0.002
[Flexibility=2]	-40.295*	12.131	11.034	1	0.001

[Flexibility=5]	-7.891*	3.117	6.41	1	0.011
User characteristics					
[User attitude=1]	58.024*	17.441	11.068	1	0.001
[User attitude=2]	53.214*	15.818	11.317	1	0.001
[User attitude=3]	54.049*	16.458	10.786	1	0.001
[User attitude=4]	50.919*	15.411	10.917	1	0.001
[User attitude=5]	40.465*	14.045	8.301	1	0.004
[User attitude=6]	30.699*	14.903	4.243	1	0.039
[Expertise level=2]	-20.539*	9.525	4.65	1	0.031
[Expertise level=3]	-7.152*	3.58	3.991	1	0.046
Characteristics of the planning process					
[Active uptaker=4]	14.842*	7.52	3.896	1	0.048
Planning style					
[Planning style=1]	-5.675*	1.842	9.495	1	0.002
Political context					
[Political pressure=2]	-19.442*	5.786	11.292	1	0.001
[Political pressure=3]	-23.22*	6.617	12.315	1	0.000
[Political pressure=4]	-24.007*	6.379	14.163	1	0.000
[Political pressure=5]	-22.787*	6.957	10.729	1	0.001
[Political pressure=6]	-22.288*	9.133	5.955	1	0.015

Sig. codes: * $p \leq 0.05$

In particular, the regression coefficient for overall usefulness has a positive value and the observed significance of the "overall usefulness" is satisfactory (all p-value≤ 0.05). The positive sign indicates that the influence of the contextual factors in general is positively related to the level of PSS usefulness. In other words, improvements in the positive effects and/or limitations on the negative impact of some contextual factors can increase the usefulness of PSS.

In terms of "characteristics of the technology," some indicators show a positive sign whereas others are negatively related to PSS usefulness. First, the estimates of "informing," "communicating," and "transparency" are positive, which means the better performance of these indicators in practice leads to a higher evaluation of PSS usefulness. However, the positive relationship between these indicators and PSS usefulness varies. For instance, the influence of "informing" is only significant at level 2, whereas the significance of "communicating" is determined at levels 5 and 6. This reflects that the higher score on "communicating" could contribute significantly to the increase in PSS usefulness. Finally, the influence of "transparency" is significant at all 6 levels, indicating that the extent to which the underlying models and variables of the PSS are visible to users is important for PSS usefulness.

Second, “analyzing,” “designing,” and “flexibility” show negative signs, which means that a high score on these functionalities leads to lower usefulness perception. In terms of “analyzing” and “designing,” the result might seem odd and contradict findings presented in literature. A plausible explanation is that the frequency of the use of “analyzing” and “designing” in practice is high; thus, even low scores on these functionalities could lead to a high evaluation of the overall usefulness of PSS. Regarding “flexibility,” it is understandable that tools that can handle different planning tasks often indicates low specialization. In other words, users prefer more specialized tools.

As regards the variable “user characteristics,” the estimates of the indicator “user attitude” have a positive sign, indicating that users with a high positive attitude toward using PSS are more likely to give PSS a higher score on usefulness in practice. The estimate of “expertise level” is negatively associated with PSS usefulness at levels 2 and 3, indicating that a high level of expertise could lead to low PSS usefulness. This seemingly odd result perhaps arose because the majority of the participants were academic researchers and practitioners with high levels of expertise; therefore, they could have been more critical about the supportive role of PSS tools and thus gave a low evaluation of PSS usefulness.

In terms of “characteristics of the planning process,” the positive estimate of “active uptaker” implies that active users have a positive influence on PSS usefulness. As Vonk and Geertman (2008) argue, active users act as a catalyst because of their demonstration effect; that is, they encourage other stakeholders to emulate their behaviors via observation of the actions.

The estimate of the variable “planner style” shows a negative sign and the relevant p-value is 0.002. This means that users in “closed planning” are more likely to give high scores to PSS usefulness. This can be understood from a reverse perspective, namely that closed planning processes are less influenced by those factors that appear in interactive planning, such as information overload, conflict of interest occurring when different actors oppose each other, and the difficulty of facilitating interpersonal communication and reaching consensus through PSS (Luque-Martín and Pfeffer, 2020; Pelzer, 2005; Vonk, 2006)

The estimate of “political pressure” shows a negative sign, indicating that political pressure has a strong negative influence on PSS usefulness. According to Cairney (2016), political pressure and intervention highly affect the cognition, perception, and actions of the stakeholders involved in the policy-making process. As for PSS users in planning practice, politically motivated external pressure has a significant influence on the emotional and physical condition of users and how PSS is implemented and performed.

Finally, it should be noted that a range of other contextual factors (e.g., “types of urban problems” in Appendix V) are not statistically significant, which means these indicators do not appear to be related to the level of PSS usefulness, at least for the current model and the study period.

9.5 Discussion

The results of the present study suggest an association between contextual factors and PSS usefulness, namely that, in general, “characteristics of the technology,” “user characteristics,” “characteristics of the planning process,” and “political context” have a significant influence on the usefulness of PSS, although their impacts vary significantly in practice. In particular, the indicators of “characteristics of the planning process” showed a positive sign, whereas the indicators of “political context” were found to be negatively associated with PSS usefulness. The indicators of “characteristics of the technology” and “user characteristics” showed both positive and negative associations with PSS usefulness. In addition, PSS usefulness can be better achieved in “closed planning.” Some of the results presented in this paper are in line with previous studies, while others are in contradiction with them.

First, the findings concerning the effects of usability indicators on PSS usefulness correspond with Pelzer’s argument that while “usability can be a necessary condition to achieve usefulness, it is never a sufficient condition” (Pelzer, 2017:94). For instance, some studies found that simple and transparent PSS applications were positively associated with PSS usefulness (Pan and Deal, 2020; Russo et al., 2018; Vonk and Ligtenberg, 2010). The results obtained in terms of the “transparency” indicator confirm their findings. Silva et al. (2017) surveyed a number of instrument developers and found that user-friendliness improvement may make a limited contribution to the successful implementation of accessibility concepts in planning practice. In the present study, the influence of “user friendliness” on PSS usefulness was not significant. However, it should be noted that in an experimental environment, user-friendliness is significant in terms of its influence on PSS usefulness (Pelzer, 2017). A possible explanation for this discrepancy is that the broader contextual factors considered in this study downplayed the significance of user-friendliness.

In terms of the functionality indicators, previous studies found that PSS that are able to facilitate social interaction, interpersonal communication, and community debate can empower professionals and citizens alike to have a better PSS experience and make better informed decisions (Zhang et al., 2019; Saad-Sulonen, 2012; Pelzer, 2015). Our findings indicate that the influence of "informing" and "communicating" functionalities is statistically positively associated with the overall evaluation of PSS usefulness, revealing its positive effects. Nevertheless, the findings concerning "analyzing" and "designing" functionalities contradict previous findings. For instance, Moghadam and Lombardi (2019), Vonk and Ligtenberg (2010), and Pettit (2005) found that analyzing and designing tools allows decision makers to systematically generate and evaluate alternative solutions, gaining insights that were introduced as inputs to help guide further analyses (e.g., GIS, Maptable, What-If and CommunityViz). However, the large-scale survey carried out for the present study showed that the significance of "analyzing" and "designing" functionalities is negative rather than positive. As mentioned, the high implementation frequency of these tools is a plausible reason for this.

Second, the findings in terms of the variable "user characteristics" correspond with those of earlier studies on how users define technological functions and their use. As Geertman and Stillwell (2004) argue, the user interface of a PSS should be sensitive to the characteristics of the user and to the kind of information that it communicates to that user. The findings of the present study confirm their argument that a high level of positive attitude toward using PSS would improve the awareness of the benefits of using PSS. This finding supports Vonk et al. (2006), who found that a low level of intention to use PSS among possible users reduces the potential expectation of PSS usefulness. Nevertheless, the results obtained concerning "user characteristics" also seem to contradict earlier results. For instance, Holsapple et al. (2005) and Hoc et al. (2013) show that higher educated users have greater user satisfaction due to their ability to learn and to develop a high level of expertise. However, the findings presented in this paper show that this relationship could be negatively associated, since experts with a high level of expertise tend to have a fault-finding attitude. As mentioned, they are often more critical of the performance of PSS tools in practice.

Third, the negative influence of "active uptaker" shows that in order to improve awareness of the existence and potential of PSS, more effort should be made to demonstrate to users the benefits of applying the diversity of PSS (Geertman and Vonk, 2008). Only such an effort will increase the awareness of PSS, making the PSS message more likely to be picked up and appreciated by employees of planning organizations (Vonk et al., 2005).

Fourth, it is interesting that “closed planning” seems to be more beneficial for optimizing the supportive role of PSS. Although few previous studies have compared the performance of PSS in these two distinctive planning styles (Vonk and Ligtenberg, 2010; Pelzer et al., 2015), an inverse perspective can be used to explain this finding. For example, in ICT-facilitated interactive planning, PSS are more vulnerable to externalities and a range of side effects or consequences.

Fifth, the significant negative influence of “political context” on PSS usefulness confirms the claims by some authors that a broad field of politics impacts the likelihood that actors in the process will absorb new PSS knowledge, and that they will be able to use this knowledge to assess problems and find solutions. For instance, Zhang et al. (2019) identified that in the earlier divergence period, the top-down government-led approach in China often limited the usefulness of web-based PSS in eliciting ideas from independent citizens and supporting participation and engagement. And te Brömmelstroet (2015) shows that in the later convergence period, power relations and hierarchical structures affected the group dynamics and how PSS perform.

Finally, we hypothesized that “characteristics of the urban issue” have a significant influence on PSS usefulness. Some studies highlight that the attributes of the urban issue help judge the appropriateness of the supportive role (Jiang et al., 2020c; Pelzer et al., 2015; Vonk and Ligtenberg, 2010), and thus their importance should be given more attention. However, the estimate of the indicator “types of urban problems” was not found to be as significant due to the broader multiple and multidimensional aspects of context impact.

The present study had some limitations. Because of our selection procedure, the opinions and attitudes of civil society were not considered. According to some authors, however, ideas and knowledge from civil society can effectively promote the advancement of PSS (Geertman and Stillwell, 2020; Zhang et al., 2019; Pelzer, 2015). It should be noted that although the usefulness of PSS is comprised of different dimensions, in this study we considered only the overall evaluation of PSS usefulness. The importance of these different kinds of usefulness of PSS was acknowledged in another article by Jiang et al. (2020a). Thirdly, it should be noted that not all the functionality and usability indicators were discussed in this paper due to the semantic overlap between some concepts (e.g., communicative support capabilities as part of functionality, and communicative value as a usability indicator) (Pelzer, 2017).

9.6 Conclusion

Studies on PSS usefulness pay much attention to developing a conceptual and empirical understanding of the relation between planning tasks and PSS (i.e., task–technology fit) and the interaction between the user and a PSS (i.e., human–computer interaction) (Pan and Deal, 2020; Jiang et al., 2020a; Russo et al., 2018; Silva et al., 2017; Pelzer, 2017; Pelzer et al., 2014; te Brömmelstroet, 2012). As a consequence, there is a lack of empirical evidence concerning the importance of the multidimensional aspects of contextual factors in analyzing the development, implementation, and effects of PSS in planning practice. In the present study, we comprehensively examined the extent to which contextual factors influence PSS usefulness via an international questionnaire survey. This paper contributes empirically to insights that "the way in which [PSS] are handled within a specific planning situation will enhance their potential for performing a more effective planning-supportive role (Geertman, 2006: 878)." While this study did not provide evidence that all contextual factors are associated with PSS usefulness, our results suggest that some contextual factors (i.e., "characteristics of the technology," "user characteristics," "characteristics of the planning process," and "political context") indeed have differentiated effects on the usefulness of PSS. The results of our study expand the knowledge of the complex relations between contextual factors and PSS usefulness in the realm of smart cities. Base on this, we emphasize that only when PSS users can identify the critical contextual factors that are favorable and unfavorable, will the potential benefits of PSS for spatial planning be fully achieved.

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Chapter 10

Conclusion

Abstract: This dissertation conceptualized and presented an empirical investigation of smart urban governance. Empirical smart city cases were used to illustrate how smart urban governance works in practice. A planning support perspective provided guidelines on the role of ICT in smartening urban governance, which were verified by questionnaire data and expert interviews. The underlying argument is that the mentioned perspectives on urban governance, smart governance, and planning support ICT can learn from each other to arrive at smart urban governance and provide insights into how ICT can be developed and implemented to smarten urban governance in the realm of smart cities. This chapter first summarizes the main findings presented in each of the previous chapters in order to answer the eight research questions. This is followed by a reflection on the theoretical framework. Based on this reflection, policy implications are outlined and recommendations for future research are made.

10.1 Findings

Chapter 1 presented two key research objectives, namely to conceptualize smart urban governance and investigate the role that ICT can play in smart urban governance. In this section, the main findings with respect to the three groups of questions that were investigated in Chapters 2–9, respectively, are summarized. The first group of questions revolve around how smart urban governance can be conceptualized. The second group concentrate on what insights planning support perspectives can provide into the role of ICT in smartening urban governance. The third group focus on what the role ICT should be in smartening urban governance from evidence-based perspectives.

Part I: Smart urban governance: theory and practice

Chapter 2: *How can smart urban governance be conceptualized in the realm of smart cities?*

By conducting an intensive literature review, the framework for smart urban governance presented in this dissertation comprises the sociospatial context of urban challenges associated with smart cities, three interlinked components (institutions, technology, and urban space) and four sustainability-oriented purposes (economic, political, ecological, and cultural purposes) (see Figure 10.1). The internal logic of this model suggests four potential relations. First, there is a potential relation between the sociospatial context and smart urban governance. Second, the potential effect of the sociospatial context on smart urban governance arrangements relies on the interaction between technology, institution, and urban space. Third, smart urban governance arrangements are intended to realize desired purposes (economic, political, ecological, and cultural purposes). Fourth, there is a feedback effect of smart urban governance purposes (or outcomes) on the sociospatial context. Taken together, the framework for smart urban governance integrates the "smart" from smart governance literature and the "urban" from urban governance literature, as a means to "smarten" urban governance as well as draw attention to the importance of urban dynamics in shaping it.

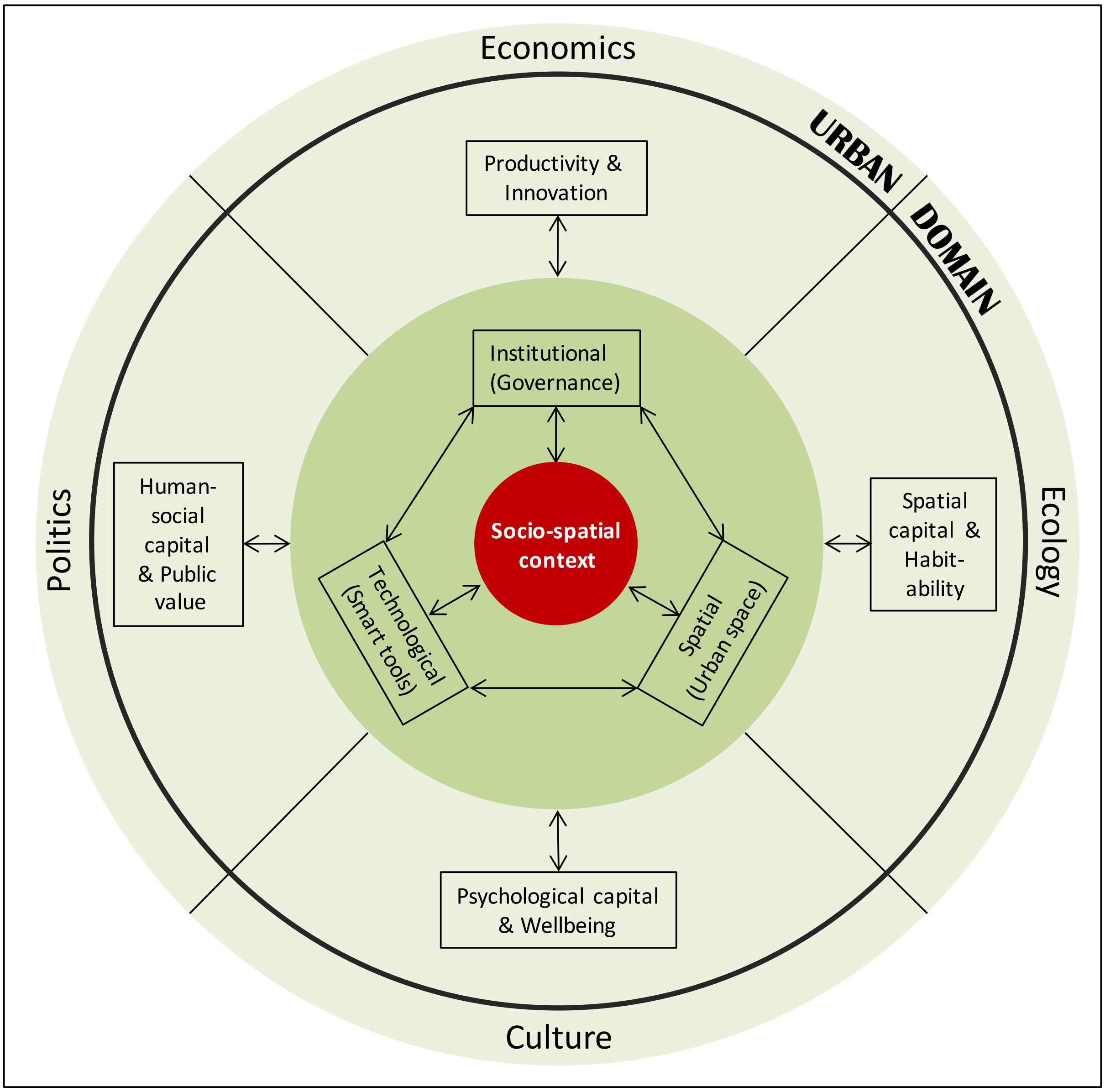

Figure 10.1 Conceptual framework for smart urban governance (adopted from Chapter 2)

The framework highlights the importance of the urban (i.e., as a set of social relationships) in shaping the usage of ICT and the structure of smart urban governance. It “follows the identification of what the urban problem is and how the people … would want to frame and address and actively respond to that problem” (McFarlane and Söderström, 2017:313). Then, smart urban governance as “a complex process of institutional change” is acknowledged. In the conceptualization of smart urban governance, the participation and collaboration of different stakeholders is acknowledged as contributing to achieving sustainable outcomes, such as a circular economy, sustainable transport, recycling, social equality, and the smallest possible ecological footprint. According to Webster and Leleux (2018), citizen participation can provide facts, information, skills, inputs, feedback, and reactions to the governance process and directly contribute to the formulation and coproduction of policy content. In addition, the role of technology is framed to handle the urban issue and support the governance process. Finally, the smart urban governance analysis and interventions are argued to pay more attention to the impact of sociospatial contexts. In doing so, smart urban governance goes beyond ICT-driven governance approaches and facilitates “a context-dependent contribution of ICT-enabled citizen-government collaboration to urban sustainability” (Tomor et al., 2019).

Chapter 3: *How can the components of a smart urban governance approach and their interactions be conceptualized from a sociotechnical approach?*

Based on Chapter 2, Chapter 3 further zoomed in on the three intertwined key components (i.e., the spatial, institutional, and technological components) of smart urban governance shown in Figure 10.1. A more in-depth analysis of the components of smart urban governance showed that the spatial component is concerned with handling urban challenges in terms of economic, social, and environmental issues (i.e., the sustainability triangle); the institutional component involves institutional modes of governance in terms of the steering and coordination of the three mentioned types of actors (i.e., government, market, and civil society—the “governance triangle”); and the technological component is concerned with technological intelligence and includes three types of information-handling capabilities, namely informing, communicating, and analyzing & designing (i.e., the “technology triangle”) (see Figure 10.2). Taken together, the resulting refined smart urban governance framework conceptualizes its constituting components and interactions within the sociospatial context. The analysis of an international questionnaire survey showed the applicability of the smart urban governance framework in more smart city cases and wider contexts. Two real-world cases (Singapore Smart Nation and Helsinki

Smart City) were introduced to illustrate the detailed working mechanisms of this framework.

The results form a critical response to the ongoing smart city debate. They show that large ICT and technology companies like IBM, Cisco, Alibaba, and Huawei see this smartness as a great opportunity to boost innovation in technology and increase their market competitiveness and interests. The development of smart governance is primarily driven by technologies and government policies. In this refined framework, smart urban governance solutions begin with the urban issue rather than being preoccupied with a prime focus on technology—the so-called technocratic approach to smartness. It stresses the "place-based, experiential and very often neglected" knowledge generated through the wishes, demands, requirements, conditions, and facts of ordinary lives to handle substantive urban challenges (McFarlane and Söderström, 2017). For smart urban governance to be effective, it requires the close and mutual attunement of the particular spatial, institutional, and technological components and promotes a sociotechnical approach to governing cities.

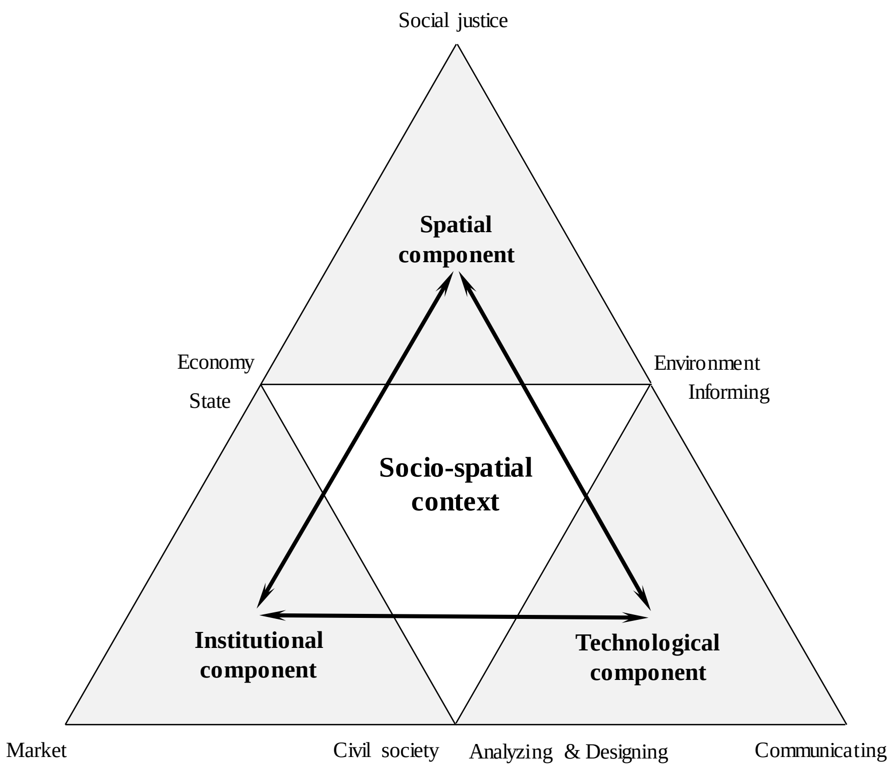

Figure 10.2 Smart urban governance framework (adopted from Chapter 3)

Chapter 4: *How does the urban context influence the conceptualization of and the sociotechnical interaction between the components of smart urban governance?*

The smart urban governance frameworks presented in Chapters 2 and 3 argue for the importance of context in smart city governance and planning (Geertman, 2006; McEvoy et al., 2019; Champlin et al., 2019; Meijer, 2016). Chapter 4 paid further attention to the specific role of context in developing smart urban governance. Special emphasis was put on the impacts of urban contexts on the sociotechnical interaction between urban technological innovations and urban governance. By presenting three real-world cases (Smart Ulaanbaatar Program, Mongolia; Hangzhou City Brain Project, China; and Amsterdam Smart City, the Netherlands), our analyses show that the urban contexts in different cities indeed have a distinct influence on the sociotechnical interaction of components in the framework and produce different smart urban governance modes. More specifically, in the Smart Ulaanbaatar Program, the severity of the urban challenges combined with Mongolia's weak technological basis prompted it to build partnerships with foreign tech companies. As a result, the adoption and use of privately controlled technological innovations are the Ulaanbaatar government's contribution to the governance of smart cities. In the Hangzhou City Brain Project, the top-down political institutional setting, the problem of heavy traffic congestion, and the city's technological strength produced a government-led triple helix model of urban technological innovation for governing the traffic issue. However, in this process, citizens and their concerns were largely excluded from the project. Finally, in Amsterdam, the vulnerable ecological system, the long tradition of democratic systems, high internet literacy, and strong awareness of civic engagement have given rise to various open and collaborative platforms for different urban actors to participate in the governance processes and contribute their knowledge to shape urban technological innovation and the urban spatial environment.

As Zhou (2017) asserts, since governance needs continuous exchange of materials and energy with the environment, thus it is the surroundings or conditions in which a typical governance apporoach operates impact the structures of that governance approach. Following this, the sociospatial context constitutes the precondition of smart urban governance developments. The results presented in this chapter show that this context not only influences the arrangement and outcome of smart urban governance, but also shapes the role of ICT in smartening urban governance in smart cities. Due to the fact that cities follow different development trajectories and are in distinct growing stages, it is necessary to analyze the creation and implementation of smart governance by considering context-specificities. For instance, cities with pressing environmental problems should use ICTs to both understand the nature of the environmental problems and increase citizens' awareness of environmental protection. Doing so helps to improve the suitability and applicability of intended governance approaches in practice.

In brief, Part I presented a framework for smart urban governance and examined the interconnected components and their interactions. In addition, the fact that contextual factors play a role in analyzing the development, implementation, and effects of smart urban governance was identified.

Part II: Planning support perspectives on the role of ICT in smartening urban governance

Chapter 5: *What can we learn from the evolving perceptions of planning and ICT-enabled planning support to improve the role of ICT in governing and planning cities?*

By conducting a genealogical investigation of planning thoughts and associated ideas on ICT supports over the past 70 years, which was further cross-checked by expert interviews, this chapter identified three main findings: 1) Challenges in the urban context influence the perceptions of planning (i.e., planning complexity and planning rationality) and ultimately affect the choice of ICT support functions and the way ICT is applied; 2) there is a trend toward transforming the current expert-led ICT innovation into more user-oriented, demand-induced ICT developments in order to offer high-quality ICT that can meet the factual needs of users and planning practices; and 3) context has been receiving increased attention because of its influential role in the effective integration of ICT into planning practice.

The results correspond with the argument made by Klosterman (1997) that the evolving perceptions of planning determine the role ICT can play in planning and that more effort should be made to investigate the changing views on planning in practice. In different places and different planning periods, unique planning tasks may require specific planning support tools to satisfy the demands of the places and the period. For instance, according to the so-called rational comprehensive model, functionalities that can support the analysis, design, simulation, and modeling of urban problems are needed. And according to communicative planning, the functionalities of a technology facilitate social interaction and communication and help to achieve collective goals. For different users, the user-friendliness, flexibility, and transparency of technological functionalities influence their assessment of the applicability of these tools. For a factual planning support role, we should thus consider planning support as a sociotechnical innovation of transformation shaped through contingent and changing challenges in urban contexts.

Chapter 6: *What can smart urban governance learn from efforts in spatial planning practice to overcome the PSS implementation gap?*

This chapter linked the smart governance debate with research on PSS implementation in practice and examined what the further development of smart governance can learn from the experiences in the PSS debates. Two particular lessons were distilled: 1) For technology to be of added value to practice, it should be attuned to the wishes and capabilities of the intended users and to the specifics of the tasks to be accomplished, given the particularities of the context in which the technology is applied; and 2) overcoming the PSS implementation gap reveals that knowledge of the context specificities is of great importance and will also be of importance to the smart governance developments.

The lessons learned indicate that urban issues as perceived, identified, acknowledged, and accepted by local people should be taken more seriously, since they provide the place-based, contextualized knowledge for dealing with these urban issues. The interested stakeholders should be more actively engaged in the processes of smart governance and more prominently articulate their role in identifying the goals, purposes, themes, and objectives that they intend to achieve. In addition, in terms of ICT innovation in smart urban governance, the lessons learned imply that the development of ICT is a process of collaborative efforts and societal support. Although the technology-driven, systematic engineering approach is recognized for its comparative advantage in designing and developing technologies, it lacks the strength to implement them. In particular, a lack of instrumental quality, low usability, and the low applicability and flexibility of the use create a discrepancy between the supply of and the demand for ICT. The results of this chapter are expected to shift the emphasis from today's technology-focused, supply-driven governance development, to a sociotechnical and demand-driven smart urban governance development.

In brief, a planning support view indicates that ICT should be closely attuned to the wishes and capabilities of the intended users and to the specifics of the tasks to be accomplished, given context specificities; that is, a sociotechnical, demand-driven approach to ICT innovation is needed in smart urban governance. Based on this, the third part focused on the performance of ICT in smartening urban governance in practice.

Part III: Evidence-based perspectives on the role of ICT in smartening urban governance

Chapter 7: *How can ICT add value in smartening urban governance?*

This chapter provided evidence-based guidelines on how ICT can be used to smarten urban governance. Three main findings arose from an analysis of an international questionnaire (268 respondents) and expert interviews (12 experts). First, the added value of ICT tools is best illustrated by tools that possess analytical functionalities to tackle transportation and mobility problems (e.g., urban data analytics for transportation), whereas some communicating and designing ICT functionalities are less used (e.g., ICT-enabled collaborations). Second, greater interaction between ICT functionalities, urban problems, and governance processes results in the higher added value of these functionalities, and vice versa (e.g., high added value of analytical functionalities in handling transportation and mobility problems). Third, contextual factors (i.e., user characteristics and the content of governance issues) have a significant influence on the process of transforming technological functionalities into added value.

The results presented in this chapter first reflect the importance of analyzing tools in handling transportation and mobility problems. According to Vella-Brodrick and Stanley (2013), the difficulties associated with applying ICT to deal with transportation and mobility issues are due to the complexity of these issues and the fact that transportation planners have a long history of using modelling and analysis to facilitate their work. Tools with analyzing functionalities are the tools most commonly used by practitioners to facilitate the advanced processing of data and information and to understand the nature of the urban problems they are trying to solve; as a result, their added value in practice is often high. To improve ICT's capabilities in supporting urban governance, this means that we should "learn from the more successful application of transport engineering analytical tools and see whether they are applicable to the less successful spatial planning [tools]" (Geertman, 2017:75). In addition, the study also confirmed that the main bottlenecks—such as users' skills and knowledge and the content of governance issues—block the actual usefulness of ICT in smartening urban governance in practice. If any action were to be taken, it would undoubtedly help remove the obstructions and improve the capabilities of ICT in smartening urban governance. These differentiated strategies would benefit not only the stakeholders or users involved in this process, but also the whole field of ICT applications in city governance.

Chapter 8: *What are important success and failure factors determining the usefulness of PSS in the realm of smart cities?*

Chapter 7 showed that ICT can be transformed into added value in smartening urban governance; however, many factors influence the performance of ICT in practice. Chapter 8 further examined the determinants of PSS usefulness in the realm of smart cities. Here, the usefulness of PSS refers to the positive influence a PSS can have on practice (Pelzer, 2015), which is explained by two main factors, namely utility and usability, that taken together constitute the notion of usefulness. “Utility is the question of whether the functionality of the system in principle can do what is needed” (Nielsen, 1993:24) and usability is “how well users can use that [utility] functionality” (Nielsen, 1993:24). The questionnaire data led to three findings. First, utility (explained by 10 indicators) constituted the primary reason for the success of PSS usefulness in practice, which means the extent to which the functionality of a PSS can handle a planning task is crucial for PSS usefulness. Second, context (explained by 11 indicators) primarily acted as a failure factor for PSS usefulness, which indicates its negative impact on the performance of PSS in practice. Third, usability (explained by 7 indicators) was identified as a necessary but not sufficient factor to achieve PSS usefulness.

According to Pelzer (2017) and Vonk (2006), the support capabilities of a PSS are expected to accomplish particular functions or purposes. In planning practice, a PSS provides the fundamental support to facilitate information modelling for projection, simulation, and evaluation (e.g., analyzing tools) and facilitates the flow of planning-related information between different stakeholders (e.g., communicating tools). The results presented in this chapter confirm the observation that whether the capabilities of a PSS can support the planning tasks is decisive to the actual usefulness of a PSS. The results also support studies that found that usability was necessary but not sufficient. For instance, Pelzer (2017) states that the importance of usability in planning practices differs from one issue to another, while Te Brömmelstroet (2017) reports that the high user-friendliness of a PSS cannot ensure a high added value of that PSS; that is, it cannot be guarantee that a more user-friendly PSS will be useful in practice.

Finally, although this chapter showed that contextual factors acted primarily as a failure factor for PSS usefulness, it should be noted that the results were obtained by averaging the scores. In Chapter 9, the quantitative study of the relation between contextual factors and PSS usefulness revealed that context can also play a positive role and act as a success factor for PSS usefulness. Based on the discussions, we highlight that PSS developments in the future should: 1) Be more responsive to the relation between planning tasks and PSS (i.e., task–technology fit) and the interaction between the user and a PSS (i.e., human–computer interaction); and 2) be more sensitive to the potential effects of the various contextual factors, as shown in this chapter, on PSS usefulness.

Chapter 9: *What are important contextual factors influencing the usefulness of PSS in practice?*

In smart cities, the specific situations or contexts in which PSS are embedded have consistently been argued to have a significant influence on how PSS work in actual planning practice (McEvoy et al., 2019; Champlin et al., 2019; Geertman, 2017). This chapter drew attention to the critical importance of contextual factors on the usefulness of PSS in smart cities. It showed that, in general, four contextual factors—namely the characteristics of the technology, user characteristics, the characteristics of the planning process, and the political context—have a significant influence on the usefulness of PSS, but their impacts vary significantly. In particular, the indicator "characteristics of the planning process" (i.e., active uptaker) showed a positive sign, whereas the indicator "political context" (i.e., political pressure) was found to be negatively associated with PSS usefulness. The indicators "characteristics of the technology" and "user characteristics" showed both positive and negative associations with PSS usefulness. Some of the results presented in this paper are in line with previous studies, while others contradict the claims made in these studies.

The importance of the characteristics of the technology itself is easy to understand, since the functionality (utility) and usability of a PSS significantly determine its actual performance in practice (Pelzer, 2015, 2017). The importance of user characteristics shows that it is not only a useful source of information that helps designers to develop a PSS, but also influences how a PSS tool performs (e.g., the influence of users' attitude, competency, skills, knowledge, qualifications, and proficiency). This chapter also showed that the overall usefulness is negatively related to interactive planning. One possible explanation for this is that the usefulness of a PSS in interactive planning is more influenced by external elements, such as information overload, conflict of interest, and the difficulty in facilitating interpersonal dialogue. In addition, the influence of political pressure confirms the political nature of PSS applications (Vonk and Geertman, 2008). Finally, as outlined in previous chapters, it may well be that "characteristics of the urban issue" would have a significant influence on PSS usefulness. However, in this chapter, the estimate of the indicator "types of urban problems" was not found to be as significant.

This shows that the broader multiple and multidimensional aspects of context impact (i.e., user, institution, and technology) weaken the role of the urban problem/issue in shaping PSS usefulness.

According to Geertman (2006), "the way in which PSS are handled within a specific planning situation will enhance their potential for performing a more effective planning-supportive role." In accordance with this, this chapter highlights that only when PSS users identify the critical contextual factors that are favorable and unfavorable will the potential benefits of PSS for spatial planning be fully achieved.

Answering the main research question

Having summarized the answers to the eight sub-questions, the main research question can be answered.

How can smart urban governance be conceptualized and what role can ICT play in smart urban governance?

Although the answer to the main research question has many nuances, the focus here is on the key elements that are relevant to the conceptualization of smart urban governance and the role of ICT in smartening it.

First, from a conceptual point of view, the meaning of smart urban governance is conceptualized from three dimensions: purposes, components, and contexts. It integrates the "urban" from urban governance with the "smart" from smart governance and strives to create a context-focused, sociotechnical governance approach to coordinate and steer the objectives, actors, and artifacts, namely urban challenges, institutional modes of governance, and technological intelligence. From a practical point of view, this dissertation emphasizes the importance of sociospatial contexts (e.g., historical, political, cultural, political, and technological contexts) in analyzing the development, implementation, and effects of smart urban governance. In summary, smart urban governance is conceptualized as a context-focused, sociotechnical way of governing cities in the "smart" era.

Second, planning support perspectives show that the best way for ICT to smarten urban governance is to connect ICT more directly to the needs of users and governance practices, and to pay more attention to the influence of contextual factors. Evidence-based perspectives have verified that the fit of task-technology and user-technology and contextual factors indeed has a significant influence on the usefulness of ICT in smartening urban governance. Based on this, we advocate sociotechnical approaches to ICT innovation in smartening urban governance.

10.2 Theoretical reflection

This section reflects on the smart urban governance framework and the role of ICT in smartening urban governance.

Start with the urban

Although ICT constitutes an important factor, the importance of the "urban" in conceptualizing and developing smart urban governance is acknowledged. The present smart governance debate has been criticized for over-relying on technocratic solutions for standardized problems. As shown in the literature, technocratic smart governance believes in the realization of governing cities through data and the data-driven production of knowledge. In this process, urban problems are often framed as technological problems to be addressed by technological solutions (León and Rosen, 2020). Due to the failure to consider the broader urban setting, ICT-enhanced smart governance can hardly make a response to the political disputes and debates about what the real-world urban problems are and the appropriate solutions and desired effects.

According to Lefebvre (1991), the urban issue can be described as a cluster of associated social relations (e.g., subjectivity and space; politics and public space; social difference and spatial divisions; gentrification and urban renewal; and experience and everyday practice in the city) that are constructed and shaped by groups of people (see also Tonkiss, 2005). It goes beyond its geographical and physical elements or features to reflect the "rich, complex and indeterminate dynamics of "cityness" (Pieterse, 2013). This reminds stakeholders or actors that urban processes are always interlinked and intertwined, and that urban governance mechanisms ought to be perceived and comprehended as compound, synthesized actions. Besides, due to the fact that growing urban issues such as poor air quality, traffic congestion, increasing urban density and social inequality are produced and lived by ordinary people, it is highly recommended to connect the governance response to the urban setting and to include arguments, controversies and discussions that will possibly shape the policy content.

In this dissertation, the conceptualization of smart urban governance was used to explore urban social processes of smart governance innovation. Such governance integrates technology into the urban setting and facilitates an interactive relation between the urban dynamics and technology-facilitated governance (the interaction between the three key components, i.e., spatial, institutional and technological components). It implies that the smartness of smart urban governance is not just derived from its power to implement and reconfigure technology, but also relies heavily on its ability to respond to the changing urban settings and create new sets of social relations. It responds to critical studies on smart city and smart governance that posit that alternatives to the present governance of smart cities should conduct "a solid epistemological and ontological understanding of the urban … and be more aware of how urban problems and their proposed smart solution are socially constructed" (Verrest and Pfeffer, 2019).

Promote demand-driven smart governance

Smart governance is mostly driven by governmental policy on technological implementation and application, with a limited focus on what smart and innovative governance structures are. However, it has been argued that cities are shaped and created through different types of stakeholders with distinct interests, benefits, and demands. Accordingly, the place-based knowledge produced by the demands, requirements and pursuits of local residents is vital for creating smart solutions. In terms of governance innovation, this indicates that actors offering knowledge for smart governance processes should be included. For instance, in handling non-routine, strategic urban issues, collaborative efforts between state, market, and citizens should be made to produce knowledge to be able to handle ill-structured or semi-structured issues (Rittel and Webber, 1984). However, in tackling community-based issues—such as inadequate emergency services, a lack of jobs, a lack of affordable housing, poverty, crime, and environmental contamination—the role of citizens in processes of public decision-making is argued to be more vital (Beard, 2019). This means that smart solutions should start not with the technology itself, but with the knowledge generated through the needs and demands of place-based residents. It is worth noting that smart urban governance focuses on the potential of the contextualized actors and their dedication and commitment to stimulating a demand-driven "smart" governance. In this process, grounded knowledge and relevant place-based smart solutions are expected to be produced. This helps to preclude the technology-driven, corporate-led vision of smartness that smart solutions are just a collection of digital, often real-time or near real-time, data, ubiquitous computing data analytics, networked and integrated technologies, and control systems (Kitchin, 2014).

Facilitate sociotechnical ICT development and implementation

Planning perspectives on the role of ICT in smartening urban governance highlight a sociotechnical approach to ICT development and application. As shown in the literature, critical voices censure neoliberal, corporate-led, top-down ICT innovations for promoting the interests of big tech-companies (Hollands, 2008, 2015). Based on the traditional systems engineering approach, technology developers assume that there exists one impartial, unbiased, and optimal technical system with optimized functionality and performance (Vonk and Ligtenberg, 2010). However, this approach seriously neglects the political and social features of technological innovation. It also neglects the fact that new technologies need to be incorporated into urban social processes and structures to make them work (Cels et al., 2012). Technological solutions are increasingly designed, produced, and implemented in close cooperation with organizations for scientific research and groups of ordinary residents (Chesbrough, 2006). I therefore argue that ICT development in smart urban governance is a social construction process that takes place through stakeholders' engagement and collective efforts. This implies that a sociotechnical approach to technological innovation is needed. Here, "the socio-technical approach starts from the constructivist assumption that an optimal system is only optimal for a particular situation, and that the optimum is always the outcome of the sharing of views and knowledge of people in a social process" (Vonk and Ligtenberg, 2010: 167). As for smart urban governance, the strategic way to develop and implement ICT in smartening urban governance in smart cities is to closely connect functionalities in order to tackle the urban issue (e.g., analyze data and information to understand the nature and patterns of concerned urban issues) and support the governance process (e.g., support flows of policy-related data and information between different stakeholders). In other words, "it requires to understand why smart technologies become to be seen as the best solutions for the constructed problems" (Verrest and Pfeffer, 2019: 1338). Such understanding acknowledges the critical engagement with the rationale and the target groups in shaping the innovation of smart technologies and smart solutions. It helps to preclude the type of technocratic governance that leads city governments to depend on provided varieties of digital devices and the related software, ICT-based services, platforms, networking and apps, and technological lock-ins.

Be aware of the requirements and/or restraints related to contextual factors

The framework of smart urban governance and the role of ICT in smartening urban governance both pay attention to the needs, requests and /or restrains related to the context.

“Context factors” refer to the conditions and environments in which smart urban governance is embedded and implemented. For smart urban governance development, contextual factors shape the interaction of its components and the ultimate governance structure. In terms of the potential of ICT in smartening urban governance, contextual factors influence how the capabilities of ICT are and/or can be used to support the governance process and tackle urban problems. However, it is worth noting that many current smart governance policies and interventions rely or are based on “best practices” (e.g., Tianjin Eco-city, Hangzhou City Brain, Songdo Ubiquitous City). As a result, many contextual factors such as the urban problem, political system, economic level, cultural preference, and technological development are hardly conceptualized to explain the success or failure of certain smart initiatives.

In this dissertation, the analysis of the multiple smart city cases showed that contextual factors play an important role in influencing the choices both within each component (e.g., which governance mode is most appropriate?) and in their interaction, resulting in distinct forms of smart urban governance and different outcomes. For instance, in Chapter 4, it was shown that the weak technological basis and low digital literacy rate in Mongolia oblige the Ulaanbaatar government to focus on the acceptance and use of privately controlled technologies to digitalize Ulaanbaatar’s infrastructure. However, urgent problems—such as a lack of infrastructure, insufficient housing, limited public transport, overwhelming traffic, and poor urban services generated by the mass immigration of nomadic people into Ulaanbaatar—were hardly solved. Another example is the influence of contextual factors on the usefulness of ICT in smartening urban governance. As shown in Chapter 9, the characteristics of the technology, user characteristics, the characteristics of the planning process, and the political context all have a significant influence on the usefulness of PSS. Thus, identifying the critical contextual factors that are favorable and unfavorable will help in realizing the full potential benefits of PSS for spatial planning. Based on this, this dissertation fully acknowledges the importance of contextual factors in understanding the emergence, development, implementation, and effects of smart urban governance. Such acknowledgement moves smart urban governance away from a simple technology-based policy intervention, toward a more compound and contextualized comprehension of how interactions of the urban issues, urban actors, and urban technologies generate smart solutions and what their impacts are on contemporary urban life and urban settings.

10.3 Policy implications

A key insight stemming from this research is that smart urban governance is useful and smart only when the role of ICT in smartening urban governance is closely attuned to the real needs of users and governance practices, and when the importance of context in analyzing its development, implementation, and effects is explicitly acknowledged.

Based on this insight, one policy implication is that practice should focus more on the interplay between the components of smart urban governance and see how technology can play a better role in smartening urban governance. Technocratic smart governance largely separates the role of technology from the other two components, which leads to the situation whereby the exponential growth of ICT is driving today's governance change. However, the resulting governance structure may not be capable of handling the proposed technology or dealing in a proper way with the urban issue at hand. As mentioned, the smartness of smart urban governance refers to the ability of its components' interactions to increase our understanding of and capacity to deal with urban challenges, to enhance stakeholders' capabilities for collaboration, and to improve the usefulness of technology, aimed at achieving smart city developments. Therefore, more emphasis on the interaction between the components of smart urban governance in practice will help us to better understand the role technology could best play in smart urban governance.

Another policy implication is that existing policy/governmental structures should be flexible enough to change along with technological innovations. Although this dissertation took a critical view on the technology-driven solutions for various urban problems, it does not mean that we should exclude technology. In fact, the interaction of components of smart urban governance indicates that for smart urban governance to be effective, a mutual shaping process of technology and governance structures in the light of the urban issue at stake is needed. Therefore, if new technological innovations are expected to better smarten urban governance and contribute to better problem-solving, we need to explore the best governance institutions suitable for the implementation of these technologies (e.g., recruit specialist professionals and train current staff, have the right technical skills, and reform organizational cultures and structures).

Finally, there is a need for more real-practice implementation of technology in close collaboration with the urban issue at hand and the attuned governance approach. At present, the development of ICTs is largely controlled by tech companies and dominated by the systems engineering approach; as a result, technology-driven, experimental smart city projects prevail. However, many authors contend that the design, development, and implementation of technological innovations should pay more attention to the concerned urban issues, especially social issues such as overcrowding, unemployment, housing problems, slums, degraded environmental quality, sanitation problems, water shortages, health hazards, disposal of trash, transportation problems, and urban crime. In addition, the implementation of technology should support users' need for debate, interpersonal communication, participation, collective design, etc. In doing so, ICT can be better implemented and better integrated into the urban governance process and create new governance mechanisms for developing smart cities.

10.4 Recommendations for future research

One recommendation is that more real-world empirical research should be performed to examine the role of ICT in smartening urban governance. For instance, the role of ICT in "the small-scale and fledgling examples of participatory and citizen-based types of smart initiatives" could be examined (Hollands, 2015:61). Using community-based, user-oriented, and place-driven smart initiatives would help us to understand how ICT facilitates the role of citizens and service users and contributes to the place-based analysis and interventions in the creation of smart plans and policies. An evaluation of multi-jurisdictional smart-city projects could be performed to understand the opportunities and potential pitfalls of ICT in creating innovative governance structures and handling city–regional issues.

Another recommendation is that it is preferable to compare a larger number of real-world cases in distinct sociospatial contexts that could empirically demonstrate the influence of contextual factors on sociotechnical ways of governing cities in the smart era. Doing so would help us to understand the influence of the urban context on the sociotechnical interaction between the components of smart urban governance.

In addition, studies on smart urban governance could also focus more on a city's multidimensional issues. The present study treated the city as a whole and highlighted how different models can be used to achieve smart governance. However, the urban issues involved and the potential solutions required are far more complicated, thus more specific views could be studied, especially in fields such as unemployment, social inequality, overcrowding, environment, living, housing, and government. Only when such studies have been completed will we obtain a full understanding of the meaning and added value of smart urban governance. In addition, we could learn from the successful cases.

Finally, studies could test the smart urban governance framework in a quantitative way. Chapter 3 showed that the interaction between the three intertwined components of smart urban governance can produce diverse types of smart urban governance modes. Therefore, it would be interesting to see the extent to which these modes in general can produce higher added value and contribute to a better handling of urgent urban issues. To do so, we could design and implement a series of questions to gather, sample, analyze, and interpret data from stakeholders involved in different real-world smart city projects and compare the results in a statistical way. Another option is to make an inventory of smart city practices worldwide and subject this to a systematic quantitative analysis.

In closing, this dissertation addressed smart urban governance from two main angles, namely conceptualizing smart urban governance and investigating the role ICT can play in smart urban governance. The present research responded well to the argument in international literature that there is need for alternatives to policy-driven, corporate-led, technocratic smart governance and traditional urban governance in the realm of smart cities. Based on this, the main recommendation is that practitioners should use smart urban governance to tackle the most pressing urban issues by starting with the urban issue at stake, promoting demand-pulled governance modes, and shaping technological intelligence more socially and in close accordance with the urban and the governance component. Accepting this ideology of smart urban governance does not mean, however, that the value of smart urban governance can actually be realized. It is worth noting that context plays a decisive role in the development, application, and effects of smart urban governance. Therefore, further empirical studies should test the added value of smart urban governance in distinct urban contexts. As such, a context-based, sociotechnical way of governing cities (smart urban governance) is promoted in the smart era to achieve more urban social justice and sustainability.

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Summary

Over the past decade, cities, planners, developers, and governments around the world have embraced the concept of the "smart city"—which is predominantly composed of big data (accrued through sensors) and associated information and communication technologies (ICTs)—as a way to help achieve sustainable development goals and improve the management of cities (see Young et al., 2020; Kitchin, 2014, 2019; Benevolo et al., 2016; Meijer, 2016; Batty et al., 2012; Caragliu et al., 2011). It is said that by connecting a wide range of electronic and digital technologies to government systems, communities, and city operations, a smart city can bring together technology, government, and society to realize urban sustainability in the following forms: smart people, smart governance, smart economy, smart living, smart mobility, and smart environment (Giffinger et al., 2007; Anthopoulos, 2017; Caragliu et al., 2011). According to many scholars, building a smart city requires "smart" governance approaches, including new government structures, new relationships, and new processes (Webster and Leleux, 2018; Meijer, 2016; Testoni and Boeri, 2015). Here, smart governance can be generally understood as the capacity to apply digital technologies and intelligent activities in the processing of information and in decision-making and creating innovative institutional arrangements (Scholl and Alawadhi, 2016; Meijer, 2016). It requires reshaping the role of governments, citizens, and other social actors, innovating organizational and decision-making processes, and improving the use of existing and emerging information technologies to conceptualize and frame a new generation of e-participation (Kleinhans et al., 2015; Sandoval-Almazan and Gil-Garcia, 2014; Gil-Garcia, 2012; Sandoval-Almazan and Gil-Garcia, 2012).

The earlier work on ICT-enabled city governance in the realm of smart cities was made in the field of smart governance, which advocates employing new technologies to develop innovative governance arrangements (Meijer and Bolívar, 2016). In practice, however, neither the development nor the advancement of smart governance is satisfactory. The implementation of smart governance in practice is mainly characterized by a corporate-led, technocratic way of governing cities. In this process, governments treat the smart governance of cities as a management issue that can be addressed through technological and technocratic approaches. In that, the design, development, implementation, and evaluation of technologies in augmenting governance processes are mainly delivered by high-tech companies. As a result, many artificial intelligence and data analytics tools are simply used to update the current physical infrastructure (e.g., power grids, transportation networks, sewerage and waste disposal systems, the built environment, surveillance equipment, and other physical assets) and support private interests and a strong economic development (Kitchin, 2019; Datta, 2015; Shelton et al., 2015; Söderström et al., 2014). This raises the question how a transformative smart governance of cities can be conceptualized and developed and what role ICT should play in the transformative smart governance of cities.

More recent studies show that the long experience of planning support ICT studies in handling technological innovations is able to offer potential insights into the innovative development and application of new ICTs in the field of the smart city and its subfield of smart governance (Geertman and Stillwell, 2020; Pettit et al., 2018). The key statement is that planning support systems (PSS) innovations and applications in urban planning should be closely related to the needs of users and planning practices. Then, authors from urban studies claim that there is a need to link smart city governance to the "urban issue," since knowledge cannot be simply gained through data-mining and ICT-based urban analytics (Verrest and Pfeffer, 2019; McFarlane and Söderström, 2017; Stratigea et al., 2015). Referring to Lefebvre (1991), the urban issue is produced by urban social processes which indicates a set of social relationships. For urban governance to become smart, the development of functionalities, applications, and ICTs in augmenting urban governance should be closely linked to urban issues (e.g., political, social, cultural, historical, and spatial issues) and support a smart urban governance in the service of local communities and ordinary people, rather than a small group of highly skilled experts (Allam, 2018). According to Meijer and Bolívar (2016), we should analyze the complex interactions between technology and social structure and conceptualize smart urban governance as an emergent sociotechnical practice.

To respond to this, I argue that the mentioned perspectives can learn from each other to arrive at smart urban governance. Unlike previous technocratic smart governance approaches in public administration, this dissertation highlights that urban space and its unveiled problems and potentials constitute an inseparable part of smart urban governance. For a planning-support ICT perspective, it means that more specific emphasis should be put on how ICT can be developed and implemented to smarten urban governance in the realm of smart cities. However, at a conceptual level, we still lack such a potentially valuable framework for smart urban governance, let alone the actual operability of such an approach. Because of this limitation, this dissertation specifically focuses on how smart urban governance approach can be conceptualized and what role ICT could play in such governance.

It is argued in Chapter 2 that the multiple perspectives on the governance of smart cities can learn from each other to arrive at new transformative smart governance approaches. By conducting an intensive literature review, the framework for smart urban governance presented in this dissertation comprises the sociospatial context of urban challenges associated with smart cities, three interlinked components (institutions, technology, and urban space) and four sustainability-oriented purposes (economic, political, social, ecological, and cultural purposes). The framework highlights the importance of the urban (i.e., as a set of social relationships) in shaping the usage of ICT and and in particular the interplay between these three components.Then, the participation and collaboration of different stakeholders is acknowledged in the framework as contributing to achieving sustainable outcomes. Besides, the smart urban governance analysis and interventions are argued to pay more attention to the impact of sociospatial contexts. Taken together, by combining the "smart" from smart governance literature and the "urban" from urban governance literature, we propose an urban planning view on smart governance—labelled as smart urban governance—as a way to "smarten" urban governance and to draw attention to the importance of urban dynamics in shaping smart governance.

Chapter 3 zooms in on the interrelated components (i.e., spatial component, institutional component and technological component) of smart urban governance and focuses on their interaction within the sociospatial context. Two sources of data – an international questionnaire survey and two real-world smart city projects – were used to show the applicability of the framework in practice. The questionnaire survey on the wider inventory of smart city projects reveals that smart urban governance varies remarkably worldwide—as urban issues differ in distinct contexts, the governance modes and relevant ICT functionalities being applied also differ considerably. The two-case analysis indicates that a focus on substantive urban challenges helps to define the appropriate modes of governance and develop dedicated technologies that can contribute to the successful solution of specific smart city challenges in practice. It is worth mentioning that the analyses of both cases highlight the importance of the specific context (cultural, political, economic, etc.) in analyzing the interactions between the components within their specific context. In this, smart urban governance promotes a context-focused, socio-technical way of governing cities in the 'smart' era by starting with the urban issue at stake, promoting demand-driven governance modes, and shaping technological intelligence more socially, given the context-specificities.

Chapter 4 examines the importance of sociospatial contexts in analyzing the development, implementation and effects of smart urban governance. Special emphasis was put on the impacts of urban contexts on the sociotechnical interaction between urban technological innovations and urban governance. According to Zhou (2017), a typical governance approach must exchange resources with its environment, since it is the environment that constrains, shapes, or forms the structures of that governance approach. Following this, the sociospatial context constitutes the precondition of smart urban governance developments. The results presented in this chapter show that this context not only influences the arrangement and outcome of smart urban governance, but also shapes the role of ICT in smartening urban governance in smart cities. As cities in different societies are in different developmental stages and transitions, it is recommended to identify approaches to sociotechnical governance that suit their own contexts.

Critical studies on the governance of smart cities show that the potential of ICT in augmenting the planning process and dealing with the planning issues in the realm of smart cities is significantly restricted by structural factors (e.g., a technology-driven governance approach, over-reliance on corporate power, and a systems engineering approach to developing technology). Thus, the second part of this dissertation (Chapters 5 and 6) takes a planning support perspective on how the role of ICT in smartening urban governance can be better achieved. In the research underlying this dissertation, we conducted a genealogical investigation of planning thoughts and the associated ICT support over the past 70 years, cross-checked by expert interviews, in order to provide an up-to-date view on the development of PSS in smart cities in Chapter 5. The results obtained correspond with the argument made by Klosterman (1997) that the evolving perceptions of planning determine the role ICT can play in planning and that more effort should be made to investigate the changing views on planning in practice. In different places and different planning periods, unique planning tasks may require specific planning support tools to satisfy the demands of the places and the period. For a factual planning support role, we should thus consider planning support as a sociotechnical innovation of transformation shaped through contingent and changing challenges in urban contexts.

In Chapter 6, we then explored both the academic field of smart governance and the debates on the PSS implementation gap, and identified efforts in spatial planning practice to overcome that gap. The lessons learned indicate that urban issues as perceived, identified, acknowledged, and accepted by local people should be taken more seriously, since they provide the place-based, contextualized knowledge for dealing with these urban issues. Then, the interested stakeholders should be more actively engaged in the processes of smart governance and more prominently articulate their role in identifying the goals, purposes, themes, and objectives that they intend to achieve. In addition, in terms of ICT innovation in smart urban governance, the lessons learned imply that the development of ICT is a process of collaborative efforts and societal support. The results of this chapter indicate that a sociotechnical, demand-driven approach to ICT innovation is needed in smart urban governance.

The third part of this dissertation provides evidence-based perspectives on the usefulness of ICTs in smartening urban governance (Chapters 7–9). Based on an international questionnaire (268 respondents) and expert interviews (12 experts), Chapter 7 explores how ICT can be transformed into added value in smartening urban governance. The key argument is that ICT functions should be incorporated into urban problems and governance processes to produce perceived added value. The results presented in this chapter first reflect the importance of analyzing tools in handling transportation and mobility problems. To improve ICT's capabilities in supporting urban governance, this means that we should "learn from the more successful application of transport engineering analytical tools and see whether they are applicable to the less successful spatial planning [tools]" (Geertman, 2017:75). In addition, the study also confirmed that the main bottlenecks—such as users' technical skills and the urban issue itself—block the actual usefulness of ICT in smartening urban governance in practice. Thus, being more aware of these contextual factors would undoubtedly improve the capabilities of ICT in smartening urban governance. These differentiated strategies would benefit not only the stakeholders or users involved in this process, but also the whole field of ICT applications in city governance.

Chapter 8 further examined the determinants of PSS usefulness in the realm of smart cities. The results presented in this chapter confirm the observation that whether the capabilities of a PSS can support the planning tasks is decisive to the actual usefulness of a PSS. Then, the results support studies that found that usability was necessary but not sufficient. Besides, this chapter also shows that contextual factors acted primarily as a failure factor for PSS usefulness. Based on the discussions, we highlight that PSS developments in the future should: 1) Be more responsive to the relation between planning tasks and PSS (i.e., task–technology fit) and the interaction between the user and a PSS (i.e., human–computer interaction); and 2) be more sensitive to the potential effects of the various contextual factors, as shown in this chapter, on PSS usefulness.

Chapter 9 drew attention to the critical importance of contextual factors on the usefulness of PSS in smart cities. It showed that, in general, four contextual factors—namely the characteristics of the technology, user characteristics, the characteristics of the planning process, and the political context—have a significant influence on the usefulness of PSS, but their impacts vary significantly. In particular, the indicator "characteristics of the planning process" (i.e., active uptaker) showed a positive sign, whereas the indicator "political context" (i.e., political pressure) was found to be negatively associated with PSS usefulness. The indicators "characteristics of the technology" and "user characteristics" showed both positive and negative associations with PSS usefulness. Some of the results presented in this paper are in line with previous studies, while others contradict the claims made in these studies. For instance, some studies highlight that the attributes of the urban issue help judge the appropriateness of the supportive role (Pelzer et al., 2015; Vonk and Ligtenberg, 2010), and thus their importance should be given more attention. However, the estimate of the indicator "types of urban problems" was not found to be as significant due to the broader multiple and multidimensional aspects of the context impact.

The conceptualization of smart urban governance responds to arguments that alternatives to corporate-led, technocratic smart governance should have "a solid epistemological and ontological understanding of the urban … and be more aware of how urban problems and their proposed smart solution are socially constructed" (Verrest and Pfeffer, 2019). It explores the role of the situated agents and their contribution to promoting a demand-driven smart governance. It also highlights a sociotechnical approach to ICT development and implementation. In other words, it is necessary to understand why smart technologies are designed, developed, and implemented as an appropriate answer to the perceived and constructed problems. Finally, smart urban governance highlights the importance of contextual factors for finding solutions to urban challenges.

To enhance the development of smart urban governance, we propose recommendations for practice:

1) Focus more on the interplay between the components of smart urban governance and see how technology can play a better role in smartening urban governance; This will increase our understanding of and capacity to deal with urban challenges, to enhance stakeholders' capabilities for collaboration, and to improve the usefulness of technology, aimed at achieving smart city developments.

2) Be more aware that existing policy/governmental structures should be flexible enough to change along with technological innovations. In fact, the interaction of components of

smart urban governance indicates that for smart urban governance to become effective, a mutual shaping process of technology and governance structures in the light of the urban issue at stake is needed.

3) Pay attention to more real-practice implementation of technology in close collaboration with the urban issue at hand and the attuned governance approach. In doing so, ICT can be better implemented and better integrated into the urban governance process and create new governance mechanisms for developing smart cities.

We also recommend further research on smart urban governance:

1) Perform more real-world empirical research to examine the role of ICT in smartening urban governance; An evaluation of multi-jurisdictional smart-city projects will help understand the opportunities and potential pitfalls of ICT in creating innovative governance structures and handling city–regional issues.

2) Compare a larger number of real-world cases in distinct sociospatial contexts, as this could empirically demonstrate the influence of contextual factors on sociotechnical ways of governing cities in the smart era;

3) Focus more on a city's multidimensional issues (e.g., unemployment, social inequality, overcrowding, environment, living, housing, and government). Only when such studies have been completed will we obtain a full understanding of the meaning and added value of smart urban governance.

4) Test the smart urban governance framework in a quantitative way. It would be interesting to see the extent to which these modes in general can produce higher added value and contribute to a better handling of urgent urban issues

The above recommendations will promote a context-based, sociotechnical way of governing cities—smart urban governance—in the smart era to achieve urban sustainability.

Samenvatting

In het afgelopen decennium hebben steden, planners, ontwikkelaars en overheden over de hele wereld het concept van de 'slimme stad' omarmd. Dit concept bestaat voornamelijk uit big data (verzameld via sensoren) en bijbehorende informatie- en communicatietechnologieën (ICT's) - als een slimme manier om duurzame ontwikkelingsdoelen te helpen bereiken en het beheer van steden te verbeteren (Young et al., 2020; Kitchin, 2014, 2019; Benevolo et al., 2016; Meijer, 2016; Batty et al., 2012; Caragliu et al., 2011). Door een breed scala aan elektronische en digitale technologieën te verbinden met overheidssystemen, leefgemeenschappen en het functioneren van een stad, kan een slimme stad technologie, overheid en samenleving samenbrengen om stedelijke duurzaamheid te realiseren (Giffinger et al., 2007; Anthopoulos, 2017; Caragliu et al., 2011). Volgens veel wetenschappers vereist het bouwen van een slimme stad 'slimme' bestuursbenaderingen, waaronder nieuwe overheidsstructuren, nieuwe relaties en nieuwe processen (Webster & Leleux, 2018; Meijer, 2016; Testoni & Boeri, 2015). Hier kan slim bestuur worden gezien als het vermogen om digitale technologieën en intelligente activiteiten toe te passen bij de verwerking van informatie en bij besluitvorming en het creëren van innovatieve regels en werkwijzen (Scholl & Alawadhi, 2016; Meijer, 2016). Het vereist een hervorming van de rol van overheden, burgers en andere sociale actoren, het innoveren van organisatorische en besluitvormingsprocessen en het verbeteren van het gebruik van bestaande en opkomende informatietechnologieën om een nieuwe generatie van e-participatie te conceptualiseren en vorm te geven (Kleinhans et al., 2015; Sandoval-Almazan & Gil-Garcia, 2014; Gil-Garcia, 2012; Sandoval-Almazan & Gil-Garcia, 2012).

Het eerdere wetenschappelijke werk op dit gebied ging voornamelijk in op slim bestuur, dat pleit voor het gebruik van nieuwe technologieën om innovatieve bestuursregelingen te ontwikkelen(Meijer & Bolívar, 2016). In de praktijk is echter de ontwikkeling van ‘smart governance’ onbevredigend. De implementatie van smart governance wordt voornamelijk gekenmerkt door een door bedrijven geleide, technocratische manier om steden te besturen. In dit proces behandelen overheden het slimme bestuur van steden als een beheerskwestie die kan worden aangepakt door middel van technologische en technocratische benaderingen. Vervolgens worden het ontwerp, de ontwikkeling, de implementatie en de evaluatie van technologieën bij het verbeteren van governance processen voornamelijk geleverd door hightechbedrijven. Als gevolg hiervan worden veel hulpmiddelen voor kunstmatige intelligentie en gegevensanalyse eenvoudigweg gebruikt om de huidige fysieke infrastructuur bij te werken (bijv. elektriciteitsnetten, transportnetwerken, riolering en afvalverwijderingssystemen, de gebouwde omgeving en andere fysieke activa) en om bedrijfsbelangen en een sterke economische ontwikkeling (Kitchin, 2019; Datta, 2015; Shelton et al., 2015; Söderström et al., 2014). Dit roept de vraag op hoe een transformatief slim bestuur van steden kan worden geconceptualiseerd en ontwikkeld en welke rol ICT zou moeten spelen in het transformatieve slimme bestuur van steden.

Meer recente studies tonen aan dat de lange ervaring met het plannen van ICT-studies bij het omgaan met technologische innovaties potentiële inzichten kan bieden in de innovatieve ontwikkeling en toepassing van nieuwe ICT's op het gebied van de slimme stad en – meer specifiek - haar slimme bestuur (Geertman & Stillwell, 2020; Pettit et al., 2018). De belangrijkste verklaring is dat innovaties en toepassingen van planningsondersteunende systemen (Planning Support Systems; PSS) in stedelijke planning nauw moeten worden gerelateerd aan de behoeften van gebruikers en planningspraktijken. Vervolgens is het nodig om slim stadsbestuur te koppelen aan de 'stedelijke kwestie', aangezien kennis niet eenvoudigweg kan worden verkregen door middel van datamining en op ICT gebaseerde stedelijke analyse (Verrest & Pfeffer, 2019; McFarlane & Söderström, 2017; Stratigea et al., 2015). In overeenstemming met Lefebvre (1991) wordt deze stedelijke kwestie opgevat als een reeks sociale relaties, dat wil zeggen, de sociale productie van stedelijke ruimte. Wil stedelijk bestuur slim worden, dan moet de ontwikkeling van functionaliteiten, toepassingen en ICT ter versterking van stedelijk bestuur nauw verband houden met stedelijke kwesties (bijvoorbeeld politieke, sociale, culturele, historische en ruimtelijke kwesties) en een slim stedelijk bestuur ondersteunen in de dienstverlening aan lokale gemeenschappen en gewone mensen, in plaats van aan een kleine groep hoogopgeleide experts (Allam, 2018). Volgens Meijer en Bolívar (2016) moeten we de complexe interacties tussen technologie en sociale structuur analyseren en zodoende slimme stedelijke samenwerking conceptualiseren als een opkomende socio-technische benadering en toepassing.

Om hierop in te spelen, beargumenteer ik dat de genoemde perspectieven van elkaar kunnen leren om te komen tot slimme stedelijke samenwerking; i.e. ‘smart urban governance’. In tegenstelling tot eerdere technocratische benaderingen van slim bestuur, benadrukt dit proefschrift dat de stedelijke ruimte en zijn onthulde problemen en mogelijkheden een onlosmakelijk onderdeel vormen van slim stedelijk bestuur. Voor een planningsondersteunend ICT-perspectief betekent dit dat er meer specifieke nadruk moet worden gelegd op de manier waarop ICT kan worden ontwikkeld en geïmplementeerd om het stedelijk bestuur slimmer te maken. Op conceptueel niveau ontbreekt het ons echter nog steeds aan een potentieel waardevol kader voor slimme stedelijke samenwerking, laat staan aan de daadwerkelijke bruikbaarheid van een dergelijke benadering. Vanwege deze beperking richt dit proefschrift zich specifiek op hoe de genoemde ‘smart urban governance’-benadering kan worden geconceptualiseerd en welke rol ICT zou kunnen spelen in dergelijk bestuur.

In hoofdstuk 2 wordt beargumenteerd dat de verschillende perspectieven op het bestuur van slimme steden van elkaar kunnen leren om tot nieuwe transformatieve benaderingen van slim bestuur te komen. Door een intensieve literatuurstudie uit te voeren, omvat het raamwerk voor slim stedelijk bestuur dat in dit proefschrift wordt gepresenteerd de sociaal-ruimtelijke context van stedelijke uitdagingen die verband houden met slimme steden, drie onderling verbonden componenten (instituties, technologie en stedelijke ruimte) en vier op duurzaamheid gerichte doelen (economisch, sociaal, politieke, ecologische en culturele doeleinden). Het raamwerk benadrukt het belang van de stad (d.w.z. als een reeks sociale relaties) bij het vormgeven van het gebruik van ICT en de structuur van slim stedelijk bestuur. Vervolgens wordt de deelname en samenwerking van verschillende belanghebbenden in dit kader erkend als een bijdrage aan het bereiken van duurzame resultaten. Bovendien wordt gepleit voor de analyse en interventies van slimme stedelijke samenwerking om meer aandacht te besteden aan de impact van sociaal-ruimtelijke contexten. Door de combinatie van 'slim' uit de literatuur over slim bestuur en het 'stedelijk' uit literatuur over stedelijk bestuur, stellen we een stedelijke visie op slim bestuur voor - aangeduid als slim stedelijk bestuur - als een manier om stedelijk bestuur 'slimmer' te maken en om de aandacht te vestigen op het belang van stedelijke dynamiek bij het vormgeven van slim bestuur.

Hoofdstuk 3 zoomt in op de onderling verbonden componenten (d.w.z. ruimtelijke component, institutionele component en technologische component) van slimme stedelijke samenwerking en focust op hun interactie binnen de sociaalruimtelijke context. Twee databronnen - een internationale enquête en twee smart city-projecten - werden gebruikt om de toepasbaarheid van het raamwerk in de praktijk aan te tonen. De brede inventarisatie van smart city projecten laat zien dat slim stedelijk bestuur wereldwijd opmerkelijk verschilt - aangezien stedelijke kwesties verschillen in verschillende contexten, verschillen de bestuursvormen en relevante ICT-functionaliteiten die worden toegepast ook aanzienlijk. De analyse in de twee gevalstudies geeft aan dat een focus op wezenlijke stedelijke uitdagingen helpt om de juiste bestuursvormen te definiëren en specifieke technologieën te ontwikkelen die kunnen bijdragen aan succesvolle oplossingen van specifieke smart city-uitdagingen in de praktijk. Het is vermeldenswaardig dat de analyses van beide cases het belang benadrukt van de specifieke context (cultureel, politiek, economisch, enz.) bij het analyseren van de interacties tussen de componenten. Hierin bevordert slim stedelijk bestuur een contextgerichte, sociaal-technische manier om steden in het 'slimme' tijdperk te besturen door te beginnen met de stedelijke kwestie die op het spel staat, vraag gestuurde bestuursvormen te bevorderen en technologische intelligentie meer sociaal vorm te geven, gezien de specifieke contextuele kenmerken.

Hoofdstuk 4 onderzoekt het belang van sociaalruimtelijke context bij het analyseren van de ontwikkeling, implementatie en effecten van slim stedelijk bestuur. Bijzondere nadruk werd gelegd op de impact van stedelijke contexten op de socio-technische interactie tussen stedelijke technologische innovaties en stedelijk bestuur. Volgens Zhou (2017) moet een typische bestuursbenadering middelen uitwisselen met zijn omgeving, aangezien het de omgeving is die de structuur van die bestuursbenadering beperkt, vormgeeft of vormt. Hierna vormt de sociaal-ruimtelijke context de randvoorwaarde voor slimme stedelijke samenwerkingsvormen. De resultaten die in dit hoofdstuk worden gepresenteerd, laten zien dat deze context niet alleen de opzet en uitkomst van slim stedelijk bestuur beïnvloedt, maar ook de rol van ICT bij het slimmer maken van stedelijk bestuur in slimme steden vormgeeft. Aangezien steden in verschillende samenlevingen zich in verschillende ontwikkelingsstadia en overgangen bevinden, wordt aanbevolen om benaderingen van socio-technisch bestuur te identificeren die passen bij hun eigen specifieke context.

Kritische studies over het bestuur van slimme steden tonen aan dat het potentieel van ICT bij het verbeteren van het planningsproces en het omgaan met de planningskwesties op het gebied van slimme steden aanzienlijk wordt beperkt door structurele factoren (bijvoorbeeld een door technologie gedreven bestuursbenadering, overmatige focus op bedrijfskracht en een systeemtechnische benadering voor het ontwikkelen van technologie). In het tweede deel van dit proefschrift (hoofdstukken 5 en 6) wordt daarom vanuit een planningsondersteunend (planning support) perspectief bekeken hoe de rol van ICT bij het slimmer maken van stedelijk bestuur beter kan worden bereikt. In het onderzoek dat aan dit proefschrift ten grondslag ligt, hebben we in hoofdstuk 5 genealogisch onderzoek gedaan naar planningsgedachten en de bijbehorende ICT-ondersteuning in de afgelopen zeventig jaar, gecontroleerd door interviews met experts, om een up-to-date beeld te geven van de ontwikkeling van PSS toepassingen in slimme steden. De verkregen resultaten komen overeen met het argument van Klosterman (1997) dat de veranderende percepties van planning bepalen welke rol ICT kan spelen bij planning en dat er meer moeite moet worden gedaan om de veranderende opvattingen over planning in de praktijk te onderzoeken. Op verschillende plaatsen en in verschillende planningsperioden kunnen unieke planningstaken specifieke planningsondersteunende tools vereisen om aan de eisen van de plaatsen en de periode te voldoen. Voor een feitelijke planningsondersteunende rol zouden we planningsondersteuning dus moeten beschouwen als een socio-technische innovatie van transformatie, gevormd door contingente en veranderende uitdagingen in stedelijke contexten.

In hoofdstuk 6 hebben we vervolgens zowel het academische veld van smart governance als de debatten over de PSS-implementatiekloof onderzocht, en de inspanningen in de ruimtelijke ordeningspraktijk geïdentificeerd om die kloof te overbruggen. De geleerde lessen geven aan dat stedelijke problemen zoals waargenomen, geïdentificeerd, erkend en geaccepteerd door de lokale bevolking serieuzer moeten worden genomen, aangezien ze de plaatsgebonden, gecontextualiseerde kennis bieden om met deze stedelijke problemen om te gaan. Vervolgens moeten de geïnteresseerde belanghebbenden actiever worden betrokken bij de processen van slim bestuur en hun rol bij het identificeren van de doelen, doelen, thema's en doelstellingen die ze willen bereiken, duidelijker verwoorden. Wat betreft ICT-innovatie in slim stedelijk bestuur, impliceren de empirische uitkomsten bovendien dat de ontwikkeling van ICT een proces is van gezamenlijke inspanningen en maatschappelijke ondersteuning. De resultaten van dit hoofdstuk geven aan dat een socio-technische, vraag gestuurde benadering van ICT-innovatie nodig is bij smart urban governance.

Het derde deel van dit proefschrift biedt verschillende empirisch onderbouwde perspectieven op het nut van ICT bij het slimmer maken van stedelijk bestuur (hoofdstukken 7–9). Hoofdstuk 7 onderzoekt aan de hand van een internationale vragenlijst (268 respondenten) en interviews met experts (12 experts) hoe ICT kan worden omgezet in een meerwaarde bij het slimmer maken van stedelijk bestuur. Het belangrijkste argument is dat ICT-functies moeten worden geïntegreerd in stedelijke problemen en bestuursprocessen om meetbare meerwaarde te produceren. De resultaten die in dit hoofdstuk worden gepresenteerd, weerspiegelen eerst het belang van het analyseren van instrumenten bij het omgaan met in het bijzonder transport- en mobiliteitsproblemen. Om de mogelijkheden van ICT ter ondersteuning van stedelijk bestuur te verbeteren, betekent dit dat we "*moeten leren van de meer succesvolle toepassing van analytische instrumenten voor transporttechniek en kijken of ze toepasbaar zijn op de minder succesvolle ruimtelijke planning [toepassingen]*" (Geertman, 2017:75). Bovendien bevestigde het onderzoek ook dat de belangrijkste knelpunten - zoals de vaardigheden en kennis van gebruikers en de inhoud van bestuurskwesties – het daadwerkelijke nut van ICT bij het slimmer maken van stedelijk bestuur in de praktijk blokkeren. Een beter besef van deze contextuele factoren zou dus ongetwijfeld de mogelijkheden van ICT om het stedelijk bestuur slimmer te maken, verbeteren. Deze gedifferentieerde strategieën zouden niet alleen ten goede komen aan de belanghebbenden of gebruikers die bij dit proces betrokken zijn, maar ook aan het hele gebied van ICT-toepassingen in het stadsbestuur.

Hoofdstuk 8 onderzocht verder de determinanten van het nut van PSS op het gebied van slimme steden. De resultaten die in dit hoofdstuk worden gepresenteerd, bevestigen de observatie dat of de capaciteiten van een PSS de planningstaken kunnen ondersteunen, doorslaggevend is voor het daadwerkelijke nut van een PSS. Vervolgens ondersteunen de resultaten andere bestaande onderzoeken die aantonen dat bruikbaarheid een noodzakelijke maar niet voldoende voorwaarde voor succesvolle implementatie was. Daarnaast laat dit hoofdstuk ook zien dat contextuele factoren primair werkten als een faalfactor voor het nut van PSS. Op basis van de discussies benadrukken we dat PSS-ontwikkelingen in de toekomst: 1) beter moeten reageren op de relatie tussen planningstaken en PSS (d.w.z. taak-technologie-aansluiting) en de interactie tussen de gebruiker en een PSS (d.w.z. mens-computerinteractie); en 2) gevoeliger moeten zijn voor de mogelijke effecten van de verschillende contextuele factoren, zoals weergegeven in dit hoofdstuk, op het nut van PSS.

Hoofdstuk 9 vestigde de aandacht op het cruciale belang van contextuele factoren voor het nut van PSS in slimme steden. Het toonde aan dat in het algemeen vier contextuele factoren - namelijk de kenmerken van de technologie, gebruikerskenmerken, de kenmerken van het planningsproces en de politieke context - een significante invloed hebben op het nut van PSS, maar hun impact varieert aanzienlijk. In het bijzonder vertoonde de indicator "kenmerken van het planningsproces" (d.w.z. actieve gebruiker) een positief verband, terwijl de indicator "politieke context" (d.w.z. politieke druk) negatief geassocieerd bleek te zijn met het nut van PSS. De indicatoren "kenmerken van de technologie" en "gebruikerskenmerken" lieten zowel positieve als negatieve associaties zien met het nut van PSS. Sommige van de resultaten die in dit artikel worden gepresenteerd, zijn in overeenstemming met eerdere onderzoeken, terwijl andere de beweringen in deze onderzoeken tegenspreken. Sommige studies benadrukken bijvoorbeeld dat de kenmerken van de stedelijke kwestie helpen bij het beoordelen van de geschiktheid van de ondersteunende rol (Pelzer et al., 2015; Vonk & Ligtenberg, 2010), en daarom zou hun belang meer aandacht moeten krijgen. De schatting van de indicator "soorten stedelijke problemen" bleek echter niet zo significant te zijn vanwege de bredere meervoudige en multidimensionale aspecten van contextuele factoren.

De conceptualisering van slim stedelijk bestuur beantwoordt aan argumenten dat alternatieven voor door bedrijven geleid, technocratisch slim bestuur "*een solide epistemologisch en ontologisch begrip van de stad moeten hebben ... en meer bewust moeten zijn van hoe stedelijke problemen en hun voorgestelde slimme oplossing sociaal worden geconstrueerd*" (Verrest & Pfeffer, 2019). Het onderzoekt de rol van de gesitueerde actoren en hun bijdrage aan het bevorderen van een vraag gestuurd slim bestuur. Het benadrukt ook een socio-technische benadering van de ontwikkeling en implementatie van ICT. Met andere woorden, het is noodzakelijk om te begrijpen waarom slimme technologieën worden ontworpen, ontwikkeld en geïmplementeerd als het optimale antwoord op de waargenomen en geconstrueerde problemen. Ten slotte erkent smart urban governance het belang van contextuele factoren bij het begrijpen van de opkomst, ontwikkeling, implementatie en effecten van slimme stedelijke samenwerking.

Om de ontwikkeling van slim stedelijk bestuur te bevorderen, stel ik de volgende aanbevelingen voor de praktijk voor:

1) Meer aandacht besteden aan de wisselwerking tussen de componenten van slim stedelijk bestuur en zien hoe technologie een betere rol kan spelen bij het slimmer maken van stedelijk bestuur; dit zal ons begrip en vermogen vergroten om met stedelijke uitdagingen om te gaan, de samenwerkingsmogelijkheden van belanghebbenden vergroten en het nut van technologie, gericht op het realiseren van slimme stadsontwikkelingen, verbeteren.

2) Wees je er meer van bewust dat bestaande beleids- / overheidsstructuren flexibel genoeg moeten zijn om mee te veranderen met technologische innovaties; de interactie tussen componenten van slim stedelijk bestuur geeft zelfs aan dat slim stedelijk bestuur effectief kan worden als er een wederzijds vormingsproces van technologie en bestuursstructuren nodig is in het licht van de stedelijke kwestie die op het spel staat.

3) Besteed aandacht aan meer praktijkgerichte implementatie van technologie in nauwe samenwerking met de stedelijke problematiek en de afgestemde bestuursbenadering. Door dit te doen, kan ICT beter worden geïmplementeerd en beter worden geïntegreerd in het stedelijk bestuursproces en kunnen nieuwe bestuursmechanismen worden gecreëerd voor de ontwikkeling van slimme steden.

Ik stel ook verder onderzoek naar slim stedelijk bestuur voor:

1) Meer praktijkgericht empirisch onderzoek uitvoeren om de rol van ICT bij het slimmer maken van stedelijk bestuur te onderzoeken; een evaluatie van smart-city-projecten in verschillende bestuurlijke contexten zal helpen de kansen en potentiële valkuilen van ICT te begrijpen bij het creëren van innovatieve bestuursstructuren en het aanpakken van metropolitaanse problemen.

2) Vergelijk een groter aantal praktijkgevallen in verschillende sociaalruimtelijke contexten, aangezien dit empirisch gezien de invloed van contextuele factoren op socio-technische manieren om steden te besturen in het smart city tijdperk zou kunnen aantonen.

3) Focus meer op de multidimensionale vraagstukken van een stad; pas als dergelijke onderzoeken zijn afgerond, krijgen we een volledig begrip van de betekenis en meerwaarde van slim stedelijk bestuur.

4) Test het slimme stedelijke bestuurskader op een kwantitatieve manier. Het zou interessant zijn om te zien in hoeverre deze modi in het algemeen een hogere toegevoegde waarde kunnen opleveren en kunnen bijdragen tot een betere aanpak van urgente stedelijke problemen.

De bovenstaande aanbevelingen zullen een context-gebaseerde, socio-technische manier bevorderen om steden te besturen - slim stedelijk bestuur - in het smart city tijdperk om zodoende bij te dragen aan het bereiken van stedelijke duurzaamheid.

Appendix

Appendix I

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Appendix V

Curriculum Vitae

Appendix I

Table 2.3 in Chapter 2 Description of smart urban governance (SUG)-relevant terms

SUG-relevant purposes	Selected descriptions	References
Efficiency and productivity	"Smart governance helps to promote economic growth performance of cities due to the expected improved efficiency of public sector services in Smart cities."	Bolívar and Meijer (2016:681)
Learning and innovation	"To really achieve smart cities—that is to create the conditions of continuous learning and innovation."	Campbell (2012:1)
Technological savviness	Smart governance aims to create "infrastructure overhaul and ubiquitous high-speed connectivity."	Scholl and Scholl (2014:167)
	"…citywide information and communication technologies (ICTs) turned out to be at the core of creating an environment conducive to smart operations and smart services, and ultimately, smart city government."	Scholl and AlAwadhi (2016:21)
Human and social capital	"Smart governance, which relies and rests on timely and actionable information as well as the underlying facilitating ICTs, requires human skills capable of bringing the component parts of smart governance into action and interaction."	Scholl and Scholl (2014:169)
	"Such smart cities are based on a promising mix of human capital (e.g., skilled labor force), infrastructural capital (e.g., high-tech communication facilities), social capital (e.g., intense and open network linkages) and entrepreneurial capital (e.g., creative and risk-taking business activities)."	Kourtit et al. (2012:93)
Public services and value	In smart cities, public services are services provided by government via innovative ICTs, including "smart traffic and bus services, smart parking, water management, smart metering and grid, smart buildings and so on."	Pérez González, and Díaz Díaz (2015:252)
	"Public value generation, which aims to measure the outcomes and/or the long-term impacts of the initiatives implemented. This value generation usually includes the more general social objectives that the interventions address, such as economic growth, employment, social inclusion, and well-being."	Castelnovo et al. (2016:733)
Organization improvements	"Smart governance is the pro-active and open-minded governance structures, with all actors involved […]."	Kourtit et al. (2012:18)

	"…the need for fundamental change and overhaul with regard to organizational integration and alignment as well as interorganizational information system interoperability as a pre-requisite for creating smart operations and providing smart services."	Scholl and AlAwadhi (2016:21)
Social inclusion and cohesion	"Policies have been undertaken under the heading of smart governance with the aim of achieving of the social inclusion of urban residents in public services."	Caragliu et al., (2009:48)
Transparency and trust	"Transparency appears as a key to effective administration of the 21st century as well as to the legislative process."	Scholl and Scholl (2014:169)
	"[Smart governance] create open technologies for government, private sectors and citizens to work together for their daily issues. Improved services, a more transparent government and allowed participation with the help of a combined use of open and closed technologies [increase] the satisfaction and trust of local citizens."	Jiang et al. (2019:109)
Improvements to city	"Third-order outcomes: improvements to the city" includes "economic growth, social inclusion, ecological performance, highly educated citizens."	Bolívar and Meijer (2016:679)
Ecological performance	"Ecological performance is another expected outcome derived from Smart governance."	(Kourtit et al., 2012 :232)
	"Smart governments should possess both dimensions being able to take into account the ecological implications of growth and development, improving the quality of life for future generations, and quickly recover and respond to their citizens in cases of emergency and disaster."	Pereira et al. (2018:16); also see Gil-Garcia et al. (2016)
Sustainability	"The smart system represents a real support for an urban development, which will generate a sustainable development of our cities."	Bătăgan (2011 :83)
Quality of life and well-being	The main goal of governing smart city is to "utilise information and communication technologies with the aim to increase the life quality of their inhabitants […]."	Bakici Almirall and Wareham, 2013:137)
Belonging and liveability	The governance of smart cities "strives to meet aspirations of citizens," and "provides assurance to citizens."	(BSI-RoS, 2014:4); also see Joss et al. (2017)

SUG-relevant components	**Selected descriptions**	**References**
Government or governance	"We believe a smart city to be 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,	Caragliu et al. (2011:70)

	with a wise management of natural resources, through participatory governance."	
	"The concept Smart governance is a label associated to a governmental management of a city whenever the city is badging itself as smart."	Batty et al. (2012:505)
	"Smart cities are supposed to be supported by appropriate and trustworthy governance structures and by open-minded, creative people, who through a joint effort are able to increase local productivity, […]."	Kourtit and Nijkamp (2012:93)
	"We should study smart city governance as a complex process of institutional change and acknowledge the political nature of appealing visions of socio-technical governance."	Meijer and Bolívar (2016:392)
Political actors or stakeholders	"The stakeholder term has been widely defined and refers to individuals groups, agencies, parties or organizations that are involved in smart city governance in any way."	Ruhlandt (2018:6)
Participation or engagement	"Citizen engagement in and evidence-based decision-making processes: […] the engagement of citizens in decision-making processes rather than participating in the improvement of services based on a citizen/customer approach."	Pereira et al. (2018:11)
	"Smart governance comprises aspects of political participation, services for citizens as well as the functioning of the administration."	Giffinger et al. (2007:11)
Collaboration or partnership	In ICT-enabled governance, "collaborating across departments and with communities, helping to promote economic growth and at the most important level making operations and services truly citizen-centric."	Bătăgan (2011:85)
Openness and transparency	"Open Government, Transparency, and Accountability" are crucial to define smart governance, which "encompass a proactive involvement of stakeholders in the public decision making processes."	Scholl and Scholl (2014:167)
Leadership and accountability	"The concept of smart cities with the notion of governance, in which it perceives a greater intention on value creation for society through aspects such as leadership, accountability, responsiveness."	Osella et al. (2016)
Power and empowerment	Castelnovo et al. (2015:12) "reaffirm the central role of citizens in the decision-making process and their fundamental contribution to public value creation in the city context."	Castelnovo et al. (2016:12)
Policy	"Government in Smart cities must promote policies oriented toward strengthening innovation systems, specially focused on knowledge that might be more basic, fundamental."	Yigitcanlar et al. (2008:17)

Management and organization	"Community building and management, which aims to assess urban stakeholders' engagement in smart city governance and decision-making processes."	Castelnovo et al. (2016:733)
Decision-making	"Smart cities need to develop Smart governance systems that take all key factors into account, which includes three-step policy-making process: "beginning by diagnosing the situation, then developing a strategic plan, and finally taking action."	Berrone and Ricart (2012:52)
Strategies and visions	"Vision and strategy formulation, which aims to assess a smart city's capability of using strategic planning and implementing monitoring and evaluation techniques to generate evidence to inform future strategic plans."	Castelnovo et al. (2016:733)
Legal and regulatory	"Regulatory, legal and policy frameworks play a conditioning role in scaling processes of smart city pilot projects."	van Winden and van den Buuse (2017:58)
Technology or ICT	"Smart city governance is about crafting new forms of human collaboration through the use of ICTs to obtain better outcomes and more open governance processes."	Meijer and Bolívar (2016:681)
	"In the context of smart governance, ICTs and other technologies play highly critical roles as they technically facilitate the "smartness" of governance, and consequently, government. In that sense, they apply to and permeate all eight areas of focus."	Scholl and Scholl (2014:169)
Big data	"[Big] data, smart city advocates argue enables real-time analysis of city life, new modes of urban governance, and provides the raw material for envisioning and enacting more efficient, sustainable, competitive, productive, open and transparent cities."	Kitchin (2014:1)
Place or space	"Place matters in smart towns and cities."	Walters (2011:198)
	"The intelligence of a city should be measured by its ability to produce favourable conditions to get urban operators (citizens, organizations, private companies, etc.) actively involved into sociospatial innovation dynamics."	Roche (2014:7.3)
	"Spatial (urban and environmental) development in smart cities: We need to reform our cities by adopting sustainable urban development principles—e.g., minimising urban footprint, limiting emissions, establishing urban farms."	Yigitcanlar et al. (2018:149)
SUG-relevant contexts	**Selected Descriptions**	**References**
Economic structure	"The availability of economic and financial resources" influence the capability of government to cities.	Castelnovo et al. (2016:733)

Technological development	"Smart governance is influenced by contextual factors such as […] technological factors."	Bolívar and Meijer (2016:688)
Political system and institution	In practice, "different institutions have largely affected smart governance strategies, arrangements and outcomes."	Lin (2018:1)
	"Different levels of [political] regulation (transnational, international, national, regional, local) […]" influence the governance of smart cities.	Walravens (2012:125)
	"Issues of responsibility, […] and the regulations that extra national government agencies may impose on what and how and where and why citizens are able to influence the governance of their cities.''	Batty et al., 2012:512).
Culture and customs	"There are cultural barriers to ICT-enabled governance": 1) "bureautic culture-formality, uniformity and hierarchy-preserves the traditional ways of interacting with citizens"; 2) "citizens may be opposed to changes in the relationship with government because they feel it threatens their autonomy or privacy."	Meijer (2015:199)
Personal rationality and preference	"The availability of relevant knowledge among citizens and stakeholders, and the willingness to contribute this knowledge to collective problem-solving" will influence the governance of smart cities.	Meijer (2016:77)
Geographical particularity	"Situational characteristics, such as democratic institutions and culture, the physical environment, the economic production, etc., matter for the effectiveness of smart city governance since these characteristics are either conducive or limiting to different modes of smart city governance."	Meijer (2016:77).
Resources constraints	Resource constraints represent the limitation and enrichment of spatial resources (e.g. facilities and utilities) to be utilized in dealing with social and urban issues.	Hawkins (2011)
Urban problems as context	"Social, economic and environmental challenges associated with urbanization are key drivers of the development of smart cities. They influence the choice of smart governance models and related strategies and actions."	Lin (2018:3)

Appendix II

Questionnaire survey used in Chapter 2, Chapter 7, Chapter 8 and Chapter 9: Technology in Computational Urban Planning for Smart Cities.

Part One: Basic Information

1.What is your gender identity?

Please choose only one of the following:

Male

Female

Prefer not to say

2.What's your date of birth (year only)?

Please choose only one of the following:

From 1910 to 2005

3.What is your profession/job?

Please choose only one of the following:

Academic researcher/scholar

Student

Planner

Designer

Politician

Entrepreneur

Citizen

Others

4.Which country/region do you come from?

Please choose only one of the following:

Countries/regions based on United Nation member states

5.Which city do you come from?

Please write your answer here:

6.What is your level of expertise in planning support technology?

Please choose the appropriate response for each item:

	Very Low 1	2	3	Neutral 4	5	6	Very High 7
Your level of expertise							

Part Two: Planning Support Technology within Your Projects

Planning support technology has been widely used to augment urban planning and management, especially in the context of smart cities. In this section, we want to collect detailed information about the role of planning support technology in your [urban] projects because this sheds light on the strengths and weaknesses of planning support technology in practice.

7.Are you professionally and/or academically involved in urban projects in which planning support technology plays an important role?

Please choose only one of the following:

Yes

No

8.Who are main stakeholders in your projects?

Please choose all that apply:

Central government

Local government

Market parties

Civil society

Collective companies

Other:

9.What types of planning support technology did you use in your projects (multiple answers possible)?

Please choose all that apply:

Informing (e.g., website)

Communicating (e.g., MapTable)

Analyzing (e.g., What if?)

Modelling (e.g., UrbanSim, CityEngine)

Designing (e.g., Computer-Aided Design, Freehand)

Other:

10.What kinds of urban problems do the planning support technology you applied intend to solve (multiple answers possible)?

Please choose all that apply:

Urban economic development (e.g., industrial policy)

Urban transport and mobility (e.g., traffic congestion, greenway)

Urban housing problem (e.g., overcrowding, slums and squatter, urban village)

Urban social problem (e.g., unemployment, education, medical care)

Urban environmental problem (e.g., trash disposal, sewerage problems, urban pollution)

Other:

Looking back at your last projects, please evaluate the following questions relative to the functionalities, characteristics, added value and contextual factors of the applied planning support technology in your projects.

11. To what extent did the planning support technology in your projects succeeded into:

Please choose the appropriate response for each item:

	Very Unsuccessful 1	2	3	Neutral 4	5	6	Very Successful 7	Not Applicable
Supporting geodata gathering (e.g., sensors; digitizing)								
Supporting geo-data storage (e.g., registers, cloud)								
Supporting visualization (e.g., images, diagrams, maps, and animations)								
Supporting one-way information provision (e.g., website)								
Supporting two-way communication (interaction)								
Supporting spatial analysis (e.g., land use analysis)								
Supporting spatial modelling (e.g., traffic modelling)								
Supporting spatial design (e.g., geo-design)								
Supporting scenario-building								
Supporting impact analysis (e.g., ecological impact of new developments)								
Supporting urban management and administration								

12.To what extent did the planning support technology in your projects possesses these <u>characteristics</u>:

Please choose the appropriate response for each item:

	Completely Disagree 1	2	3	Neutral 4	5	6	Completely Agree 7	Not Applicable

The working of the planning support technology is understandable (transparency)
The planning support technology can be used in an intuitive way (user friendliness)
The planning support technology responds directly to the user requests (interactivity)
The planning support technology is able to perform a diversity of planning tasks
The planning support technology is able to perform computing in real-time
The planning support technology produces high-quality information
The planning support technology produces reliable outcomes

13.To what extent do you consider the planning support technology of <u>added value</u> in:

Please choose the appropriate response for each item:

	Extremely Poor 1	2	3	Neutral 4	5	6	Extremely Good 7	Not Applicable
Arousing participants' enthusiasm for the planning issue								
Supporting participants to understand the urban issues better								
Helping you to understand how other people view the same issue								
Facilitating the participation of lay persons								

(citizens) in the planning process
Facilitating the working together between stakeholder groups (state, civil society, market) in the planning process
Supporting information exchange between stakeholders in the planning process
Supporting consensus building between different stakeholder groups
Gaining quicker outcomes at less costs (efficiency)
Achieving a better outcome with the same means (effectiveness)
Improving participants' commitment to the planning outcome (e.g., decision or plan)
Improving the creativeness of the outcome
Improving the transparency of decisions or plans

14.The uptake of planning support technology in my projects is influenced by:

Please choose the appropriate response for each item:

	Extremely Negative 1	2	3	Neutral 4	5	6	Extremely Positive 7	Not Applicable
The technical skills and experiences of users								
The adaptability of the technology to specific user needs or desires								
The adaptability of the technology to new circumstances								
Characteristics of the dominant planning style								

(e.g., blueprint, participatory, collaborative or communicative)	
Time pressure on the planning process	
Political pressure on the planning process	
Characteristics of the political system (e.g., centralized/decentralized; democratic/authoritarian)	
Users' attitudes towards technology (e.g., openness, awareness, and intention to use)	
Characteristics of the planning issue (e.g., complexity; wickedness; quantitative versus qualitative)	
Availability of fundings (e.g., money from government or private investors)	
Characteristics of technology (e.g., compatibility, attractiveness; user-friendliness)	
Enthusiastic uptaker of the planning support technology in the project (i.e., demonstration effects)	
The phase in the planning process (e.g., brainstorming; scenario development; plan-making)	

Look back at your last projects, please evaluate:

15. The overall added value of planning support technology in your projects [Scores 1-100].

Please choose only one of the following:

From 1 to 100

16.The overall influence of contextual factors upon the uptake of planning support technology in your

Please choose only one of the following:

From 1 to 100

Part Three: CUPUM Organization/Conference

CUPUM has been one of the major international conferences to discuss latest ideas of planning support technology in research and practice. In this section, we want to collect detailed information about your relationship with the CUPUM Organization/Conference because it helps us to improve the conference.

17.Have you attended the CUPUM Conference before? *

Please choose only one of the following:

Yes

No

18.How many times have you participated in a CUPUM conference (excluding Wuhan 2019)?

Please choose only one of the following:

1

2

3

4

5

≥6

19.What are your personal main goals of attending CUPUM conferences (multiple answers possible)?

Please choose all that apply:

To network

To expand my knowledge and find solutions to my problems

To present my ideas and work to others

For people to meet me

Learn beyond my field or interest

Other:

20.What do you appreciate most about CUPUM conferences (multiple answers possible)?

Please write your answer here:

21.What improvements would you like to propose concerning the CUPUM organization and/or the CUPUM conferences (multiple answers possible)?

Please write your answer here:

22.If you didn't attend before, would you like to participate in the conference in the future?

Please choose only one of the following:

Yes

Probably

No

23.What are your purposes when attending the CUPUM conference?

Please choose all that apply:

To network

To expand my knowledge and find solutions to my problems

To present my ideas and work to others

For people to meet me

Learn beyond my field or interest

Other:

Part Four: Other Comments

24.Do you have any other comments regarding the role of planning support technology in Computational Urban Planning and Management for Smart Cities?

Please write your answer here:

25.Please indicate your email address, if you are interested in knowing the follow-up results of this survey. The e-mail address will be stored separately from other data and will be used solely for this survey.

Please write your answer here:

Appendix III

Table 5.2 in Chapter 5 and Table 7.2 in Chapter 7 Details about the expert interviews

Experts	Expertise	Date(s) undertaken	Places	Purposes
Expert 1	Around 25 years experience in decision-aiding systems	July 9, 2019	Face-to-Face at 2019 CUPUM Conference, Wuhan (China)	Semi-structured interviews with PSS/Smart Governance experts to infer the conceptual and visionary insights on the mutually potential contributions between PSS and Smart governance
Expert 2	More than 25 years experience in urban informatics	July 9, 2019	Face-to-Face at 2019 CUPUM Conference, Wuhan (China)	
Expert 3	More than 30 years experience in urban and transport planning	July 10, 2019	Face-to-Face at 2019 CUPUM Conference, Wuhan (China)	
Expert 4	More than 40 years experience in Urban Information Systems	July 10, 2019	Face-to-Face at 2019 CUPUM Conference, Wuhan (China)	
Expert 5	More than 35 years experience in urban modeling	July 10, 2019	Face-to-Face at 2019 CUPUM Conference, Wuhan (China)	
Expert 6	Around 20 years experience in digital city and Planning Support Systems	July 11, 2019	Face-to-Face at 2019 CUPUM Conference, Wuhan (China)	
Expert 7	More than 25 years experience in transport, urban, and regional planning	July 11, 2019	Face-to-Face at 2019 CUPUM Conference, Wuhan (China)	
Expert 8	More than 50 years experience in developing computer models of cities and regions	July 12, 2019	Face-to-Face at 2019 CUPUM Conference, Wuhan (China)	
Expert 9	Around 15 years experience in urban informatics	August 22, 2019	Face-to-Face in Beijing (China)	
Expert 10	More than 50 years experience in planning theory, planning methods,	September 9, 2019	Online Video	

	and computer applications in planning		
Expert 11	Around 10 years experience in new information technologies applications in urban governance / planning	September 11, 2019 and September 30, 2019	Online Video
Expert 12	More than 20 years experience in ICT-enabled governance	October 10, 2019	Face-to-face in Utrecht (Netherlands)

Questions in semi-structured expert interviews:

Past

In general, what were the main urban problems twenty years ago in the project(s) you were involved?

What were the main stakeholders in handling these problems?

What kind of roles did government/the private/citizen play? (ask separately)

How about the role of planning support technologies at that period of time (informing, communicating or analyzing)? / How technology were used to deal with these urban problems?

What were the main stakeholders (state, government, citizen) that promote the uptake of technology in planning practice at that period of time?

What were the factors that influence the uptake and usefulness of technology at that period of time?

Present

At the present era of smart cities, what are the tricky urban problems in the project(s) you are involved?

What are the main stakeholders in handling these problems?

What kind of roles does government/the private/citizen play? (ask separately)

How technology are used to deal with these urban problems?

What are the new technological functions applied to deal with these urban problems?

Which stakeholders do you consider of importance to promote the uptake of technology in planning practice?

Which factors are influencing the uptake and usefulness of technology in planning practice now?

Future

In the upcoming 10 years, what are the main problems we will face from your view?

What can government/the private sector/citizen do to deal with these problems? (ask separately)

How can technology help us imagine the future city?

What expectation do you have about the application of technology in the upcoming 10 years (positive or negative)?

What can government/technology-companies/academic researcher/citizens do to meet these expectations in planning practice? (ask separately)

What factors do you think will influence the uptake and usefulness of technology in planning practice in the upcoming 10 years?

Appendix IV

Table 9.4 in Chapter 9 Frequency statistics of each variable

	Measures	Frequency	Marginal Percentage (%)
Overall usefulness	1	9	5.1
	2	41	23.4
	3	86	49.1
	4	36	20.6
	5	3	1.7
Characteristics of the technology			
Informing	1	4	2.3
	2	4	2.3
	3	16	9.1
	4	48	27.4
	5	26	14.9
	6	34	19.4
	7	20	11.4
	1	7	4
Communicating	2	9	5.1
	3	24	13.7
	4	51	29.1
	5	21	12
	6	24	13.7
	7	15	8.6
Analyzing	1	3	1.7
	2	7	4
	3	5	2.9
	4	18	10.3
	5	24	13.7
	6	53	30.3
	7	53	30.3
Designing	1	2	1.1
	2	7	4
	3	15	8.6
	4	40	22.9
	5	26	14.9
	6	33	18.9
	7	26	14.9
Transparency	1	4	2.3
	2	1	0.6
	3	14	8
	4	38	21.7

	5	47	26.9
	6	42	24
	7	26	14.9
User-friendliness	1	4	2.3
	2	8	4.6
	3	12	6.9
	4	42	24
	5	50	28.6
	6	33	18.9
	7	23	13.1
Interactivity	1	3	1.7
	2	15	8.6
	3	21	12
	4	45	25.7
	5	41	23.4
	6	30	17.1
	7	15	8.6
Flexibility	1	3	1.7
	2	5	2.9
	3	20	11.4
	4	44	25.1
	5	52	29.7
	6	27	15.4
	7	20	11.4
Characteristics of the urban issue			
Types of urban issues	1	42	24
	2	28	16
	3	104	59.4
User characteristics			
Profession	1	108	61.7
	2	67	38.3
User attitude	1	15	8.6
	2	46	26.3
	3	53	30.3
	4	44	25.1
	5	11	6.3
	6	3	1.7
	7	2	1.1
Expertise level	1	5	2.9
	2	3	1.7
	3	16	9.1
	4	45	25.7
	5	41	23.4
	6	47	26.9

	7	18	10.3
Characteristics of planning process			
Time pressure	1	23	13.1
	2	39	22.3
	3	31	17.7
	4	48	27.4
	5	11	6.3
	6	8	4.6
	7	6	3.4
Active uptaker	1	28	16
	2	47	26.9
	3	34	19.4
	4	43	24.6
	5	11	6.3
	6	4	2.3
	7	3	1.7
Funding	1	33	18.9
	2	31	17.7
	3	32	18.3
	4	48	27.4
	5	12	6.9
	6	4	2.3
	7	7	4
Planning style			
Planning style	1	78	44.6
	2	97	55.4
Political context			
Political pressure	1	12	6.9
	2	23	13.1
	3	34	19.4
	4	58	33.1
	5	17	9.7
	6	6	3.4
	7	18	10.3
Valid	114	100%	
Missing	61		
Total	175		

Appendix V

Table 9.5 in Chapter 9 Parameter estimates

	Estimate	Std. Error	Wald	df	Sig.
[Overall usefulness=1]	30.358*	12.029	6.369	1	0.012
[Overall usefulness=2]	37.128*	12.362	9.02	1	0.003
[Overall usefulness=3]	48.775*	14.839	10.804	1	0.001
[Overall usefulness=4]	55.825*	15.66	12.708	1	0.000
Characteristics of the technology					
[Informing=1]	-3.287	11.122	0.087	1	0.768
[Informing=2]	40.269*	12.256	10.796	1	0.001
[Informing=3]	0.638	2.984	0.046	1	0.831
[Informing=4]	0.16	2.057	0.006	1	0.938
[Informing=5]	0.602	2.348	0.066	1	0.798
[Informing=6]	2.776	1.964	1.998	1	0.158
[Informing=7]	0[a]	.	.	0	.
[Communicating=1]	13.103	7.152	3.356	1	0.067
[Communicating=2]	6.606	5.31	1.548	1	0.213
[Communicating=3]	3.574	3.142	1.294	1	0.255
[Communicating=4]	6.389*	2.828	5.102	1	0.024
[Communicating=5]	12.077*	3.704	10.628	1	0.001
[Communicating=6]	4.178	2.745	2.317	1	0.128
[Communicating=7]	0[a]	.	.	0	.
[Analyzing=1]	-18.705	20.842	0.805	1	0.369
[Analyzing=2]	-0.694	3.978	0.03	1	0.861
[Analyzing=3]	-15.067*	6.2	5.905	1	0.015
[Analyzing=4]	0.498	2.813	0.031	1	0.86
[Analyzing=5]	-13.194*	4.212	9.812	1	0.002
[Analyzing=6]	1.133	1.67	0.461	1	0.497
[Analyzing=7]	0[a]	.	.	0	.
[Designing=1]	-25.854	9583.456	0	1	0.998
[Designing=2]	-22.704*	7.975	8.106	1	0.004
[Designing=3]	0.07	3.835	0	1	0.986
[Designing=4]	-2.096	2.29	0.838	1	0.360
[Designing=5]	2.189	2.735	0.641	1	0.424
[Designing=6]	-8.845*	2.878	9.447	1	0.002
[Designing=7]	0[a]	.	.	0	.
[Transparency=1]	53.717	17.164	9.795	1	0.002

[Transparency=2]	0[a]	.	.	0	.
[Transparency=3]	27.313*	7.692	12.609	1	0.000
[Transparency=4]	13.914*	4.724	8.674	1	0.003
[Transparency=5]	6.383*	2.887	4.887	1	0.027
[Transparency=6]	9.666*	3.176	9.265	1	0.002
[Transparency=7]	0[a]	.	.	0	.
[User friendliness=1]	-21.25	9583.401	0	1	0.998
[User friendliness=2]	-11.125	7.714	2.08	1	0.149
[User friendliness=3]	-12.795	7.027	3.316	1	0.069
[User friendliness=4]	2.003	3.702	0.293	1	0.589
[User friendliness=5]	-2.003	3.854	0.27	1	0.603
[User friendliness=6]	-0.69	2.927	0.056	1	0.814
[User friendliness=7]	0[a]	.	.	0	.
[Interactivity=1]	0[a]	.	.	0	.
[Interactivity=2]	-1.296	4.77	0.074	1	0.786
[Interactivity=3]	-6.775	4.244	2.549	1	0.110
[Interactivity=4]	-7.34	4.757	2.381	1	0.123
[Interactivity=5]	-1.311	3.487	0.141	1	0.707
[Interactivity=6]	-1.635	3.205	0.26	1	0.610
[Interactivity=7]	0[a]	.	.	0	.
[Flexibility=1]	6.785	15.425	0.193	1	0.660
[Flexibility=2]	-40.295*	12.131	11.034	1	0.001
[Flexibility=3]	-5.517	3.578	2.378	1	0.123
[Flexibility=4]	-5.497	3.005	3.346	1	0.067
[Flexibility=5]	-7.891*	3.117	6.41	1	0.011
[Flexibility=6]	2.414	2.224	1.179	1	0.278
[Flexibility=7]	0[a]	.	.	0	.
Types of the urban issue					
[Types of urban issues=1]	-1.27	1.495	0.721	1	0.396
[Types of urban issues=2]	-2.61	2.16	1.46	1	0.227
[Types of urban issues=3]	0[a]	.	.	0	.
User characteristics					
[Profession=1]	3.543	1.9	3.477	1	0.062
[Profession=2]	0[a]	.	.	0	.
[User attitude=1]	58.024*	17.441	11.068	1	0.001
[User attitude=2]	53.214*	15.818	11.317	1	0.001
[User attitude=3]	54.049*	16.458	10.786	1	0.001
[User attitude=4]	50.919*	15.411	10.917	1	0.001
[User attitude=5]	40.465*	14.045	8.301	1	0.004
[User attitude=6]	30.699*	14.903	4.243	1	0.039

[User attitude=7]	0[a]	.	.	0	.
[Expertise level=1]	-0.563	3.638	0.024	1	0.877
[Expertise level=2]	-20.539*	9.525	4.65	1	0.031
[Expertise level=3]	-7.152*	3.58	3.991	1	0.046
[Expertise level=4]	4.837	2.596	3.471	1	0.062
[Expertise level=5]	-0.843	2.551	0.109	1	0.741
[Expertise level=6]	2.154	2.149	1.005	1	0.316
[Expertise level=7]	0[a]	.	.	0	.
Characteristics of planning process					
[Time pressure=1]	-5.368	5.222	1.057	1	0.304
[Time pressure=2]	-1.732	5.292	0.107	1	0.743
[Time pressure=3]	-3.894	5.153	0.571	1	0.450
[Time pressure=4]	-4.529	5.69	0.634	1	0.426
[Time pressure=5]	-3.222	6.084	0.28	1	0.596
[Time pressure=6]	3.349	12.604	0.071	1	0.790
[Time pressure=7]	0[a]	.	.	0	.
[Active uptaker=1]	12.424	7.83	2.517	1	0.113
[Active uptaker=2]	13.796	7.167	3.706	1	0.054
[Active uptaker=3]	11.042	7.182	2.364	1	0.124
[Active uptaker=4]	14.842*	7.52	3.896	1	0.048
[Active uptaker=5]	5.853	8.639	0.459	1	0.498
[Active uptaker=6]	-13.784	12.007	1.318	1	0.251
[Active uptaker=7]	0[a]	.	.	0	.
[Funding=1]	-3.126	6.712	0.217	1	0.641
[Funding=2]	-5.155	6.446	0.639	1	0.424
[Funding=3]	-2.001	6.958	0.083	1	0.774
[Funding=4]	1.991	6.416	0.096	1	0.756
[Funding=5]	1.338	7.003	0.036	1	0.849
[Funding=6]	1.668	7.141	0.055	1	0.815
[Funding=7]	0[a]	.	.	0	.
Planning style					
[Planning style=1]	-5.675*	1.842	9.495	1	0.002
[Planning style=2]	0[a]	.	.	0	.
Political context					
[Political pressure =1]	-6.557	4.633	2.003	1	0.157
[Political pressure =2]	-19.442*	5.786	11.292	1	0.001
[Political pressure =3]	-23.22*	6.617	12.315	1	0.000
[Political pressure =4]	-24.007*	6.379	14.163	1	0.000
[Political pressure =5]	-22.787*	6.957	10.729	1	0.001
[Political pressure =6]	-22.288*	9.133	5.955	1	0.015

[Political pressure =7]	0[a]	.	.	0	.

Link function: Logit.

a. This parameter is set to zero because it is redundant.

b. Sig. codes: * $p \leq 0.05$

Curriculum Vitae

Huaxiong Jiang was born in Dazhou, Sichuan Province, China, on October 11th, 1989. He completed his bachelor's (degree) program at Central China Normal University (2009-2013). He continued his Master's study in Urban and Regional Planning at Peking University (2013-2016). During his master's years, he was sponsored by Peking University – Lincoln Institution of Land Policy Center (Master Thesis Fellowship). In October, 2016, he was supported by Chinese Scholarship Council (CSC Scholarships) to start a Doctoral degree at the Department of Human Geography and Spatial Planning, Faculty of Geosciences, Utrecht University. His work in research has been published in some international journals and presented in several international conferences. His present research interests include planning / governance theory, technology and smart governance, and planning support systems.