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DIFFUSION OF INNOVATIONS IN A SMART CITY CONTEXT

Facilitation of innovation-oriented smart city development in Kalasatama

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1 INTRODUCTION

Since the beginning of the 20th century, urban and regional development has been characterised by a shift towards technology, innovation, and selective urban development (Komninos 2002, 6). The migration of rural populations into cities started in the onset of industrial revolution and is still continuing (Tresman, Pásher & Molinari 2007, 55). Due to technological developments, the average size of urban areas has increased substantially, making it possible for cities to accommodate more inhabitants. As result of these developments and regardless of the many formidable challenges and disadvantages often associated with urban agglomerations, global population has been increasingly concentrating in cities. (Caragliu, Del Bo & Nijkamp. 2011, 66.) In Europe, for example, approximately 75 percent of the population lives in urban areas and the figure is expected to rise to 80 percent by the year 2020. As a result of such rapid urbanisation, most global resources are now consumed in cities. This contributes to the economic importance of urban areas as well as to their often lousy environmental performance. (Albino, Umberto & Dangelico, 2015, 3.) Growth of global population together with increased urbanisation have raised a great number of technical, social, economic, and organisational challenges in terms of economic and environmental sustainability of urban areas (Neirotti, De Marco, Cagliano, Mangano & Scorrano 2014, 25).

1.1 Smart cities shaping urban development

Successful cities are the key social engines of societies, attracting investments, businesses, and talented individuals, as well as catalysing ideas and innovation, thereby triggering growth and prosperity (Dameri 2015, 880). However, the metabolism of cities, which consists of the input of goods and the output of waste, causes negative externalities which intensify social and economic problems. Because of this, most cities are in a position in which they have to find ways to manage new challenges and look for solutions that foster transportation linkages, mixed land uses, and other economically beneficial urban services which, for example, connect labour with employment opportunities. Several of these urban service initiatives and approaches are based on utilising new technologies. (Albino et al. 2015, 4.)

As the challenges of increased urbanisation have become recognised, the concept of smart cities has begun to attract considerable attention (Schaffers, Komninos, Pallot, Trousse, Nilsson, & Oliveira 2011, 431). The smart city movement originated from the

need to find solutions to urban problems, such as pollution, high-population density, land consumption, congestion, and difficulties accessing public services, largely caused by urbanisation (Dameri 2015, 862). According to Angelidou (2014, S3), smart cities represent a conceptual urban development model that is founded on the utilisation of human, technological and collective capital, and strives to enhance the development and prosperity in urban agglomerations. While there is no agreed upon definition of a smart city, cities described as smart are often expected to invest in high-tech information and communication technologies (ICT) in order to "wire-up" the city and enhance its efficiency, boost its high-tech sector as a motor of growth, and attract skilled talent by delivering high quality of life (McLaren & Agyeman 2017, 2).

The concept smart city has become a relatively widespread topic in academic and scientific fields as well as in public governance as cities all over the world are striving to become smart (Dameri 2016, 2). Many national and international institutions have devoted time and effort to devising strategies, investment programmes and projects that could help to achieve smart urban growth (Caragliu et al. 2011, 67). At the European Union level, for example, European Commission programmes FP7-ICT and CIP ICT-PSP have promoted smart city concept experimentations, such as piloting user-driven open innovation environments (Schaffers et al. 2011, 432). However, publicly driven development processes have been slow because most smart city development models are still in their infancy and many cities are only just beginning to understand the urban challenges ahead of them. In addition, most of the national and international development measures have been relatively small-scale and are still in their early stages making their longer term impact unclear. (Cosgrave, Arbuthnot & Tryfonas 2013, 670.) Such development challenges may be due to the lack of sufficient benchmarking and evaluation frameworks, and analytical tools for managing smart cities planning processes (Zygiaris 2013, 218). Furthermore, a universally fixed smart city assessment system can be difficult to establish due to the variety of differing characteristics of cities around the world (Albino 2015, 18).

Perhaps because of the challenges in the smart city development processes and their as of yet ambiguous implications, the notion of a smart city has also become somewhat of a loaded concept with a buzzword-like status. In the absence of guidance and coordination, many cities have self-declared themselves as smart in a fairly arbitrary manner. Hollands (2008, 316) has criticised this tendency arguing that smart progressive cities require the input and contribution of various different stakeholders, and urban areas should not be labelled as smart solely on the basis of adopting an upgraded ICT infrastructure or through creating self-promotional websites. According to him, actual

smart cities "[…] are more than just wires and cables, smart offices, trendy bars and luxury hotels, and the vast number of people who live in cities deserve more than just these things. Because the smart city label can work to ideologically mask the nature of some of the underlying changes in cities, it may be a partial impediment toward progressive urban change. Real smart cities will actually have to take much greater risks with technology, devolve power, tackle inequalities and redefine what they mean by smart itself, if they want to retain such a lofty title." (Hollands 2008, 316).

Furthermore, while smart city agendas have been partly guided by the priorities of contemporary city governance and urban development, global players of the ICT sector have been eagerly involved in the shaping of smarter city environments. This has resulted in a situation in which many smart city initiatives have been dominated by technology and vendor push rather than by city government pull. (Schaffers et al. 2011, 437.) For example, Rio de Janeiro partnered with IBM to create the city's first integrated operations center in order to develop an Emergency Response System integrating data from various different agencies (Angelidou 2014, S7). Despite the success of the system in certain areas, the smartness brand of the project received criticism because it was perceived as an attempt to gloss over the various social and environmental issues burdening the city (Angelidou 2014, S8). Many smart city initiatives have also been criticised for causing damage such as social exclusion. McLaren and Agyeman (2015, 315) note that smart cities can, if fact, have a darker side to them as smart infrastructure is often privatised and constructed to provide services exclusively for the rich. Caragliu et al. (2011, 68) share this view noting that social, economic, spatial, and cultural polarisation may arise in smart city development if social and relational issues are not considered properly. For example, digitalisation of services can have undesirable impact on the social cohesion of a society if people with limited access to digital resources find themselves isolated from the rest (Angelidou 2014, S9). Neirotti et al. (2014, 34) also note that cities with a broader portfolio of investments in smart systems are not necessarily more liveable or better as such cities can turn into undesirable urban environments continuously observing and scrutinising citizens, and creating an unintended social divide.

1.2 Innovation in smart cities

Although smart city development tends to divide opinions, a seldom challenged notion is that because cities are facing many global challenges at a local level, new ideas and ways of solving urban problems are needed, and urban planning needs to contain innovations

that contribute to a smarter future (Zygiaris 2013, 229). Innovations can be defined as ideas, practices and objects perceived as new by the people, organisations or other entities (Rogers 2003, 12). They have become necessities for urban development as cities are forced to review their existing systems and solutions for sufficiency and functionality (Brorström 2015, 170). However, the relationship between urban development and innovations is not a new phenomenon. While the concept of smart cities has been developing during the past few decades, cities have a longer history of urban development shaped by the new technologies and production systems of different eras (Angelidou 2015, 105). The idea behind smart cities is thus strongly rooted in the focal role that urban areas have always had in terms of knowledge creation, culture, innovation, and economic development (Dameri 2015, 863).

The relationship between cities and innovations may be at least partly due to the characteristics of cities as environments. Cities as urban settlements are often intricate systems with various interconnected citizens, businesses, modes of transport, services, utilities and communication networks (Neirotti et al. 2014, 25). Cities as environments are also often cited as cultural cores where people congregate to exchange ideas (Srivastava, Prashar, Sunil, Akhilesh & Rajib 2012, 147). Inventions, which are necessary precursors of innovations, usually entail a certain level of creativity, and because cities are believed to attract creative people, urban areas are usually perceived as central to the process of innovation (Shearmur 2012, S11). In other words, due to their buzz and the capacity they provide for frequent, stimulating, and serendipitous face-to-face contacts, cities are often assumed to be inherently innovative environments that excel in fostering innovations and nascent industries. Similarly, cities are expected to harbour innovative companies and organisations because they are able to provide the necessary workforce, infrastructure, and access to markets. In other words, cities should be able to provide enough cost- and risk-reducing externalities which are especially relevant for emerging industries and firms. (Shearmur 2012, S15.) In this sense, cities as environments can be viewed as prolific platforms for innovations.

Because of the nature and history of cities as environments and urban settlements which can provide fertile ground for innovations, it would perhaps be understandable to presume that cities are predisposed to innovate their way to smartness. However, as the criticism towards the notion of smart cities indicates, there are often bumps on the road. Brorström (2015, 167) notes that although cities can be described as systems and organisms subject to constant change, it is often paradoxically difficult to change what a city is and what is its development trajectory. Angelidou (2015, 102) notes that many smart city developments have remained relatively fragmented, focusing only on some

aspects of the city rather than approaching the city in an integrated manner. Perhaps as a symptom of this, many smart city investments have been characterised by fairly small demonstrators usually lacking the scalability to place any real or long-lasting impact on urban development (Cosgrave et al. 2013, 668). The reasons behind the challenges in innovation-based smart city development are likely to be varied and multifaceted. In many cases, effective implementation models for smart city development have been challenging to realise because discussions tend to focus exclusively on technological innovations while concepts concerning innovation implementation methods are still in their infancy. Furthermore, cities are complex entities and their futures are often obscured by multiple unknowns which makes the long-term implications of innovations difficult to estimate. (Cosgrave et al. 2013, 669.)

Some of the reasons behind the challenges in innovation-oriented smart city development are likely to be at least partly to do with the dual role of cities as both urban environments and as governing bodies of urban settlements. As noted by a recent report published by Future Cities Catapult, while technological development has allowed companies to disrupt existing urban ecosystems by providing solutions and opportunities to citizens and other urban stakeholders, city governments have often been slow to consider whether their regulations and strategies are fit for such rapid disruption (Global Review of Smart City Strategies 2017, 6). Indeed, due to their bureaucratic procedures, cities as governing entities are sometimes thought of as being antagonistic to innovation (Brorström 2015, 167). Perhaps because of this, city governments and policymakers often struggle to match the promise of smart cities with the actual messy reality of their cities (Global Review of Smart City Strategies 2017, 8). However, even though cities as governing entities may not always be innovative per se, they may still develop qualities that foster innovative thinking or the implementation of innovative ideas by others (Brorström 2015, 167). Cities can thus function both as platforms for innovations and as facilitators of innovations created by individuals, organisations and businesses.

This thesis explores the relationship between cities and innovations by focusing on the spreading of innovations which are regarded as beneficial for smart urban development, i.e. the diffusion of innovations in a smart city context. The purpose of the research is explained in more detail next.

1.3 Research purpose

As was suggested in the previous sub-chapters, in order to become smarter, cities need more than mere visions about smart urban futures. New solutions to various urban challenges should not only be envisioned and developed, they have to be implemented, adopted and diffused in order to have a real impact. The purpose of this thesis is to explore the ways the diffusion of innovations can be facilitated in the context of smart city development. The focus is on cities with explicit visions about being or becoming smart, and on innovations which are designed to make cities smarter by making urban areas more liveable, prosperous, sustainable, resilient, efficient, and inclusive.

The relevance of the topic stems, on the one hand, from the current situation in which many cities actively strive to be or to become smarter. On the other hand, criticism towards smart urban development and the general amount of obscurity surrounding smart cities as a concept suggest that transferring smart visions into smart reality is a challenging endeavour for cities. It seems that there is a threshold making it easy to fall into illusions about what it means to be smart and how smartness can be facilitated in and applied to cities. The topic can be described as relevant also because although both smart cities and diffusion of innovations have been researched as topics in their own right, the two have been rarely discussed together.

The main research question addressing the purpose of the research is:

How can innovation diffusion be facilitated as part of smart city development?

To address this question comprehensively, the following sub-questions concerning the factors influencing the diffusion of smart city innovations and the role of cities as actors and stakeholders in smart city development are used to broaden the explanatory potential of the main question:

1. What are the main factors influencing the diffusion innovations in the context of smart city development?
2. How does the involvement of cities as governing entities and stakeholders influence the diffusion of smart city innovations?

Based on the purpose of this study, the relevant literature and theories for this thesis focus on smart cities and the diffusion of innovations. Theories and academic

contributions on these are explored in order to assess and synthesise existing research into a theoretical foundation for the research purpose of this thesis. The theoretical background of this thesis begins with a discussion on the definitions and characteristics often associated with smart cities, the issues affecting smart city development, and the impact of those issues on smart city innovations. This part is followed by a discussion about the diffusion of innovations in terms of the factors influencing the adoption of innovations, the process of diffusion and issues associated with it, as well as diffusion of innovations in relation to smart city development. After this, the research design and methods used for data collection and analysis are discussed in more detail. Next, the findings of the empirical research are presented. Finally, the thesis concludes with a discussion of the findings of the study, their implications and the suggestions for future research. The structure of the thesis is summarised in figure 1.

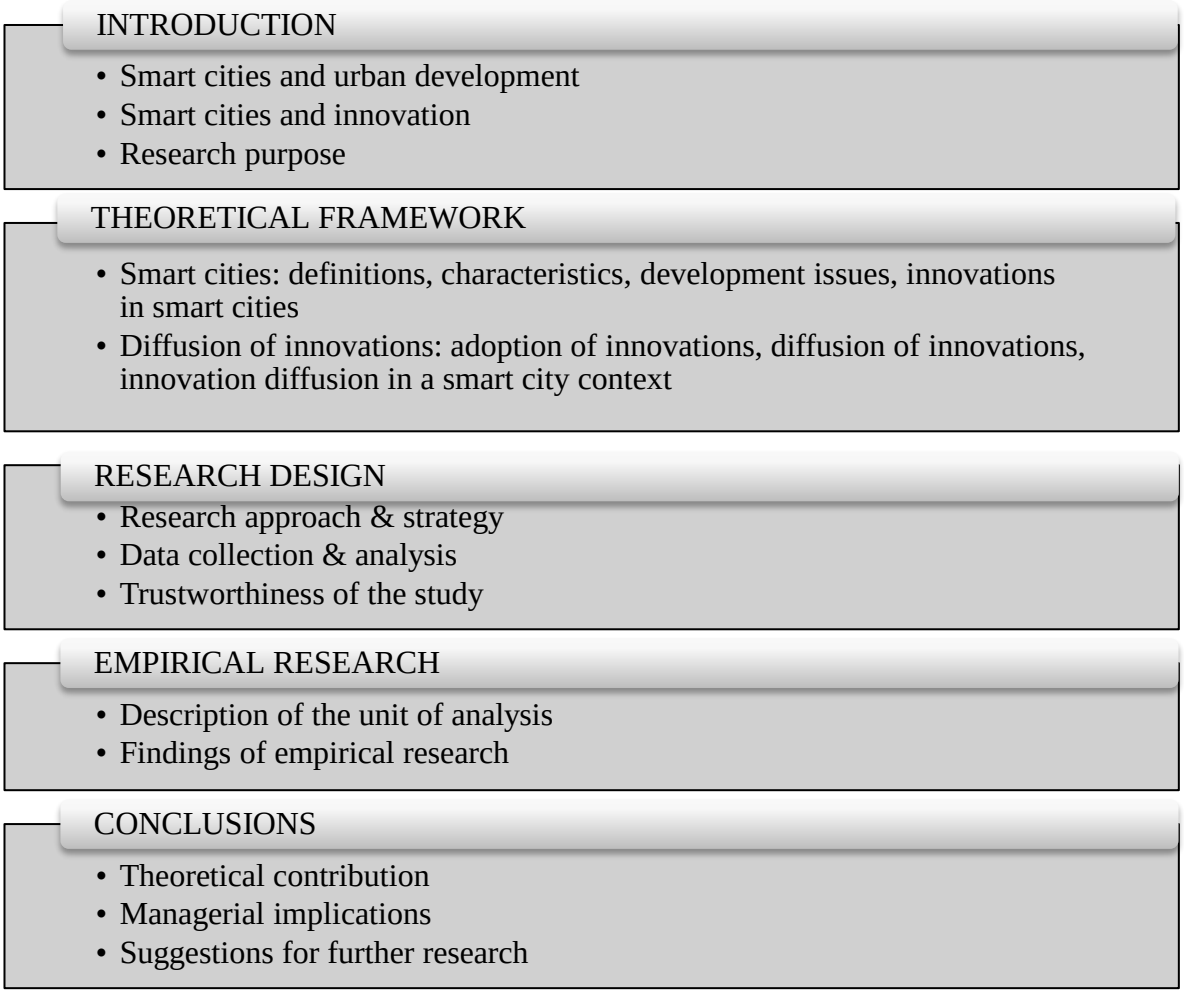

Figure 1 Structure of the thesis

While this thesis explores the general phenomenon of smart cities and the relationship between such cities and innovation diffusion, it is worth noting that the scope of the thesis is grounded on the purpose of the study and on the resources available. Temporally, this thesis focuses on smart cities as they are designed and developed in the 21st century, and especially during 2010s. As explained earlier, previous research on smart cities and innovation diffusion are used as a theoretical background for the study. In addition, the findings of the study are explored to discover their implications for innovation-based smart city development and to make suggestions for further research. However, it is beyond the scope and purpose of this thesis to make predictions about the future of smart cities or to delve extensively into their history.

Geographically, culturally and contextually, this thesis adopts a largely Westernised and Northern European perspective on smart city development and innovation diffusion. Even though both smart cities and innovation diffusion are concepts with a global reach, the scope of this thesis is bound by, for example, resource limitations which make it impossible to explore the concepts comprehensively in a global setting. Thus, while this thesis strives to recognise the sometimes differing spatial, cultural and contextual dimensions of smart cities and innovation diffusion, it is also acknowledged that the study addresses these concepts from a perspective which is sufficient and appropriate for the purpose of the research but also geographically, culturally and contextually bound.

Furthermore, because the purpose of this thesis is to explore the ways the diffusion of innovations can be facilitated as part of smart city development, the scope of the study delimits itself to exploring mainly innovation-oriented smart city development. In other words, the study recognises innovations as central building blocks for smart cities and approaches smart city development from this perspective. Therefore, while it is acknowledged that smart city development is also influenced by other factors, some of which may not be directly related to innovations, this study discusses the development from an innovation-based point of view. Similarly, although this thesis recognises that smart city development usually involves various different stakeholder groups, this study has chosen to focus mainly on the roles and views of businesses, citizens and city representatives as these were deemed most relevant for the purpose of the study. Finally, this thesis recognises that the concept of smart cities has received both praise and criticism. However, this thesis does not intend to take a stand on the on-going debate over the usefulness and appropriateness of the concept. Rather, this thesis strives to explore the development of smart cities by taking into account both its negative and positive dimensions.

2 SMART CITIES

Despite the increased public attention the concept of smart cities has received during the 2010s, the topic is still relatively little explored (Angelidou 2014, S9). Furthermore, as several terms are often used interchangeably, there is confusion concerning smart cities and what they actually are (Albino et al. 2015, 3). As mentioned in the introductory chapters of this thesis, technology is often viewed as a pivotal component of smart cities. Similarly, many current smart city conceptions tend to contribute towards growth and sustainability as cities are expected to expand their urban innovation ecosystems from their traditional urban character to green, smart, open, intelligent, and innovating (Zygiaris 2013, 218). However, regardless of similarities behind the terminology, smart city landscape is constantly shaped by local characteristics, needs, and priorities of individual cities, as well as by global market forces and available technology (Angelidou 2014, S9). Due to the crucial role of political, economic and cultural contexts in shaping cities, there is unlikely to be one unique paradigm of smart city evolution at a global scale (Neirotti et al. 2014, 26).

In addition to conceptual diversification, the empirical implementation of smart city projects and strategies displays significant heterogeneity in terms of the different fields included in the processes. Cities as governing entities are implementing their own smart projects in various different ways which contributes to additional versatility and relative obscureness of the smart city phenomenon. (Dameri 2016, 3.) Smart city stakeholders often form a diverse group of actors including representatives from, for example, local governments, technology vendors, research institutions, property developers, and grassroots movements. These groups are sometimes motivated by conflicting interest. (Angelidou 2014, S3.) The following chapters focus on the various definitions and characteristics of smart cities as well as on the challenges in smart city development in more detail.

2.1 Defining a smart city

The profusion of concepts and definitions was mentioned in the previous chapters as one of the issues causing some confusion in terms of what smart urban development actually entails. Indeed, the urban discourse has been bombarded with a wide array of concepts, such as smart, intelligent, innovative, wired, digital, and creative, which often highlight cities as places for technological transformations and economic, political and socio-

cultural changes. Because the terms often seem to share each other's assumptions, it has become difficult to separate them from one another. (Hollands 2008, 305.) The most commonly used city labels alongside smart cities are presented in the following table.

Table 1 Summary of commonly used city labels

INTELLIGENT CITY	Intelligent cities capture the innovation-friendly environment that is formed upon communities and knowledge-intensive localities with the help on information and communication technologies (Komninos 2002, 12).
KNOWLEDGE CITY	An intelligent city becomes a knowledge city when its technological policies are merged with cultural policies, and the city thus embraces knowledge as the main resource of social and economic development (Dameri 2015, 865). Knowledge cities are the first new urban formation tailored for the needs of a knowledge-based economy with infinite recipes for innovation and wealth creation, and growth based on the generation of value and sustainability from common assets (Yigitcanlar 2009, 239).
DIGITAL CITY	The intersection of physical urban areas, the people who live and work in those areas, and the nexus of technological, socioeconomic and cultural possibilities, and phenomena of the information society (Couclelis 2004, 14). Digital cities consist of citizens with computers and a network access to urban systems (Komninos 2002, 195).
CREATIVE CITY	Places inhabited by large concentrations of the so-called Creative Class and tend to rank highly as centers of innovation and high-tech industries (Florida 2005, 37). Creative cities create districts imbued with a climate of innovation and creativity in order to meet the challenges of the future (Verwijnen 1999, 12)

As can be concluded from the different labels and their definitions, there is a tendency to characterise cities according to features which denote an orientation towards specific qualities. In other words, a city is viewed as being more than a physical space or a layer

of governance. According to the labels, a city can be defined based on its approach to and relationship with something as abstract as creativity, intelligence or knowledge, or something a bit more concrete, such as a digital infrastructure.

While the concepts in table 1 mostly had their heydays during the early 2000s, the term smart city has emerged in the 2010s as a concept which strives to encapsulate the different features that contribute to the smartness of cities. According to Dameri (2015, 863), the concept of a smart city is actually a result of merging the various other city labels which distinguishes it as an integrated and comprehensive vision on all aspects of urban life. However, as noted earlier, there is no single agreed upon definition for a smart city. Table 2 below provides a glimpse of some of the definitions used to describe smart cites as separate urban entities.

Table 2 Smart city definitions

SMART CITY	Smart Cities are cities which best use modern, integrated technology services and infrastructure in energy, transport and ICT to respond to the social and economic needs of society (European Commission 2013, 1). Smart cities are cities that use new ICT innovatively and strategically to achieve their objectives (Cosgrave et al. 2013, 669). Smart city is a conceptual urban development model founded on the utilisation of human, technological and collective capital, and strives to enhance the development and prosperity in urban agglomerations (Angelidou 2014, S3). Smart cities as urban agglomerations couple areas such as creativity, innovation and entrepreneurship with digital infrastructure in order to foster economic growth and a better quality of life (Kraus et al. 2015, 602). Smart cities are able to integrate and synchronise formal leadership and democratic participation in ICT-based urban ecosystem. Smart cities thus need to be both intelligent and creative, hybrid models that combine central support, coordination, and monitoring with democratised open innovation approaches. (Ben Letaifa 2015, 1415)

As can be concluded from the definitions included in the table above, smart cities are often differentiated from other city concepts by the way smart cities are expected to utilise

technology as means rather than the end of development. Due to their innovative character, smart cities are expected to embed technology and knowledge creation in urban infrastructures, governance, culture and people (Dameri 2015, 864). The smart city idea thus also absorbs the aspects stressed by intellectual and knowledge city concepts by merging them with a wider vision incorporating issues such as environmental safeguards and good governance (Dameri 2015, 865). However, the tendency to use smart city as an all-encompassing umbrella term for urban development has also received some criticism. Hollands (2008, 306) perceives a problem with merging smart cities with labels such as digital, wired, knowledge and cyber as these concepts are by no means unambiguous. In other words, while such labels tend to emphasise the significant impact information technologies have on cities, some of the labels are more technologically driven and determinist, while others emphasise different types of information and networks, and still others refer to human capital in the form of skills, education, creativity, and competencies. Schaffers et al. (2011, 434) echo Hollands's view stating that the concept of smart cities has some unique properties within the wider digital, cyber, and intelligent cities literature. Caragliu, Del Bo and Nijkamp (2011, 66) appear to advocate a middle-ground approach stating that smart cities are the sum of creativity, human capital, cooperation, and new scientific ideas which have traditionally formed the smart solutions utilised in solving urban challenges. The concept of smart city should therefore focus on clever solutions, technological and other, which enable cities to thrive through quantitative and qualitative improvements in certain areas. These areas are discussed in more detail next.

2.2 Characteristics of a smart city

Just as there has been confusion concerning smart city definitions, there has been some debate over what characteristics are typical for a smart city. In their research into the literature focusing on main dimensions and elements characterising smart cities, Albino et al. (2015, 13) found four most commonly used characteristics. The first is a city's networked infrastructure enabling political efficiency as well as social and cultural development. The second is an emphasis on business-led urban development and creative activities promoting urban growth. The third is social inclusion of various citizens and social capital in urban development. The fourth and final is the perception of the natural environment as a strategic component for the future. Similarly, based on their overview of the smart city concept as well as the planning and economics approaches related to it, Caragliu et al. (2011, 68) summarise that cities are characterised as smart when they

utilise networked infrastructure as the main development model and connectivity as the source of growth, and emphasise business-oriented urban development. Furthermore, smart cities focus on achieving social inclusion of various citizens in public services, stress the important role of high-tech as well as creative industries in long-term urban growth, focus on the role of social and relational capital in urban development by ensuring the ability of citizens to use technology in order to benefit from it, and recognise social and environmental sustainability as a crucial strategic component.

As mentioned in previous chapters, ICT infrastructure, data, and information management are believed to form an important part of smart urban development. According to Schaffers et al. (2011, 435), in order to become smart cities must first create a rich environment of broadband networks that support digital applications. This includes the development of suitable ICT infrastructure, and the enrichment of cities' physical space and infrastructures with embedded systems, smart devices, actuators and sensors providing real-time data and information processing. Furthermore, applications for data collection, processing, web-based collaboration, and actualisation of citizens' collective intelligence are needed. From the point of view of businesses, advanced technologies can lower entry barriers and make it possible to exploit new opportunities (Kraus, Richter, Papgiannidis & Durst 2015, 602). Interestingly, however, research by Kraus et al. (2015, 606) revealed that entrepreneurs consider the availability of ICT infrastructure almost as a given for any business location. Thus, the availability of ICT infrastructure alone may not offer a competitive smartness advantage to one city over another. Furthermore, Angelidou (2014, S3) argues that the persisting belief in that innovative technological instrumentation automatically transforms a city into a smart city often hinders the clarification of the smart city concept even further. In a similar vein, Hollands (2008, 314) notes that by assuming that there is an automatically positive impact of ICT on urban development, and that the smart city label leads to a harmonious high-tech future, certain cities have managed to create a rather limited political agenda based largely on high-tech urban entrepreneurialism.

Another characterising element for many self-designated smart cities has been their emphasis on business-led urban development (Hollands 2008, 308). Schaffers et al. (2011, 436) note that city authorities hoping to make their city smart need to create a suitable environment for business models that sustain long-term operation of smart cities. However, as public investment is often limited and therefore also relatively ineffective, business-led urban development and private capital investment are often perceived as decisive factors for smart city development and urban growth (Kraus et al. 2015, 602). Much like the focus on ICT, the emphasis on business-led urban development has

received its share of criticism. Hollands (2008, 311) argues that technological determinism has made the concept of smart city merely a smokescreen for ushering in a business-dominated information city. Kitchin (2014, 10) suggests that the strong presence of big corporations in the actualisation of smart city agendas may cause corporatisation of city governance and a technological lock-in as some companies increasingly view cities, their governance and infrastructure as homogenous, long-term markets for their cookie-cutter products and solutions.

In addition to providing beneficial conditions for businesses, smart cities are often expected to be characterised by the inclusions of citizens in public services, and by transparent governance systems which enable citizen involvement. Cities often have a fairly heterogeneous population whose sense of belonging is influenced by the choices they have in terms of, for example, employment, living conditions, and their say in decision-making processes (Srivastava et al. 2012, 153). Smart citizen-centric and citizen-driven governance is expected to engage various stakeholders in decision making and public service processes by bringing smart city initiatives to citizens, and by keeping both the decision making and implementation processes transparent by the means of ICT-mediated e-governance (Albino et al. 2015, 12). Furthermore, according to Schaffers et al. (2011, 435), smart cities should initiate large-scale participatory innovation processes for the creation of applications running and improving every sector of activity, infrastructure and urban cluster. Based on this view, every urban activity and utility can be perceived as an innovation ecosystem in which organisations and citizens participate in the development, supply, and consumption of products and services. However, the research by Kraus et al. (2015, 607) revealed that most entrepreneurs did not consider citizen involvement as crucial part of smart city development. Citizens were largely perceived only as consumers and their impact on the creation of new smart solutions was not considered as important.

Finally, as was mentioned in the introductory chapters of this thesis, with more than half of the world's population living in cities, topics such as urban environment, cities and biodiversity, and urban ecological resilience have received increased attention (Srivastava et al. 2012, 145). The present situation of largely unsustainable consumption and production is harming the environment and this concerns human settlements in general and urban areas in particular. There is a heightened sense of urgency to implement local and global measures to address climate change and the deterioration of ecosystems largely caused by human intervention. (Srivastava et al. 2012, 146.) Consequently, social and environmental sustainability is often considered as one of the key objectives of smart

cities as they are expected to take into account the scarcity of resources and focus on the creation of sustainable solutions for urban issues (Kraus et al. 2015, 604).

As the discussions above and the summary presented in figure 2 indicate, smart city is a multifaceted concept in terms of its definitions and characteristics. Interestingly, while there are extensive discussions on what makes a city smart, existing research has not really delved into the potential conflicts, interdependencies and synergies between the different smart city characteristics. Based on the existing research it is, in fact, difficult to determine the stability and the relative weight of the different characteristics. It is also unclear whether a city can be or become smart by focusing only on certain features and characteristics while ignoring others. Similarly, it is unclear whether the smartness of a city is an outcome of a stage-based development or a continuous development process. Perhaps due to this kind of obscurity, strategic planning for smart city development has remained a relatively abstract idea with unexplored and interdisciplinary fields (Angelidou 2014, S3).

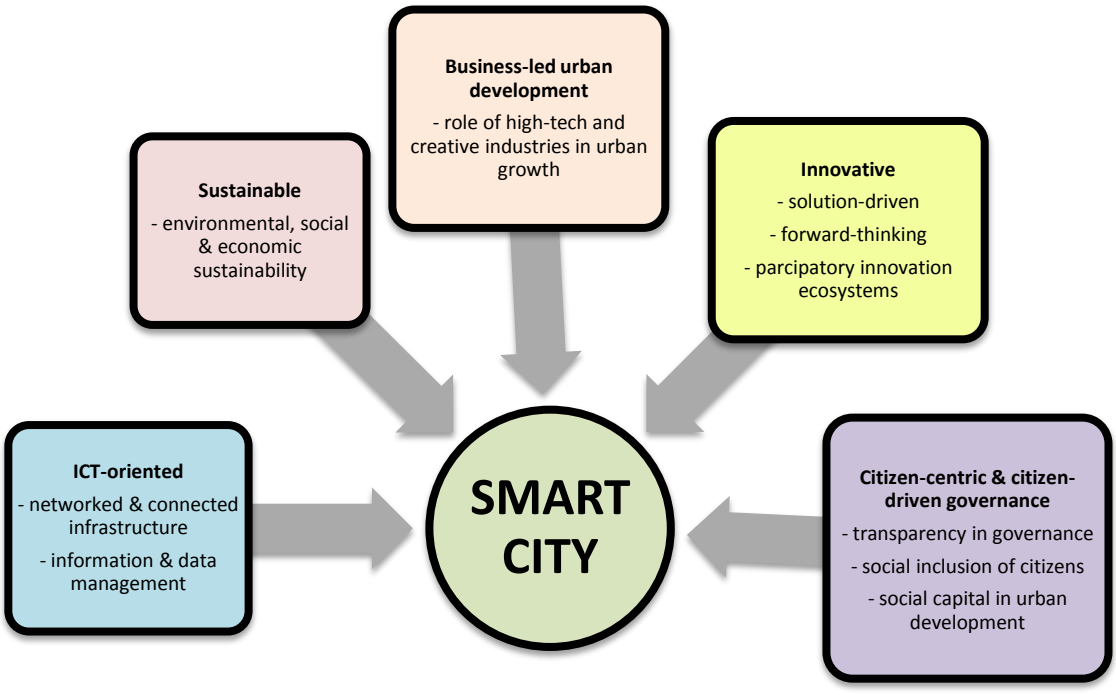

Figure 2 Commonly used characteristics to describe smart cities

Although the focus of this thesis is on the role of innovations in smart city development, it is beneficial to recognise that the concept of smart cities is often used to

refer to a sum of characteristics. This kind of richness of expectations has often caused confusion in terms of what smart city development actually entails. The factors influencing smart city development are discussed more thoroughly in the following chapter.

2.3 Factors affecting smart city development

The previous chapters focused the mixture of different concepts and characteristics that are applied to somewhat similar ideas of smart urban development. While this conceptual variation may at least partly explain the vagueness of smart cities, it is also important to take into account the more practical issues faced by smart city development. Ben Letaifa (2015, 1418) argues that public leaders often disregard the strategic steps needed to initiate and coordinate smart city development processes. Instead, they tend to believe that environmental, social, and economic development and transformation is driven by technology alone. Similarly, Angelidou (2014, S3) suggests that there is a great misunderstanding concerning what smart cities are as well as how they can be realised. Smart city development comes with several challenges such as determining which new services to prioritise and which business modes to adopt, defining how new services and business models change the established ones and the existing information architecture, and solving how to assess the sustainability of new services (Kuk & Janssen 2011, 39). Since municipal governments and the lowest tiers of governments usually have limited autonomy and resources, the governing bodies of cities often need to choose few areas or domains that need to be improved urgently (Angelidou 2014, S9).

In this chapter, the factors affecting smart city development are discussed in more detail. The first sub-chapter focuses on the ways smart cities are designed based on what is or is not already in place. The second sub-chapter explores the coordination issues associated with smart urban development.

2.3.1 Integrating smartness into cities

The fact that cities differ from each other in terms of their size, demography, and resources has raised discussion about what kind of cities can actually be or become smart. Angelidou (2014, S8) argues that for smart urban development, it is crucial to understand what is already in place and how existing resources could be capitalised on and improved.

For example, the European Union has set in motion several smart city initiatives in existing urban areas such as Barcelona and London which are generally considered as relatively good examples of cities implementing integrated smart city strategies with visions including technology, human capital advancement through knowledge economy development and efficiency-oriented targets (Angelidou 2015, 102). Masdar City in the United Arab Emirates, on the other hand, is one of the best-known examples of completely new cities built according to eco-city principles of sustainable development. Another similar smart city project is the South-Korean Songdo International Business District, a place build from scratch with plans to install telepresence in every household and for every resident in order to create an urban space that is completely ubiquitous. Much like Masdar, Songdo has been criticised for being more like a real estate initiative with the label smart included as a consequence of the utilisation of modern ICT. (Albino et al. 2015, 16.)

According to Shelton, Zook & Wiig (2015, 14), greenfield smart cities such as Masdar or Songdo are often designed and built according to the centralised plans of global technology corporations. However, such smart cities, constructed on tabula rasa, are the exception rather than the rule, and offer very little insight into the ways an increasing focus to ICT is affecting urban governance in existing cities. It is therefore more useful to examine how smart city paradigm is developed in existing regions and more mature cities. Shelton et al. (2015, 15) note that rather than constructing new cities from scratch or importing universal ideas into existing cities, smart cities are usually assembled piecemeal, awkwardly integrated into existing configurations of the built environment and urban governance. It is thus pointless to try to implement ideas and policies developed in specifically built greenfield smart cities to existing cities with different socio-economic and spatial contexts.

The uniqueness of different urban settings is challenging for many stakeholders. For example, according to Kraus et al. (2015, 611), some entrepreneurs see the market scope of smart city innovations as relatively narrow and limited to particular city boundaries due to the difficulties of transferring solutions from one urban context to another. The ways cities choose to develop smart city initiatives are varied and influenced by various different factors. Neirotti et al. (2014, 29) suggest that structural factors of size and demographic density of a city are among the key contextual conditions influencing the resources and needs of investing in smart city initiatives. Kraus et al. (2015, 610) note that while large cities often have most of the elements or characteristics required for becoming smart, blending the elements into a coherent smart city vision is not a simple task. Furthermore, it is not enough to have a vision at the city government level as the

vision has to be clearly communicated to potential entrepreneurs in order to achieve a sense of direction with priorities (Kraus et al. 2015, 611). Smaller cities, on the other hand, can prove to be more flexible settings with shorter installation times and lower costs for pilot projects (Neirotti et al. 2014, 29).

Technology development is another factor impacting how cities choose to approach smart city initiatives. According to Cosgrave et al. (2013, 669), governments often struggle with establishing the quantifiable value sources and opportunities that new ICT applications and smart technologies can generate. Since development and diffusion tend to follow path-dependent dynamics, cities that have already adopted ICT-systems that characterise the trends of smart city initiatives often operate with more favourable conditions to further develop and adopt emerging technologies belonging to the same trajectory. Correspondingly, limited technology diffusion can reflect digital divide which hinders the realisation of critical mass of users and jeopardises the development smart city initiatives as well as their economic and societal value. (Neirotti et al. 2014, 30.)

Lastly, Shelton et al. (2015, 15) point out that it is also important to understand that smart cities differ from each other also internally, being geographically uneven at a variety of scales. Not all spaces of the city will become equally smart as smart city development will privilege some places, people, and activities over others. In addition to a city's size and its economic, technological, and environmental development, country-specific factors such as political leadership and national political agendas, cultural variables, and climatic conditions are also among the factors determining the needs and approaches to smart city policies and initiatives (Neirotti et al 2014, 30).

2.3.2 Coordination of smart city development

In terms of city governance and development, smart cities appear to require different approaches when compared to traditional city governance. According to Dameri (2015, 878), a successful smart city implies a novel form of organisation which is simultaneously knowledge-based, network-shaped, and project-oriented. Ben Letaifa (2015, 1416) argues that smart city governance is more complex that traditional city governance because smart cities must bring societal actors from both the public and the private sectors together to collaborate in order to reach a common goal. The governing entity in charge of smart city development is often a complex network of representatives from, for example, public administration bodies, universities, and municipal utilities. Relationships within these networks may be based on formal inter-organisational agreements. However, in many

cases the most important relationships shaping smart city governance are fluid and informally managed. This implies a need for new governance and coordination methods. (Dameri 2015, 878.)

The involvement of various stakeholders can be challenging as noted by Angelidou (2015, 104) who views the current smart city stakeholder system as "[…] very complex and driven by diverging interest; this fact perplexes the smart city idea, oftentimes causing it to drift away from its originating principles." According to Zygiaris (2013, 219), smart city plans require an orchestrator with executive and policy planning authority because developing a smart city requires leadership that is balanced with the ability to engage local stakeholders into a hybrid model that combines central monitoring with bottom-up participation. In addition, coordination and monitoring is crucial to ensure that smart city development benefits as many stakeholders as possible. In other words, smart city visions need to be realized through public-controlled integrated urban operating systems in order to avoid vendor monopolies and to offer unrestricted data for all citizens rather than creating virtual gated communities and corporate enclaves (Zygiaris 2013, 2020). Table 3 presents an overview of some of the most common stakeholder groups and their potential roles in smart city development.

Dameri (2016, 4) notes that the actual implementation of smart city development projects is usually a bottom-up phenomenon in which several actors independently of each other start to implement a smart initiative with a help of public infrastructure or technological solutions. For example, stakeholders such as solution vendors, municipal governments, and research and education institutions can act as enablers of smart city development by realising digital platforms, pursuing environmental protection, and striving to enhance the quality of urban life. The benefits of such smart city development are then enjoyed by various stakeholders from public administration, to businesses operating in a more innovative economic environments, and citizens benefitting from enhanced living conditions, improved public services, and better economic opportunities (Dameri 2016, 5). Ben Letaifa (2015, 1418) echoes these viewpoints stating that scholars should acknowledge that city transformation strategies go beyond top-down and bottom-up models, and that further research on decentralisation and coordination of smart city processes is needed.

Table 3 Stakeholders and their potential roles in smart city development

Stakeholder group	Description	Potential role in smart city development
Citizens	People living in the city	Initiators, beneficiaries, participants or partners, innovators, supporters or opponents
Temporary citizens	People using and visiting the city (e.g, people working in the city, tourists)	Initiators, beneficiaries, participants or partners, innovators, supporters or opponents
City governance	Authorities overseeing city management and governance (e.g. municipal authorities, public administration)	Initiators, enabler (regulatory, resources), administrators, beneficiaries, innovators, supporters or opponents
Businesses	Private entities producing goods, services and solutions	Initiators, innovators, enablers, participants or partners, beneficiaries, supporters or opponents
Public and special interest groups	Entities advancing specific interests and/or activities (e.g. industry associations, consumer & environmental activist groups)	Initiators, beneficiaries, participants or partners, innovators, supporters or opponents
Academic and research institutes	Entities responsible for providing education and conducting research	Initiators, enablers, beneficiaries, participants and partners, innovators, potential supporters or opponents
Utility service providers	Entities providing necessary services and infrastructure (e.g. water and waste management, electricity, public transportation)	Initiators, enablers (resources & infrastructural framework), beneficiaries, participants and partners, innovators, potential supporters or opponents
Financial organisations	Entities providing financial services, funding, investments and asset management (e.g. banks, foundations, development programmes)	Initiators, enablers (resources), participants and partners, potential supporters or opponents

Bottom-up approaches can indeed be helpful in prioritising smart city initiatives, as noted by Kraus et al. (2015, 611) who suggest that social capital and the ability to connect with residents can help cities to identify key problems as well as to help discover solutions to them. However, for the ideas to develop beyond prototypes, a suitable urban environment is needed for creative business ecosystem facilitating the development and commercialisation of ideas. A successful government-led smart city development and support can enable ideas to scale in a way that they become financially viable. (Kraus et al. 2015, 612.) The role of local authorities in fostering human capital and innovation, and in creating the right institutional conditions can mean, for instance, the establishment or support of local incubators for start-ups as well as their connection to international innovation systems (Neirotti et al. 2014, 27). However, Brorström (2015, 176) notes that local authorities often use much time and effort in preliminary impact evaluation because innovative ideas with positive impact are better candidates for funding. The strong emphasis on impact evaluation can be problematic because in many cases the impact of innovations is difficult to measure, especially in the short run. This can create a paradoxical situations if ambitious smart city project goals prove to be too demanding to be realised (Brorström 2015, 174). Furthermore, even though public organisations can offer stability as well as important resources needed to put ideas into practice, innovative ideas legitimised through political decisions do not automatically succeed as demand for the is still in the hands of citizens (Brorström 2015, 177).

To some extent, the need for alternative practices has already been noted. For example, Shelton et al. (2015, 16) note that the rise of smart cities has given prominence to new inter-organisational partnerships and alliances which reflect extra-territorial networks of actors at the centre of efforts to realise smart city projects. Smart city ideas and funding are often propagated through these partnerships and alliances. Furthermore, Angelidou (2014, S9) notes that there is an emerging trend to approach urban development and smart cities through small-scale integrated projects which create urban innovation ecosystems embossed in the physical space of the city with positive impacts on their surrounding area. These initiatives operate as user-friendly pilot projects encouraging citizen participation and raising both awareness and acceptance in smart city transitions. Such projects should, however, form a part of broader strategic plans of cities.

This chapter has focused on the topic of smart cities in terms of what is thought to make a city smart and what factors influence smart city development, as summarised in figure 3.

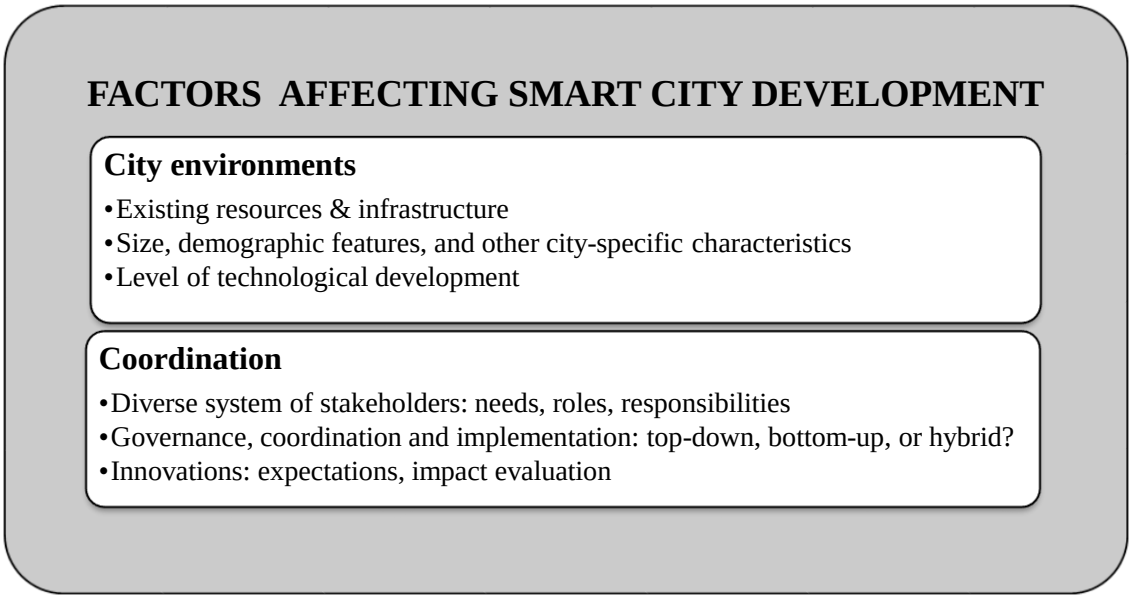

Figure 3 Factors affecting smart city development

The discussions in this chapter concerning the definitions and the characteristics associated with smart cities imply that in order to become smart, cities should respond to socio-economic and environmental challenges caused by increased urbanisation. In most cases, such smart urban development entails new solutions in the form of innovative products, services, processes, and practices. In order to have a real impact, solutions to various urban challenges need to be discovered, implemented and diffused within and among cities. The final part of this chapter discusses the relationship between smart cities and innovation-based development.

2.4 Innovating smarter cities

The introductory chapter of this thesis defined innovations as ideas, practices and objects perceived as new by individuals, organisations and other entities (Rogers 2003, 12). Innovations thus represent change that is either incremental or radical depending on the degree of newness and departure from the existing state of affairs. In this chapter, smart cities have been described and characterised as cities that utilise features such technology, especially ICT, creativity, innovation, and democratic participation processes to build urban settlements that embrace sustainability, innovations, citizen-centric and citizen-driven governance, and business-led urban development. Smart city innovations can be defined as those new ideas, practices, objects and solutions which aim for such urban

development by changing cities into more liveable, prosperous, sustainable, resilient, efficient, and inclusive places to live, spent time, work, and move around.

As was mentioned earlier in this thesis, cities as settlements and environments are often considered fertile grounds for innovations to emerge and flourish. At the same time, however, cities can also be fairly resistant to change, especially in terms of their existing infrastructure, resources, and governance structures. Most smart city development occurs in cities with long histories and developed urban environments. In order to become smarter, such cities, their stakeholders and systems need to be adaptable and open to change. However, when it comes to existing infrastructure and governance structures, change in the form of innovations can be costly, demanding and time-consuming. Furthermore, city dwellers, like most people, are creatures of habit which can make change a mentally laborious process. Thus, even though some innovations could potentially solve problems caused by urbanisation, implementing and spreading those ideas, practices, objects and solutions in order to create smarter cities is not as straightforward as it may initially seem.

The fact that cities differ from each other in terms of their demographic features, size, infrastructure, market conditions, geography, technological and environmental development, political leadership, governance structures, and other cultural variables is also likely to affect innovation-based smart city development. Business-wise, most innovations need to be scaled up in order to survive. Depending on the nature of the innovation, developing and selling smart solutions that work for more than one city can be challenging. Heterogeneity among cities can also complicate innovation deployment because the variety of smart city approaches and the lack of standardisation makes benchmarking practices difficult. Furthermore, this chapter has discussed the various different stakeholder groups present in cities. The needs, roles and responsibilities of these stakeholders can vary and even conflict with each other. What may be considered as a smart and worthy innovation by some stakeholders can be dismissed and opposed by others, thus affecting the scalability of an innovation.

Finally, the way cities as governing entities choose to approach smart city development is also likely to influence how and what kind of innovations emerge as well as how those innovations are spread. A top-down approach can make it easier to implement large-scale changes with the help regulatory measures and authority decisions. Such approach can also be useful for smart city innovation providers if local authorities are able to provide them with leverage and support. A more bottom-up approach, on the other hand, can be useful in engaging citizens and grass-roots movements into smart city development which, in turn can make it easier to discover innovations that make cities smarter from

the citizens' point of view and are thus more readily accepted as part of smart urban development.

This part of the thesis has concluded that although many cities strive to become smart, confusion and criticism towards the concept of smart cities suggest that most cities have not yet been very successful in planning and executing their visions, or in fulfilling the visions and expectations of others. This, in turn, may imply that even though innovation appears to be one of the prerequisites for smart urban development, deploying and spreading innovations that support smart urban development is a challenging endeavour for many cities. In order to better understand the issues affecting the spreading of smart city innovations, the following chapter moves on to explore the theories of innovation diffusion in more detail.

3 DIFFUSION OF INNOVATIONS

Theories on diffusion of innovations strive to explain how new ideas and practices spread within and between communities (Valente & Davis 1999, 56). Diffusion of innovations can be described as the means by which innovations are translated into economic and social benefits as they are adopted by wider populations. Most innovations tend to have only limited social or economic impact because they are not widely adopted. (Tidd 2010, 3) The success of innovations is ultimately dependent on the way they are accepted and used by the public (Wang 2010, 207). Accelerating the rate of diffusion of an innovation is a frequent challenge as most innovations usually require periods of many years from the time they become available to the time they are widely used (Rogers 2003, 1).

Research on the diffusion of innovations has developed across various disciplines and has largely focused on the flow of information, ideas, products, services, and practices both within and across cultures, markets and market segments (Gatignon & Robertson 1985, 849). Diffusion theories and understanding how individuals perceive attributes of innovations, as well as how social mechanisms can be leveraged to enhance adoption, have been valuable for many companies commercialising their innovations (Häggman 2009, 386). While most economic and marketing studies on diffusion have focused on innovations as new technologies and products, an innovation can also be an idea, belief, information, or practice (Tidd 2010, 7). The diffusion of such innovations is considered as much a social process as is the diffusion of technological innovations (Rogers 2003, 93).

This chapter focuses on factors influencing diffusion of innovations. It begins with a discussion of adoption of innovations. This discussion is followed by chapters focusing on diffusion processes, and the different ways of facilitating and managing diffusion. Finally, diffusion of innovations is discussed in relation to smart city development.

3.1 Factors affecting the adoption of innovations

Distinguishing between diffusion and adoption of an innovation can be challenging because both concepts describe how an innovation is acquired. However, while adoption of an innovation is usually determined by how the innovation is perceived by individual adopters, diffusion generally occurs within a wider population in which adoption takes place. (Rolfstam, Phillips & Bakker 2011, 454.) Adoption is thus an integral part of diffusion but it can also be separated from the wider process as a specific activity.

According to Rogers (2003, 167), innovation-decision is the process an individual or other decision-maker goes through when considering the adoption of an innovation. In many cases, the process of innovation-decision consists of five stages. The first stage is knowledge which occurs when a decision-maker is exposed to the innovation. The second stage is persuasion during which a decision-maker forms a favourable or unfavourable attitude towards the innovation. Decision stage takes place once a decision-maker either adopts or rejects the innovation. Implementation stage occurs when a decision-maker has decided to adopt the innovation and puts it into use. Confirmation is the stage during which a decision-maker seeks reinforcement of the innovation-decision made previously and may reverse the decision that has already been made. (Rogers 2003, 169.)

According to Rogers (2003, 13), the process of innovation-decision is fundamentally an information-seeking and information-processing activity of an individual who is motivated to reduce uncertainties about the potential advantages and disadvantages of an innovation. Thus, the different rates of adoption are usually explained by the characteristics of an innovation as perceived by an individual (Rogers 2003, 15). The same innovation can be desirable for some individuals in certain context but undesirable for others in different context (Rogers 2003, 12). Wang (2010, 202) notes that innovation-decisions are rarely rational processes as consumers may use shortcuts or favour feelings over reason, and are generally unaware of all the reasons affecting their decision-making. There is also evidence that even ineffective innovations can be adopted if adopters judge them as appropriate and vice versa (Croidieu & Monin 2010, 292). Diffusion researchers, on the other hand, generally agree on the existence of certain relevant variables affecting adoption. However, there is less consensus regarding the relative importance of the different variables and the direction of relationships between them. (Tidd 2010, 20.)

3.1.1 Attributes of innovation

The adoption rate of an innovation is the relative speed the innovation is adopted by members of a social system (Rogers 2003, 221). It is often determined by the innovation's perceived attributes such as the relative advantage it provides as well as its compatibility, complexity, trialability and observability (Rogers 2003, 222). The relative advantage of an innovation is the degree to which an innovation is perceived to be superior to similar alternatives (Rogers 2003, 15). Relative advantage is often measured in economic terms but non-economic attributes such as convenience and social prestige can be as important.

Generally speaking, the greater the perceived relative advantage, the faster the adoption rate. (Tidd 2010, 21.)

The compatibility of an innovation is defined in terms of the degree to which an innovation is considered as being consistent with the existing values, past experiences, and needs of potential adopters (Rogers 2003, 15).The acquisition of innovations tends to depend on prior acquisition patterns and existing inventories of goods and services (Gatignon & Robertson 1985, 854). A major barrier may occur if potential adopters already own or have access to a similar product or service, or if the innovation does not fit in the existing consumption system (Gatignon & Robertson 1985, 855). For example, the research by Naor, Bernardes, Druehl & Shiftan (2015, 46) discovered that products with lower compatibility require greater design effort by companies to foster adoption. If the degree of compatibility between the targeted market segment and the innovation's characteristics is high, the rate of adoption tends to be faster (Catignon & Robertson 1985, 860).

The degree to which an innovation is perceived as relatively difficult or easy to use defines its complexity (Rogers 2003, 16). Innovations which are easier for potential users to understand are usually adopted more rapidly than those that require new skills and knowledge (Tidd 2010, 22). Uncertainty associated with innovations is related to learning requirements, i.e. the greater the uncertainty, the greater the need for additional information before the decision about adoption can be made (Gatignon & Roberson 1985, 859).

Trialability of an innovation is defined by the degree to which individuals are able to experiment with it. Trials can decrease uncertainties and enable potential adopters to customise the innovation according to their needs. (Rogers 2003, 258.) They can also enable learning by doing which is likely to accelerate the rate of adoption (Tidd 2010, 23). Observability of an innovation is the degree to which the results of an innovation are apparent to others (Rogers 2003, 258). The easier it is to see the benefits of an innovation, the more likely it is that the innovation will be adopted (Tidd 2010, 24).

In addition to the attributes described above, attributes such as image, results demonstration, and voluntariness have also been identified as factors affecting adoption. Image refers to the degree to which it is important to be seen using the innovation. Result demonstration indicates the scale an innovation is viewed as offering tangible benefits. Voluntariness refers to the degree to which the adoption of an innovation is voluntary. (Valier, McCarthy & Aronson 2008, 221.) Figure 4 summarises the attributes of innovations believed to affect the rate of adoption.

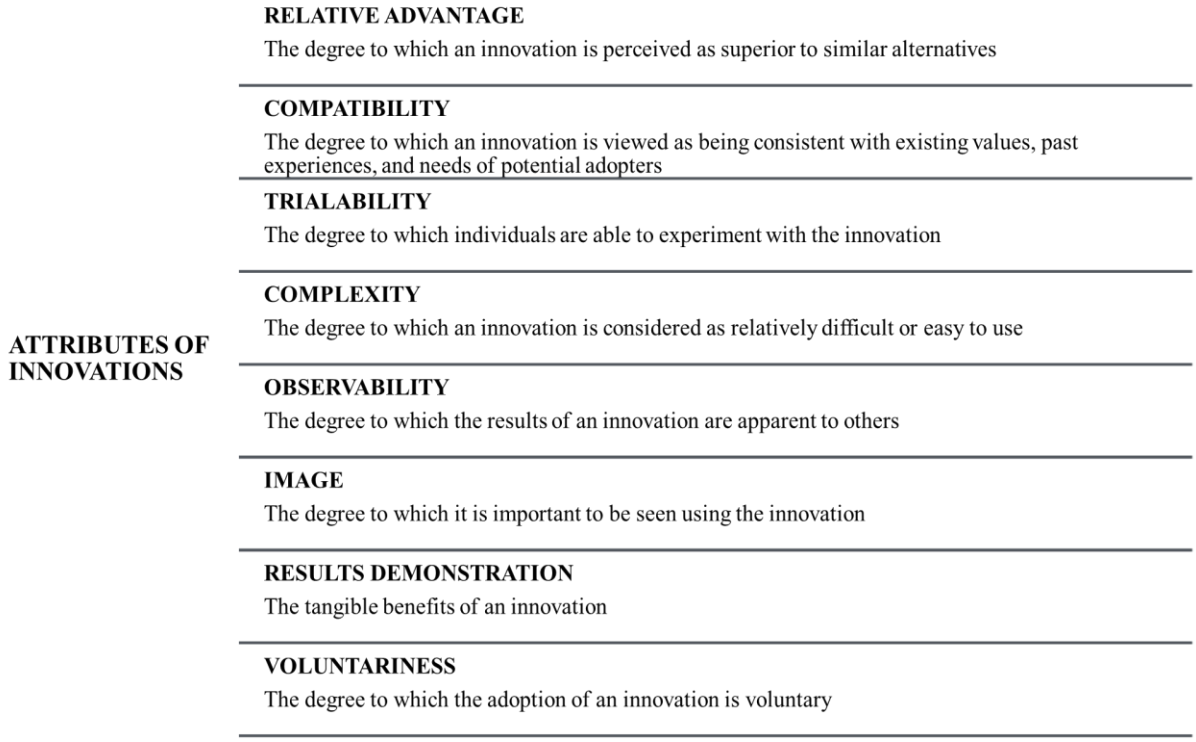

Figure 4 Attributes of innovations affecting the rate of adoption

3.1.2 Adopter characteristics

Adopter characteristics include variables such age, social status, education, and attitude towards risk (Tidd 2010, 20). Such characteristics can determine a potential adopter's perception of the value of an innovation and the feasibility of its adoption (Wejnert 2002, 320). According to Rogers (2003, 267), individuals can be classified into five categories on the basis of when they are likely to adopt new innovations. These categories consist of individuals with a similar degree of innovativeness. Innovators are the first, most innovative and venturesome adopters who import innovations into wider systems. Early adopters are the individuals that follow innovators and often serve as opinion leaders and role models for the early majority who adopt the innovation after them. (Rogers 2003, 283.) The late majority adopt the innovation just before the final group which consists of laggards with lengthy innovation-decision processes (Rogers 2003, 284). In this categorisation, the innovativeness of individuals is measured by

behavioural profiles such as personality variables and communication behaviour (Wang 2010, 199). The following figure presents a summary of Rogers's adopter classification.

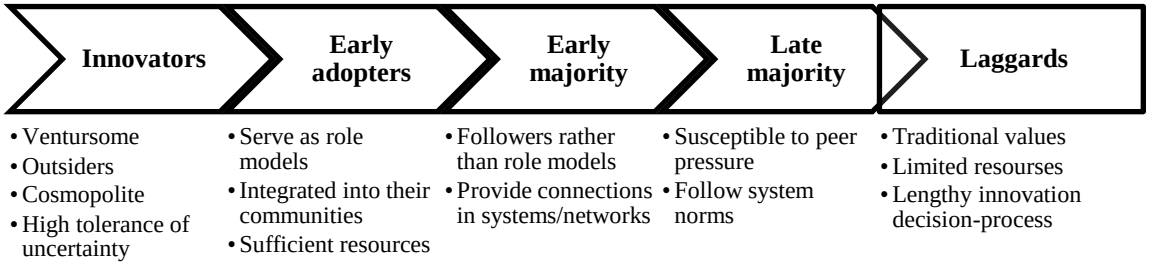

Figure 5 Adopter classification (adapted from Rogers 2003)

Although diffusion research has focused considerable attention on the characteristics of adopter categories which are defined in terms of the number of standard deviations from the mean time of adoption within a population, McMaster and Wastell (2005, 389) argue that Rogers's demographic taxonomy does not really divide individuals in to five categories as much as it polarises the world into active sources of innovations and passive receivers of innovations. The big picture thus seems to consist only of courageous innovators and a passive mass of laggards with no aspirations or resources of their own (McMaster & Wastell 2005, 387). Catignon and Robertson (1985, 861), on their part, note that findings on specific adopter traits have been questioned due to lack of consistency in empirical studies. Personal characteristics of adopters tend to apply more in some adoption cases than in others. For example, although a higher degree of change often leads to increased levels of resistance, individuals exhibit different levels of resistance depending on the situation (Naor et al. 2015, 29). Adopter categories and their characteristics should thus be identified and characterised on a case-by-case basis (Catignon & Robertson 1985, 861). Tidd (2010, 5) agrees and criticises the tendency of diffusion research to focus on categories such as early adopters as they are based on the very early studies of diffusion and are not universally applicable. Instead, what is needed is a better understanding of the factors that support and constrain adoption, and how the factors influence the rate and level of diffusion within different populations and markets.

3.1.3 Other factors affecting the adoption of innovations

Diffusion research has traditionally focused on innovation adoption in terms of either adopter characteristics or innovation characteristics, and the direct relationships between these elements. This approach may, however, provide insufficient explanation for the adoption of some innovations, and attention should also be paid to interactions among diffusion constructs as well as marketing and competitive initiatives. (Catignon and Robertson 1985, 864.) According to Tidd (2010, 14), the adoption of an innovation always depends on the interaction of factors from both demand- and supply-side. Demand-side factors include direct contact with or imitation of prior adopters, as well as adopters with different views on benefits and risks. Supply-side factors include the relative advantage of an innovation, barriers to adoption, availability of information, and feedback between developers and users.

An important factor affecting the adoption of innovations is the role of environmental context. Innovations evolve in a specific ecological and cultural context which influences their adoption and diffusion processes. (Wejnert 2002, 310.) This context manifests itself in many ways. According to Croidieu and Monin (2010, 289), cultural approaches to diffusion highlight that innovations are judged based on their cultural appropriateness and effectiveness. Innovations which are in accordance with cultural understandings of appropriate and effective action are more likely to be adopted than those that are perceived as inappropriate and ineffective (Croidieu & Monin 2010, 320). In addition to cultural aspects, Tidd (2010, 20) emphasises environmental context in terms of institutional characteristics such as market environment and communication networks, while Wejnert (2002, 310) divides environmental context into four subgroups consisting of geographic settings, societal culture, political conditions, and globalisation and uniformity. MacVaugh and Schiavone (2010, 200), on the other hand, refer to the importance of community of practice as a feature of adoption. A community of practice is defined in terms of its joint enterprise as understood by its members. Its functioning is determined by the relationships of mutual engagement which bind members together into a social entity. The capability of a community of practice is the shared repertoire communal resources, such as style and routines, developed by the community over time. (MacVaugh & Schiavone 2010, 201.) Rogers (2003, 26) echoes these views stating that innovativeness of an individual is defined both by individual characteristics and by the nature of the social system. For example, the established behavioural patterns which define standards for the members of a social system can operate at many different levels, such as national or organisational, and can function as barriers to change.

In addition to the attributes of the innovation, characteristics of the adopter, and the environmental context, the rate of adoption can be determined by the type of innovation decision. According to Rogers (2003, 28), innovations can be adopted or rejected by an individual system member, by the whole system as a collective, or by an authority decision. Optional innovation-decisions are made as choices by individuals as the main units of decision-making. Collective innovation-decisions are made by consensus among a group of potential adopters. Authority-decisions are conducted by individuals possessing power, status, or expertise over others who are made to either adopt or reject an innovation (Rogers 2003, 29). While authority-decision often result in the fastest rate of adoption (Rogers 2003, 29), systems which leave individuals in charge of the decision to either adopt or reject are more likely to diffuse innovations that fit better with users' needs (Rogers 2003, 398). The following figure 6 summarises the factors influencing adoption alongside innovation attributes and adopter characteristics.

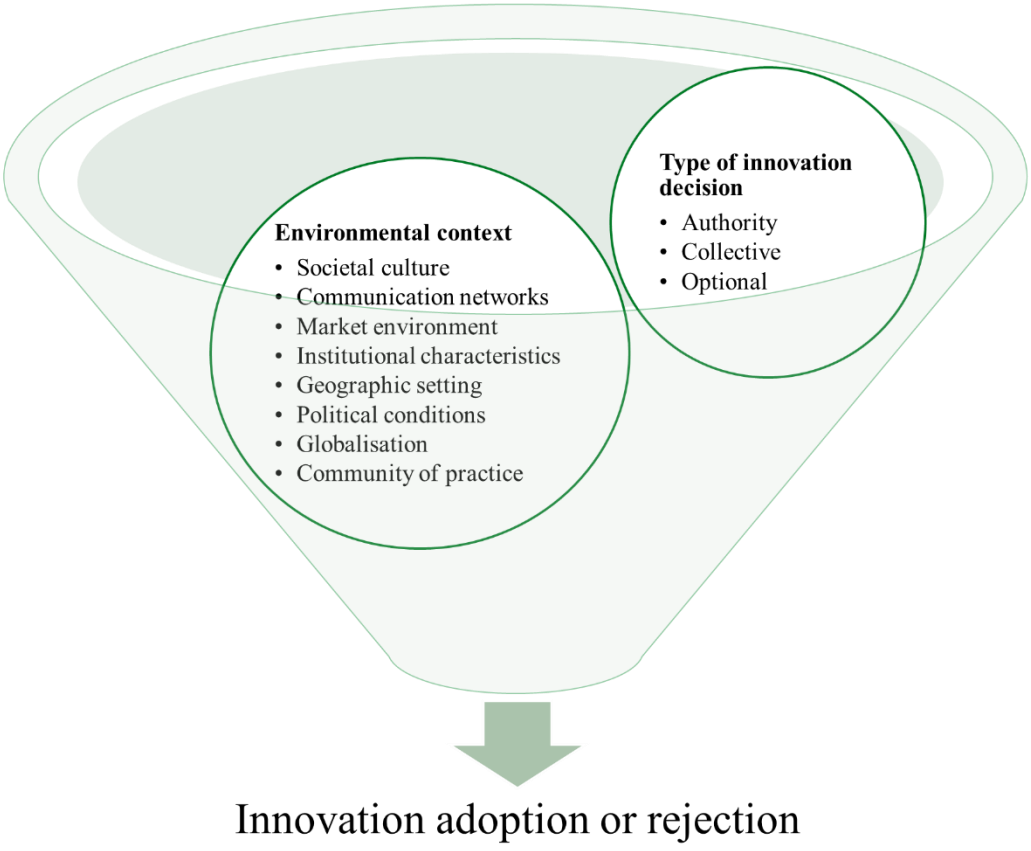

Figure 6 Other factors influencing innovation adoption

3.2 The process of innovation diffusion

While innovation-decisions concern individual decision-makers, diffusion process describes how innovations spread and are adopted within and across wider communities. According to the research by MacVaugh & Schiavone (2010, 206), there are three common players in any system of innovation diffusion. These are the potential individual user, the community of users, and the innovating industry or market, all of which are influenced by systemic technological, social and learning conditions. An innovation developed into mature product or service in one social system can later be exposed as an innovation to another social system. Much like in innovation-decision processes, an essential requirement for diffusion is that the innovation must be known to the community. (Rolfstam et al. 2011, 454.)

Everett M. Rogers's theory on the diffusion of innovations is a widely used systemic framework to describe the process of adoption or rejection of new ideas (MacVaugh & Schiavone 2010, 198). Rogers (2003, 5) defines diffusion as "[…] a process in which an innovation is communicated through certain channels over time among the members of a social system." In this definition, an innovation is any idea, practice, or object perceived as new by an individual or other unit of adoption (Rogers 2003, 12). A communication channel is the means by which knowledge about the innovation is spread to those not yet familiar with it. This is usually done via mass media and interpersonal channels. (Rogers 2003, 18.) Time is involved in the innovation-decision process in which a potential adopter passes through the stages of first gaining knowledge of an innovation to finally confirming the decision to either adopt or reject it (Rogers 2003, 20). A social system consists of a set of interrelated members, such as individuals, organisations or subsystems, who share a common objective which binds them together (Rogers 2003, 23).

According to Rogers (2003, 4), diffusion of an innovation is essentially a social process. When deciding whether or not to adopt an innovation, individuals tend to exchange information within the social communities to which they belong. This kind of individual sense-making process is thus an integral part of diffusion as potential adopters strive to decide whether an innovation satisfies their needs and is socially accepted by their communities. (MacVaugh & Schiavone 2010, 201.) Diffusion can thus be described as a social change which occurs as new ideas are invented, diffused, and adopted or rejected, thereby leading to certain consequences (Rogers 2003, 6). As a process, the diffusion of innovations is usually assumed to follow an S-shaped curve which describes the process from initial low rate of adoption by innovators and early adopters, to a higher

rate when early adopters and early and late majority join in, to final stages when the curve tails off with only the laggards remaining (Tidd 2010, 13). However, even though the S-curve model has gained a prominent position, researchers have failed to identify robust generic models of adoption (Tidd 2010, 14). As social systems differ from each other in terms of system-level qualities as well as indirect influence of individual members, it is challenging to define a common model capturing the process of diffusion accurately (Rogers 2003, 23).

While the theory by Rogers has gained prominence in diffusion research, it has also received its fair share of criticism. According to Häggman (2009, 389), the diffusion model by Rogers is useful because it focuses on a limited number of key variables. At the same time, however, it does not address many aspects that are specific to collective diffusion processes in which multiple actors influence the outcome and duration of the process. Gatignon and Robertson (1985, 857), on the other hand, have criticised the model for assuming that diffusion always takes place within a social system, the identification of which is expected to be know and to remain constant. This, they argue, is not a reasonable premise for processes where diffusion activities cross social system boundaries and require approaches that consider interactions with other social systems. McMaster and Wastell (2005, 386), on their part, argue that Rogers' model and diffusionism in general are too deterministic and positivistic in assuming that outcomes can be predicted based on the measurement of a small number of strictly defined variables. Croidieu and Monin (2010, 293) appear to concur, stating that linking action exclusively to logic seems to ignore the fact that adoption and diffusion are outcomes of interpretive processes which are based on identity-based judgements. Variables affecting innovation diffusion are discussed in more detail next.

3.3 Factors influencing the diffusion of innovations

Measuring and evaluating diffusion of innovations is often a challenging task because well-formed, reliable and complete records of diffusion, such as sales records or census data, are not always available (Nelson, Earle, Howard-Grenville, Haack & Young 2014, 927). Moreover, innovation diffusion is affected by various factors ranging from institutional issues to the abilities of the supply-side to push their innovations to users, as well as the demand-side's capability as users to adopt the innovation (Caiazza 2016, 1408). This implies that diffusion is a multifaceted phenomenon and should be evaluated and researched as such. Nevertheless, according to Tidd (2010, 4), most diffusion studies

choose to focus on the rate of adoption or the final segment of a population adopting an innovation when evaluating diffusion processes. Diffusion should, however, be treated as a trajectory with both magnitude and direction. The following sub-chapters discuss some of the most common factors influencing diffusion processes in more detail.

3.3.1 Information and personal influence

According to Gatignon and Robertson (1985, 855), personal influence is a basic underlying concept in most diffusion theories and models. Communication with and influence of others affects an individual's probability of adopting an innovation (Wejnert 2002, 297). Usually, a great deal of interdependence is common among members of a social system as adopters influence their peers' innovation-decisions by providing them with positive or negative evaluations (Rogers 2003, 360). This implies that diffusion largely consists of modelling and imitation by potential adopters of their peers who have previously adopted or rejected an innovation (Rogers 2003, 19). Most personal influence is transmitted via networks of individuals who possess similar demographic characteristics because people are more likely to interact with others like them (Gatignon & Robertson 1985, 855).

It should be noted, however, that the impact of personal influence is not always connected to the dissemination of information. For example, the phenomenon of bandwagons occurs when an innovation is adopted because of pressure caused by the number of those who have already adopted it instead of the individual assessments of the benefits of the innovation (Tidd 2010, 16). Bandwagons thus differ from other types of diffusion in that they require only limited information to flow from early to late adopters (Tidd 2010, 18).

3.3.2 Characteristics of the social system

As was mentioned earlier, a social system is the set in which diffusion is expected to take place. They can be characterised in terms of their values and norms, system evolution, and homogeneity of their population characteristics (Gatignon & Robertson 1985, 857). Values and norms are the established set of standards and limits for the members of the system. They can operate at national, community, organisational, or local system level, and can act as either barriers to or facilitators of change. (Rogers 2003, 26.) The values

and norms of different social systems vary and affect the evaluation of issues such as the costs, benefits and compatibility of innovations (Tidd (2010, 7). Values and norms are thus the underlying characteristics determining the size of the group of potential adopters for any given innovation. They can evolve over time and this change can affect a system's market potential. (Gatignon & Robertson 1985, 857.)

The degree of fragmentation of a market into different segments defines a social system's heterogeneity. Diffusion is expected to be more time-consuming if the heterogeneity of a system is higher because it often reduces interpersonal contacts. (Gatignon & Robertson 1985, 858.) As was explained in the previous sub-chapter, individuals mostly operate in their own particular communication environments consisting of their friends and acquaintances. These environments are characterised by homogeneity and closeness which facilitate effective communication. However, they can also often prevent new ideas from entering the network. Some heterophilous ties are thus needed to make the system networks more open. Such weak ties enable innovations to transfer from one environment to another. (Rogers 1976, 299.)

3.3.3 Barriers to diffusion

Barriers to innovation diffusion can range from the structure of entire economic systems to resistance from specific individuals (Caiazza 2016, 1409). According to Naor et.al (2015, 29), barriers to diffusion can be broadly divided into two categories: psychological and functional. Psychological barriers include traditions such as daily routines, customs, habits, and social norms. Functional barriers include issues associated with usage, value in terms of perceived performance-to-price relation compared to substitutes, and physical, social, economic, and functional risks. Tidd (2010, 4) divides diffusion barriers into economic, behavioural, organisational, and structural, which are defined in the next table.

Table 4 Barriers to diffusion of innovations (adapted from Tidd 2010, 4)

Economic barriers	Personal costs vs. social benefits, limited access to information, insufficient incentives
Behavioural barriers	Priorities, motivations, rationality, inertia, attitude towards change and risk
Organisational barriers	Goals, routines, power and influence, culture, stakeholders
Structural barriers	Infrastructure, sunk costs, governance

According to Caiazza (2016, 1409) barriers to diffusion can be classified into general, supply-side, and demand-side barriers. This classification reflects the barriers faced by system as a whole because it takes into account both the supply- and demand-sides as well as the context in which diffusion is expected to take place. The barriers are defined in more detail in the following table.

Table 5 Barriers to diffusion of innovations (adapted from Caiazza 2016, 1049)

General barriers	Contextual legal, economic, technical and cultural obstacles
Supply-side barriers	Obstacles faced by those pushing innovations on the markets. E.g. market resistance, high entry costs, ability to adapt innovations to different contexts.
Demand-side barriers	Obstacles faced by potential adopters. E.g. lack of interaction with suppliers, imperfect information, uncertainty, high-cost of switching, incompatibility with existing behaviour

As can be inferred from the categorisations presented above, barriers to diffusion exist at different levels. Based on their individual perception on innovations, members of a social system can hinder or advance the adoption process (Häggman 2009, 405). Similarly, the diffusion of an innovation may be impossible due to certain institutional set-ups or because the innovation does not match with existing technologies, institutional standards or values (Rolfstam et al. 2011, 456). The supply-side can also be unable to, for example, adapt their innovations according to the needs of potential adopters or provide them with suitable information, and this may make it difficult to push innovations to the market (Caiazza 2016, 1409). The following chapter focuses on the ways in which some of the barriers can be averted.

3.4 Facilitating and managing the diffusion of innovations

Most of the innovation diffusion models used in research have been developed many decades ago to explain historical data rather than to manage or predict future diffusion. Later research has tried to incorporate the influence of active efforts in the probability of innovation adoption and diffusion. (Tidd 2010, 15.) The ensuing sub-chapters discuss the ways diffusion of innovation can be facilitated by the means of marketing,

communication, opinion leaders and change agents, public administration and governance systems, and re-invention processes.

3.4.1 Marketing

Many of the ways utilised to facilitate the diffusion of innovations are marketing techniques used to reach potential adopters and influence their perceptions. According to Wang (2010, 210), diffusion can be facilitated by designing an appropriate brand strategy to combine the attributes of the innovation with its emotional appeal, positioning disruptive innovation effectively, and by using marketing communication to stimulate greater adoption. In order to reach the potential adopters, strategies such as targeting can be used in customising communication according to the intended audience's characteristics. Tailoring is another targeting strategy which directs the communication of a message to an individual representing a very homogenous audience. (Rogers 2003, 367.)

Naor et al. (2015, 49) maintain that choosing an initial target market and a suitable strategy to later expand beyond it are key decisions especially for organisations proposing alternatives, such as environmentally-friendly goods and services, to the market. Trying to pursue diffusion and economies of scale across many markets at the same time may negatively increase the complexities and dependencies making it difficult for the organisation to focus its capabilities properly. According to Tidd (2010, 15), realistic diffusion models tend to include two different groups of potential adopters consisting of innovators who are independent of emulation, and imitators for whom the process is more or less epidemic. Different marketing processes are needed for the two groups to facilitate diffusion.

3.4.2 Communication channels

Marketing decisions are heavily connected to the utilisation of appropriate communication channels. Rogers (2003, 18) divides communication channels into interpersonal channels, such as face-to-face exchanges, or mass media channels, such as newspapers or television. In a similar vein, Hart and Tzokas (2010, 142) refer to personal communication as a direct person-to-person contact which may be formal or informal in

nature. Impersonal communication, by contrast, is conducted by using the means of media.

Gatignon and Robertson (1985, 849) argue that diffusion theory is essentially a theory of interpersonal communications within social systems. In other words, personal influence is perceived to mediate the impact of mass media and function as a key factor accounting for the speed and shape of the diffusion process. Rogers (2003, 204) takes a more moderate stance noting that different communication channels play different parts at different stages in the innovation-decision process. Mass media channels are often useful in spreading knowledge about innovations while interpersonal channels can be more effective in persuading individuals to accept new ideas (Rogers 2003, 18).

3.4.3 Opinion leaders and change agents

As was mentioned earlier in this thesis, the diffusion theory by Rogers perceives diffusion as a highly social process with different actors creating and sharing information through communication. In order to facilitate the flow of information, diffusion network models often locate and use individual who are more central and influential to initiate the diffusion of new ideas and practices (Valente & Davis 1999, 57). In this process, diffusion theories often place special emphasis on the roles of opinion leaders and change agents within social structures and systems (Tidd 2010, 7). Change agents are employed to facilitate the flow of information about the innovation from a change agency, such as a supplier, to potential adopters (Rogers 2003, 368). Diffusion campaigns are more likely to succeed when change agents are able to identify and mobilise opinion leaders. Opinion leaders are the so-called role models within their communities and can thus be important determinants of behavioural change in a system (Valente & Davis 1999, 57). They act as models for their followers through their conformity to the norms of the social system, thereby exemplifying and expressing the system's structure (Rogers 2003, 27). Opinion leaders are often also able to transfer information across boundaries to members of other social systems. Possessing many weak ties instead of a few strong ties, they are brokers between groups rather than leaders within a group. (Tidd 2010, 10.)

Opinion leaders have become central features in diffusion studies as there is much evidence that they are critical to the diffusion process, especially in terms of changes in behaviour or attitude. However, change agents often make the mistake of choosing opinion leaders who are too innovative for the social system, making the opinion leaders too divergent to act as change promoters. (Tidd 2010, 10.) In addition, while many models

and theories highlight the importance of change agents and lead users in diffusion, Häggman (2009, 403) suggests that selected functional actors who perceive the innovation highly advantageous to them also have an important role in facilitating the adoption and diffusion processes, especially in organisations. There is also a reason to identify both the individuals hindering and the ones advancing the innovation as well as their motives for doing so. In order to leverage the positive momentum to overcome resistance towards adoption and diffusion, it is crucial to ensure sufficient interaction among the different members of a system. According to Edler and Yeow (2016, 414), intermediation in innovation establishes or enables links between different actors with complementary skills and interests thereby supporting the generation and diffusion of innovations. Direct intermediation brings actors together and supports their interaction whereas indirect intermediation enables and supports actors to understand others, their preferences, skill sets, knowledge etc. better (Edler & Yeow 2016, 416).

3.4.4 Public administration and governance systems

Institutions in public administration and governance systems often lag behind change because they are prone to evolve relatively slowly and reactively. Because of this, they can sometimes act as barriers and prevent the diffusion of innovations. (Rolfstam et al. 2011, 456.) However, in many cases public administration and governance systems can also facilitate the diffusion of innovations in a social system. Governments play an important part in their role as regulators defining general policies which can create favourable conditions for innovation adoption and diffusion (Caiazza 2016, 1411). For example, the research by Halila and Rundquist (2011, 295) discovered that the regulatory role of the governing institutions is often crucial for eco-innovations because regulators can pass environmental laws which support the development and diffusion of environmentally-friendly innovations. Similarly, Naor et al. (2015, 46) note that institutional actors may have more incentive to promote innovations with broader social implications than those without such implications.

Furthermore, with their relatively strong purchasing power institutions in the public sector have potential to be powerful promoters of innovations (Rolfstam et al. 2011, 453). As a means to stimulate innovation, public procurement can formulate demand for products and services that do not yet exist. It can also adopt of products and services offered by suppliers as unsolicited innovations. (Rolfstam et al. 2011, 454.) By adopting innovations, governments and other public institutions can reduce the general risks

associated with innovations and make other potential users more knowledgeable about available solutions (Caiazza 2016, 1412). Understanding the relationship between diffusion processes and the public procurement of innovations can thus help to stimulate innovation. Similarly, a better understanding of diffusion processes can help institutions to adopt new and better products thereby sustaining a more efficient service. (Rolfstam et al. 2011, 465.)

Although public administration and governance systems can facilitate the diffusion process by procuring innovations or by passing legislation that is intended to support their diffusion, it should also be noted that the decisions made by the public actors are not always beneficial for the system as a whole. For example, according to Rogers (2004, 398) social systems which are highly centralised in terms of decision-making are less likely to leave room for individual members to make decisions regarding adoption or rejection. Such authority-led systems are not necessarily able or willing to recognise innovations which are better suited for users' needs and problems.

3.4.5 Re-invention by users

Diffusion research was originally dominated by an idea of a process in which an innovation originates from some expert source and is then diffused to potential and relatively passive adopters (Rogers 2003, 394). Diffusion theories have tended to cling on the idea that there are unique sources of innovation and that others are only capable of imitation (McMaster & Wastell 2005, 388). This approach has been criticised for failing to recognise that innovations often emerge from the system and are diffused horizontally via peer networks and with a high degree of re-invention by users (Rogers 2003, 395). Re-invention can be described as the degree to which an innovation is changed or modified by individuals during the process of adoption and diffusion (Rogers 2003, 17).

Re-invention is connected to the perceived attributes of innovations which are among the factors affecting adoption and diffusion. Often the degree to which an innovation is re-invented by its users is positively related to the innovations sustainability as users are able to customise the innovation more according to their needs. (Rogers 2003, 429.) Because of their willingness to test new ideas, innovators and early adopters are often utilised in the re-invention process. However, the influence of innovators and early adopters on the characteristics of an innovation can have a disproportionate impact on the development of the innovation because they are often by definition atypical representatives of the population as a whole (Tidd 2010, 19).

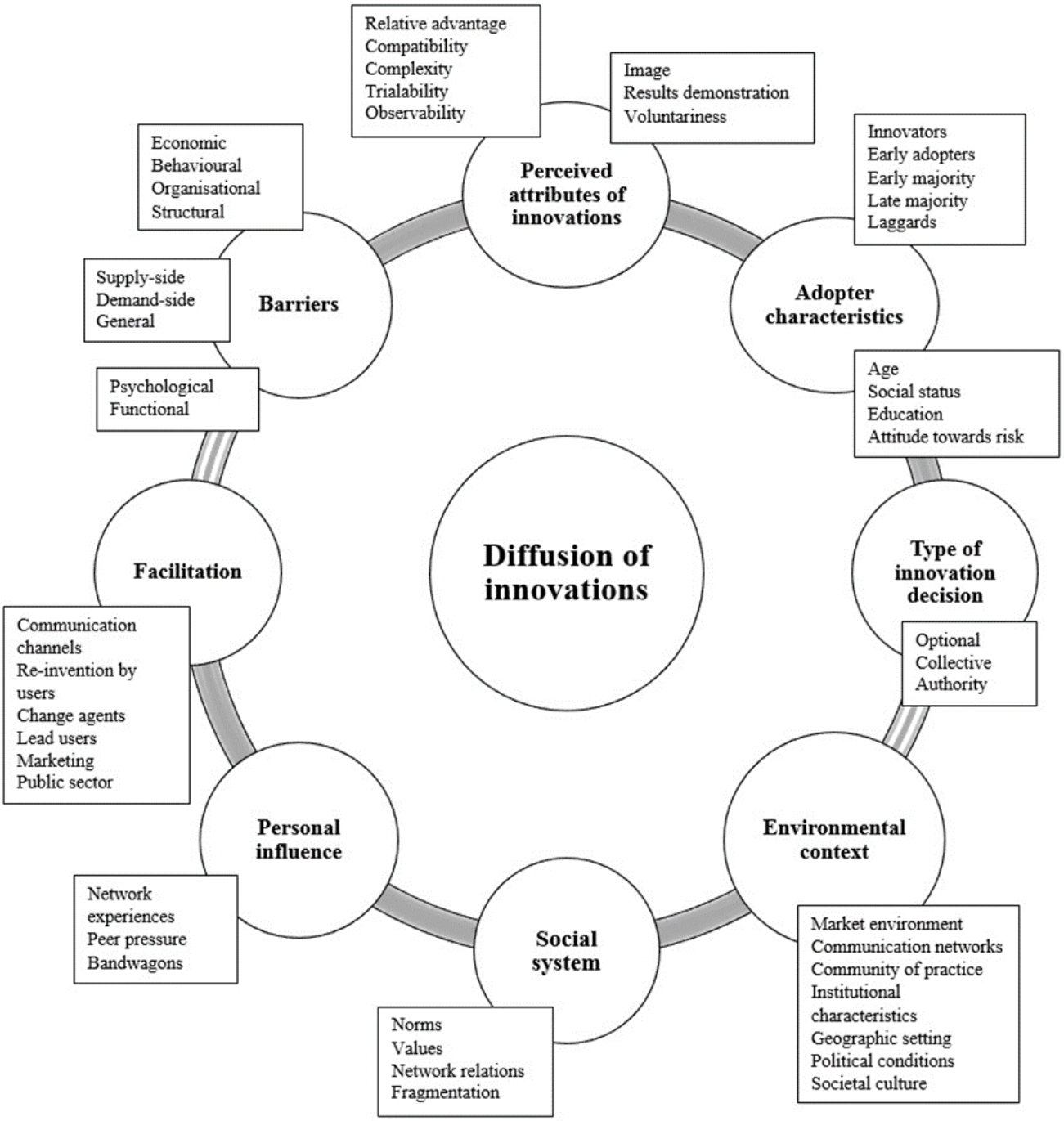

Figure 7 Summary of factors influencing diffusion of innovations

So far, this part of the thesis has discussed the theories that focus on explaining how and why innovations spread within and between communities. The factors influencing the adoption and diffusion of innovations are summarised in figure 7. Based on the preceding discussions on smart cities and innovation diffusion, the final section of this chapter focuses on diffusion of innovations in a smart city context.

3.5 Smart cities and diffusion of innovations

As was discussed earlier in this thesis, even though innovation appears to be one of the prerequisites for smart urban development, implementing and diffusing innovations that support smart city development can be a challenging endeavour for cities. Theories on diffusion of innovations shed a light on some of the potential issues affecting innovation diffusion in a smart city context. Diffusion theories suggest that innovation adoption and subsequent diffusion can be affected by issues such as the characteristics of an innovation. In innovation-based smart city development, attributes such as compatibility and relative advantage of an innovation can thus determine whether the innovation is consistent with or easily adaptable to the existing structures and conventions of a city as well as to the values and needs of various stakeholders. Similarly, attributes of innovations determine the relative advantage of the innovation compared to other available solutions. In a smart city context, innovations that are not compatible or as advantageous as other options are thus less likely to be adopted or diffused without proper facilitation.

Innovation-based smart city development was discussed to be complicated by the often diverse needs, roles and responsibilities of various stakeholders. Innovation diffusion theories also emphasise the characteristics of social systems as one of the decisive factors in innovation diffusion, suggesting that those characteristics can either hinder or promote the diffusion of innovations. Considering issues such as prevalent norms and values, network relations and the degree of fragmentation within a city's social systems can help to understand the potential barriers as well as possible drives for the diffusion of smart city innovations. Such information can determine how diffusion processes need to be facilitated in different cities and communities with the help of, for example, appropriate communication channels or marketing tactics. Furthermore, a thorough understanding of a city's social systems is likely to provide a clearer overview of the different stakeholders within various systems, and the respective adopter characteristics of those individuals. Identifying individuals and entities as adopters may help to explain challenges in innovation-based smart city development and make it easier to recognise those key actors who can facilitate innovation diffusion in smart cities as lead users and change agents.

Furthermore, many smart city researchers have emphasised the role of stakeholders and the importance of citizen engagement in smart city development processes. In a similar manner, research on diffusion of innovations has, albeit somewhat belatedly, stressed user involvement and re-invention as factors facilitating innovation diffusion. Such converges can help smart city developers understand the role of citizens as both potential adopters and co-developers of innovations. Involving citizens in the innovation

development processes may facilitate diffusion processes by lowering adoption barriers as well as by committing citizens to smart city development. Furthermore, citizen involvement may help smart city developers to recognise urban problems as well as to help discover solutions to them.

The role of public authorities both as potential barriers for and as facilitators of change has also been discussed in this thesis, as has the role of cities as governing entities in supporting smart city development. As was noted, literature on smart cities suggests that there is a role for cities as governing entities in smart city development processes. It was also proposed that smart cities may require different coordination approaches when compared to traditional city management. Innovation diffusion theories clarify the role of cities as not just environments and urban settlements but as governing actors in smart city development. They emphasise the role of city governments and public authorities as regulators and enablers that can create favourable conditions for smart city innovation adoption and diffusion. The way cities as governing entities choose to approach smart city development is also likely to influence innovation adoption and diffusion. While a top-down authority decision approach can result in faster diffusion and make it easier to implement large-scale changes with the help regulatory measures, more optional bottom-up approaches can be useful in engaging citizens, encouraging diffusion, and discovering innovations that make cities smarter from the citizens' point of view.

Finally, research on both smart cities and on diffusion of innovations recognises context as a prominent factor in their respective fields of study. In terms of smart cities and innovation, the fact that cities differ from each other in various ways affects innovation-based smart city development because developing innovative solutions that are scalable and applicable for multiple cities is challenging. Theories on innovation diffusion address some of the challenges caused by heterogeneity among cities by focusing on cities as a context with, for example, specific market features, political conditions, institutional characteristics, cultures, and geographic settings. Understanding the features that influence and create the context can help to address local barriers and requirements in innovation-based smart city development.

As the discussions above indicate, theories on diffusion of innovations can provide a theoretical background for the analysis of innovation-based smart city development. Depending on how they are utilised, innovation diffusion theories may make it easier to understand issues concerning features of innovations, roles of cities as both contexts and actors, roles of citizens as both potential users and co-developers, and the influence of social systems on smart city development. Such issues are explored further in the

empirical study part of this thesis. However, before moving on to the empirical study, the research design of the study is discussed in more detail.

4 RESEARCH DESIGN

This chapter discusses the research design applied to the empirical study conducted as part of this thesis. Research design can be described as the structure guiding the execution of a research method and the analysis of the data that is collected (Bryman & Bell 2015, 48). It is the general plan of the way the research questions will be answered taking into account issues such as the objectives of the research, data collection, resources, constraints and ethical considerations (Saunders, Lewis, & Thornhill 2007, 131). Research design thus represents the overarching strategy on gathering the information required to answer the research questions under scrutiny (Ghauri & Grønhaug 2005, 71). By choosing the right kind of design, the researcher should be able to convince others that the conclusions of the research are valid (Walliman 2011, 7). The chapter begins with a discussion of the research approach of this thesis. This is followed by a description of the research strategy chosen for the purposes of this thesis. After research strategy, data collection and analysis are discussed in more detail. The chapter concludes with a discussion of the trustworthiness of the study.

4.1 Research approach

Because the purpose of this thesis is to explore a contextual phenomenon, the research approach chosen for the thesis needs to contribute to the understanding of the conditions and reasons behind the phenomenon. Research approaches can be divided into qualitative and quantitative approaches. The distinction between the two is sometimes explained by simply stating that quantitative research employs measurement while qualitative does not. However, it is often acknowledged that there is more to the quantitative/qualitative distinction. (Bryman & Bell 2015, 37.) For example, one of the fundamental differences between qualitative and quantitative research is rooted in their procedures which reflect different perspectives on knowledge and research objectives (Ghauri & Grønhaug 2010, 109). While quantitative approach tends to be hypothetical-deductive in nature and to emphasise testing and verification with controlled measurements, qualitative approach usually focuses on interpreting and understanding reality from individual points of view (Ghauri & Grønhaug 2010, 110), and adopts a view of social reality as something that is constantly shifting as per individuals' perceptions (Bryman & Bell 2015, 38). Qualitative research is essentially descriptive and inferential, focusing primarily on the kind of evidence that enables the researcher to understand meanings and find explanations

(Gillham 2010, 10). According to Saunders et al. (2007, 472), the difference between the two approaches is ultimately down to the kind of data associated with the research. Data that is associated with quantitative research tends to be standardised, based on meanings derived from numbers, and analysed through the use of diagrams and statistics. On the other hand, data that is associated with qualitative research is usually based non-standardised, based on meanings expressed from words, and analysed by the means of conceptualisation. Because of this, qualitative research places researchers in active positions as they are expected to interpret, observe and analyse data for the duration of the whole research and data collection process (Puusa 2011, 115).

In this thesis, a qualitative approach has been chosen as the most appropriate approach for the purposes of the study. A qualitative approach has been chosen because finding answers to the research questions of this thesis does not require the utilisation of controlled and specific measurements or standardised data. Furthermore, qualitative research tends to focus on gaining insight and constructing explanations (Ghauri & Grønhaug 2010, 111), emphasising an inductive approach to the relationship between theory and research (Bryman & Bell 2015, 38). Because the purpose of this thesis is not to prove or disprove a pre-determined hypothesis, but to investigate a phenomenon that can be seen as context sensitive, qualitative research approach provides a more suitable orientation to find answers to the research questions and to fulfil the purpose of this research.

4.2 Research strategy

As already mentioned, qualitative research usually adopts an inductive standpoint, focusing rather on the generation of theories rather than on testing existing theories (Bryman & Bell 2015, 398). Furthermore, qualitative research often emphasises the importance of contextual understanding of social behaviour and is keen to provide considerable descriptive detail in order to understand issues such as behaviour and values in the situations in which they arise. The underlying idea behind this is that it is difficult to understand the behaviour of a social group other than in terms of the specific environment in which they operate. (Bryman & Bell 2015, 406) In addition, as mentioned earlier, the findings in qualitative research are not usually based on statistical methods or other quantitative procedures (Ghauri & Grønhaug 2010, 109) A suitable research strategy should accommodate these factors as well as any others that may influence the answering of the research questions of the thesis (Saunders et al. 2007, 135).

For this thesis, a single case study has been chosen as the most suitable research strategy because case studies are often used to investigate contextual activities in order to find answers to specific research questions (Gillham 2010, 1). Case studies are especially convenient if the phenomenon that is being researched is difficult to study outside its natural setting and if the concepts are difficult to quantify in a meaningful manner (Ghauri & Grønhaug 2010, 114), which applies to the study at hand. Case studies are particularly useful in generating answers to 'why?', 'what?' and 'how?' questions (Saunders et al. 2007, 139). Single case studies are usually utilised in situations in which the case is perceived as critical or unique, such as the case chosen for this thesis. A single case study strategy may also be chosen because it provides an opportunity to analyse a phenomenon which many others have not considered before. (Saunders et al. 2007, 140) It can clarify obscure theoretical relationships in a specific setting, provide data for theory construction as well as alternative explanations of causation (Fletcher & Plakoyiannaki 2011, 186).

While it would have been also possible to conduct the research for this thesis as a comparative research using two or more cases, a single case study was chosen because it provides better opportunities to collect more in-depth data from one case rather than just scratch the surface of many cases. A single case study is also more feasible in terms of resources such as time. Furthermore, a single case study leaves more room for creativity and freedom as there is no need to replicate steps in other cases in order to make it possible to compare the cases for conclusions. This, conversely, is also one of the potential downsides of choosing a single case study strategy because the lack of comparable data from similar cases may naturally be harmful in terms of the generalisability of this study.

Case studies are often associated with specific locations and their focus is on a bounded situations, systems, or entities with a purpose and functioning setting. The emphasis is usually on the setting of the case. (Bryman & Bell 2015, 68.) The major entity that is analysed in a case study is referred to as the unit of analysis. The choice of a unit of analysis is context-specific and depends on issues such as the questions and purpose of the research. (Fletcher & Plakoyiannaki 2011, 173.) The unit of analysis for this study was chosen because it encompasses those smart city characteristics presented earlier in this thesis in figure 2. Furthermore, the unit of analysis for this case study was chosen because it offers various angles from which to approach the research questions. Firstly, while the unit of analysis of this case study can be defined as a purpose-build smart city project, it is also part of a wider framework of existing city infrastructure and functions as a development platform for innovative solutions which are expected to scale-up in other places, too. Furthermore, while the development activities of the unit of analysis are largely coordinated by the city, various other stakeholder groups participate in the

development processes. Finally, the unit of analysis chosen for this case study experiments with different kinds of ways to facilitate the diffusion of innovations, ranging from larger-scale infrastructural solutions to more community-led grassroots innovations. For these reasons, the unit of analysis chosen for this study is expected to provide data that is both rich and suitable for the questions asked in this thesis.

4.3 Data collection

As was explained earlier, the research purpose and questions of this thesis favour a qualitative research approach. Similarly, the data collected and analysed for this thesis can also be classified as qualitative. Qualitative data is often used synonymously with any data that is non-numerical, collected by the means of techniques such as interviews, and analysed by procedures such as categorisation (Saunders et al. 2007, 145). Due to its preference for a rather loosely structured approach to the collection of data, qualitative research often utilises methods that do not require the researcher to develop extremely specific research questions in advance or to devise instruments for specific questions (Bryman & Bell 2015, 408)

Case studies tend to involve data collection through multiple sources which can be primary and secondary in nature (Ghauri & Grønhaug 2005, 115). While primary data is data gathered specifically for the research at hand, secondary data is information collected by others for other purposes (Ghauri & Grønhaug 2005, 91). The data collection techniques utilized in case studies include, for example, interviews, observations, documentary analysis, and questionnaires (Saunders et al. 2007, 139). In this thesis, both primary and secondary data sources were used as empirical material for the study. Table 6 summarises the primary and secondary data sources of the thesis as well as the ways data has been collected and for what purposes. The collection processes for both are discussed in the next sub-chapters.

Table 6 Summary of data collection

Data source	Type of data	Collection method	Added value of the data
Representatives from the city subsidiary	Primary	Semi-structured interview	- Coordinator's perspective, experiences & opinions on smart city development and innovation diffusion
Representatives from companies involved in the case	Primary	Semi-structured interview	- Business perspective, experiences & opinions on smart city development and innovation diffusion
Citizens/residents involved in the case	Primary	Semi-structured interview	- Citizen perspective, information & views on citizen engagement and smart city development
Organisational websites and articles	Secondary	Desk research and document assessment for suitability	- Background information about the case & those involved in it, topics for primary data collection, comparative material for primary data analysis
Promotional material such as brochures etc.	Secondary	Document assessment for suitability	- Background information about the case & those involved in it, topics for primary data collection, comparative material for primary data analysis
Newspapers and magazines	Secondary	Desk research and document assessment for suitability	- Background information about the case & those involved in it, topics for primary data collection, comparative material for primary data analysis

4.3.1 Primary data collection

In this thesis, a large part of the study is based on examining a case of smart city development in which innovations are part of development process and which involves stakeholders such as citizens, companies and the city as an actor. A big bulk of the data used in this thesis is primary data collected for this particular study at hand. Such primary data is useful because it is collected specifically for the particular research and is thus consistent with the research questions and objectives (Ghauri & Grønhaug 2005, 102). However, one of the disadvantages of primary data is that its utilisation is very dependent on the willingness and ability of sources to cooperate. Furthermore, when compared to secondary data, primary data may be more challenging to collect in terms of resources such as time. Unexpected factors may also influence or interfere with the data collection process. (Ghauri & Grønhaug 2005, 105.) These challenges were taken into account by preparing for the data collection process by planning which sources to use, exploring how and within which timeframe to approach and access the sources, and creating an alternative plan for data collection in case the initial plan failed.

The primary data for this thesis were collected by interviewing relevant stakeholders who have been involved in the case and unit of analysis chosen for this study. The interviews were conducted as semi-structured interviews, i.e. there were predetermined questions and themes to be covered in each interview but the structure of the interviews as well as the form and sequence of questions were not set in stone (Saunders et al. 2007, 312). Semi-structured interviews were chosen because the details of such interviews are only roughly predetermined and there are no fixed answers which leaves more room for the interviewees to present their own views (Ghauri & Grønhaug 2005, 123). Semi-structured interviews also enabled the researcher to explore the answers and build on interviewees' previous answers and comments (Saunders et al. 2007, 315). For the purposes of this thesis, the flexibility provided by semi-structured interviews can be perceived as a definite advantage because the research questions leave room for different interpretations and perspectives, and the study itself does not really benefit from interviewing techniques with a stricter frameworks. Furthermore, in qualitative research, a single interview is usually not valued for its merit as a stand-alone feature. Instead, each interview should add, reflect or expand other data that is collected as part of the research. (Bryman & Bell 2015, 479.) Semi-structured interviews thus provided a fruitful data collection method for this study because they accommodated the different backgrounds and points of views of the interviewees.

As for the type of primary data needed for the purposes of this thesis, it was important to plan the interviews in a way that made it possible to collect data that reveals respondents knowledge, attitudes and opinions about smart cities and the relationship between smart city development and innovations. The type of primary data that was needed guided the interview topics and questions as well as the way sampling of participants was conducted. When choosing research participants for primary data collection, qualitative research often utilises purposive sampling which is a non-probability form of sampling. The objective is to sample research participants who are relevant to the research questions and to ensure that there is enough variety in the sample. (Bryman & Bell 2015, 429.) Purposive sampling thus enables the researcher to use her/his own judgement to select participants and cases that are particularly informative and most suitable for the purposes of the research (Saunders et al. 2007, 315). As a non-probability form of sampling, however, purposive sampling often provides a poor basis for generalisations (Walliman 2011, 96).

For this thesis, a purposive sampling technique was chosen because finding answers to the research questions entailed access to representatives from different stakeholder groups. The sample needed to be diverse enough to provide comprehensive answers to research questions. At the same time, the sample could not consist of random individuals from relevant groups as the interviewees needed to have been involved in the innovation diffusion processes of the smart city case chosen for this thesis. Guided by the research questions and secondary data collected for the thesis, purposive sampling made it possible to choose appropriate interviewees based on their involvement in the case. Resource-wise, it was not possible to interview representatives from all the different stakeholder groups. A decision was made to focus on representatives from three stakeholder groups which were perceived as most central for the purposes of this thesis: the subsidiary of the city coordinating the development of the case, businesses involved in the case, and citizens involved in the case. While such purposive sampling does not allow this thesis to generalise the results of the interviews (Bryman & Bell 2015, 429), it was still perceived as the most suitable approach for the purposes of this thesis as it enabled the researcher to collect more in-depth data by focusing on selected sources.

Once the sampling for potential interviewees had been conducted, an email was sent to those potential interviewees whose contact details were available. The emails specified the basic details and purpose of the research, the reason for the interview request, and an invitation to ask for more information if needed. Once the interviewees had confirmed their willingness to participate, the dates and times for the interviews were fixed promptly in order to seal the interviewees' commitment (King 1994, 35). As the contact details of

individual citizens who had been involved in the case were not known to the researcher and because such details are private, a general letter detailing the purpose of the research, a request for an interview or, alternatively, an invitation to fill in a questionnaire, was composed by the researcher. The letter was then forwarded to potential citizens by the subsidiary coordinating the smart city development case because they had the contact details of residents with whom they had worked.

Altogether eight people agreed to be interviewed as part of the study. The details of the interviews are presented in table 7 below.

Table 7 Interview details

Interviewee	**Interview style and language**	**Duration of the interview (hours/minutes/seconds)**	**Date (dd/mm/yyyy)**
A) Business representatative (entrepreneur)	Face-to-face, Finnish	01:04:47	13/02/2018
B) Business representative	Face-to-face, Finnish	00:46:06	13/02/2018
C) City subsidiary employee	Face-to-face, Finnish	00:35:19	19/02/2018
D) City subsidiary employee	Face-to-face, Finnish	00:54:17	21/02/2018
E) City subsidiary employee	Face-to-face, Finnish	00:52:16	21/02/2018
F) Business representative (entrepreneur)	Face-to-face, Finnish	00:48:16	15/03/2018
G) Business representative	Face-to-face, Finnish	00:48:16	15/03/2018
H) Resident	Telephone, Finnish	00:25:07	20/03/2018

Three of interviewees worked in different roles for the city subsidiary responsible for smart city coordination activities. Four interviewees had been involved in smart city development as business representatives or entrepreneurs providing and developing smart

city solutions. The original plan had been to also interview approximately three residents who had participated in smart city development. However, despite the efforts trying to recruit interviewees or respondents, only one resident volunteered to be interviewed. This was unfortunate because the unit of analysis of the case study is noted for emphasising citizen engagement. Nevertheless, although the citizen perspective of the study remained somewhat underrepresented, the views of the one resident interviewed provided a valuable addition to the rest of the primary data collected as part of the study.

In addition to sampling, the interviews were organised and prepared in terms of the topics and questions that should to be covered. The preparation was done by taking into account that the interviewees in qualitative research usually actively shape the interview process rather than merely passively respond to pre-set questions (King 1994, 15). This meant that although a guide for the interviews was needed, the guide could not dictate the interview too much. In order to create an appropriate guide for the purposes of thesis, an operationalisation table was used to summarise the research questions, their key issues and theoretical background as displayed in table 8. The interview guides (Appendix 1 Interview guide for city and business representatives & Appendix 2 Interview guide for residents/citizens) were based on the operationalisation table and on the issues identified in the secondary data collected for this thesis. One guide was composed and used for city subsidiary and business representatives, and another one for residents/citizens. Separate guides were seen as appropriate because of the different backgrounds and positions of these stakeholders in the case.

All the interviews conducted as part of this study were recorded with the permission of the interviewees. Recording the interviews was beneficial because the nature of semi-structured interviews makes it quite challenging to take sufficient notes while also focusing on what is being said and guiding the conversation from one topic to another (Hart 1991, 197). Recordings of the interviews were transcribed and translated into English for the purpose of data analysis.

Table 8 Operationalisation table for primary data collection

Main research question	Sub-questions	Key issues/themes	Theoretical background (chapter)	Interview themes
How can innovation diffusion be facilitated as part of smart city development?	What are the main factors influencing the diffusion innovations in the context of smart city development?	Characteristics of smart cities	1.1; 2.2	Smart city development
		Role of innovations in smart city development	1.2; 2.3; 2.3.1; 2.3.2; 2.4	Smart city development
		Factors hindering / facilitating innovation diffusion	3.2; 3.4; 3.4.1-3.4.5;	Diffusion of innovations in a smart city context
		Innovation development and diffusion in smart cities	1.2; 2.3; 2.3.1; 2.3.2; 2.4; 3.5	Diffusion of innovations in a smart city context
		Ways to foster innovation diffusion	3.4; 3.4.1-3.4.5	Innovation diffusion in Kalasatama
	How does the involvement of cities as governing entities and stakeholders influence the diffusion of smart city innovations?	Cities as stakeholders in smart city development	1.2; 2.3.2; 2.4	Role of cities as in smart city development and innovation diffusion
		Ways to foster innovation diffusion	3.4; 3.4.1-3.4.5; 3.5	Smart city development, innovation diffusion in Kalasatama
		Cities and innovation	1.2; 2.3; 2.3.1; 2.3.2; 2.4	Smart city development, role of cities

4.3.2 Secondary data collection

As was mentioned earlier, secondary data can be described as data collected by others and for purposes other than the research at hand. It can be a useful or even necessary addition to primary data as it may function as a comparative and contextual data, help to save resources, and lead to unforeseen new discoveries (Saunders et al. 2007, 259). However, that because secondary data may have been collected for entirely different purposes, the information it provides can be exaggerated or biased. (Ghauri & Grønhaug 2005, 91) Furthermore, secondary data may be missing key variables or suffer from lack of quality (Bryman & Bell 2015, 329). Interpreting and checking the reliability of secondary data is therefore a very important part of data collection (Ghauri & Grønhaug 2005, 92).

Secondary data can be both qualitative and quantitative, and it can be roughly classified into written and non-written documentary materials, survey-based data, or multiple-source data based on documentary or survey data or a combination of both (Saunders et al. 2007, 249). In this thesis, documentary data in the form of written promotional material, newspaper and magazine articles, and organisational websites were utilised as sources of secondary data. Some of the secondary data utilised in this thesis were provided by the interviewees. Such data included mostly promotional material about the case and was primarily intended for the general public. Other secondary data were collected by the author from organisational websites, publications, newspapers, and magazines. Before choosing which secondary data to use, the suitability of the data for the research was evaluated. Selection of secondary data was based on criteria such as reliability of the source, quality of information, and the relevance of the content to the purpose of the research. The assessment was conducted by examining data sources, their background and reputation.

Collection of secondary data made it possible to construct a foundation for the case study part of this thesis. For example, organisational websites and promotional material were useful in building a picture of public image of the case and of those involved in it. Articles on magazines and newspapers provided a way to see what has been of interest to the media as well as means to further explore the general image of the case. This was important because, as was mentioned in the literature review of this thesis, the smartness of a city is often a promotional image issue as well as a concrete development goal.

Secondary data was also collected to find suitable questions and angles for the interviews as well as to assist in the sampling process to find and select suitable interviewees.

4.4 Data analysis

The purpose of data analysis is to obtain meaning from the data that has been collected (Ghauri & Grønhaug 2010, 157). Data analysis thus refers to the framework which guides the dissection of data collected for the purposes of the research (Bryman & Bell 2015, 581). One of the main challenges of qualitative research is that it often generates a large and rather cumbersome database in the form of, for example, interview transcripts, field notes, and documents (Bryman & Bell 2015, 579). The data needs to be reduced and abstracted in order to make it less fragmented and clearer (Puusa 2011, 117).

Qualitative research has not really developed standardised procedures for data analysis (Puusa 2011, 114), and the analysis is thus usually steered by relatively broad guidelines and alternative approaches (Bryman & Bell 2010, 579). In qualitative research, data collection and analysis activities are often conducted almost simultaneously (Ghauri & Grønhaug 2010, 197). The process of data analysis is thus likely to begin while the data is still being collected because the collection process allows for different themes, patterns and relationships emerge from the process while it is still continuing (Saunders et al. 2007, 484). However, such observations should not be taken at face value as the data needs to be dissected and reviewed critically (Puusa 2011, 115). Indeed, the complex and non-standardised nature of qualitative data often necessitates the data to be organised in categories before any meaning can be obtained (Saunders et al. 2007, 474). Categorisation enables the researcher to explore and analyse data systematically as well as to integrate related data from different sources and identify key themes and patterns (Saunders et al. 2007, 479).

As explained earlier, the primary data for this thesis was collected by the means of semi-structured interviews with relevant representatives from three different stakeholder groups involved in a case of smart city development. Once the recordings of the interviews had been transcribed and translated, the transcripts of each interview were read through several times in order to familiarise the data thoroughly (King 1994, 25). Reading through the transcripts also made it possible to explore the data for possible deficiencies or obscurities (Puusa 2011, 120). The next step was to find a way to explore and analyse the data in a constructive manner. For this purpose, a systematic but flexible framework was required to categorise the data in a way that reflected the purpose of the research.

According to Saunders et al. (2007, 479), the categories used in qualitative data analysis may be derived from the data or from the theoretical framework used in the research. In this thesis, preliminary thematic categories were first identified when the interviews were designed. However, as is often the case with qualitative research, the categories needed to be re-evaluated once the data collection process had begun. This was largely due to the fact that the chosen method for primary data collection was semi-structured interviewing which encourages interviewees to enter areas that may not have been covered in preliminary research, and new themes can thus easily emerge as a result of the interviews (Bryman & Bell 2010, 581).

The final categorisation process of primary data was conducted as a thematic analysis which is a commonly used way to approach qualitative data analysis through categorisation (Bryman & Bell 2010, 579). Thematic analysis was chosen as a suitable approach as it provided enough flexibility to accommodate the data from different sources while also making it possible to recognise relationships, differences, and similarities between different sources (Bryman & Bell 2010, 599). The interview transcripts were read through several times and notes were made about comments and views that stood out as relevant for the purpose of the study (Puusa 2011, 120). Central themes and their subthemes were identified from data transcripts by looking for factors such as repetitions, similarities and differences (Bryman & Bell 2010, 599). Once the themes and their subthemes had been identified, they were organised into a framework (Appendix 3 Themes used in data analysis). After this, the themes and subthemes were assigned with colours and the relevant data units from the interview transcripts were colour-coded and organised under appropriate themes and subthemes for further analysis. This helped to reduce and rearrange the data into a more manageable analytical form. As suggested by Saunders et al. (2007, 482) the process of analysis then continued by searching the rearranged data for issues such as key issues, patterns, and relationships in order to discover explanations for the research questions and objectives.

As for secondary data analysis, the secondary data collected for this thesis was first analysed and assessed by comparing the data from different sources. Because secondary data cannot be automatically expected to provide objective accounts, they needed to be examined in the context of other data sources (Bryman & Bell 2010, 562). Comparison made it easier to identify possible bias and inaccuracies as well as to discover different interpretations (Walliman 2011, 71). The content of newspaper and magazine articles used in this thesis were analysed against the background of their sources to check for signs of potential inaccuracies or partiality. Similarly, documents such as public-relations material and advertisements were evaluated by using criteria such as authenticity,

credibility, and representativeness (Bryman & Bell 2010, 561). This was important because documents from particular interest groups or reports composed by sources wishing to create a certain impression can be selective of the truth (Walliman 2011, 85).

Once the secondary data was analysed in terms of issues such as credibility and accuracy, the content of the data was analysed to find emerging issues and themes. Such analysis of secondary data strives to find patterns or trends across the data and to seek repetition of certain discoveries (Walliman 2011, 85). Recurring issues and consistencies found in the analysis were used in constructing background for the case study. As mentioned earlier, main issues identified in the secondary data were also used in identifying significant areas of interest that should be incorporated in primary data collection. In addition, secondary data and primary data were compared with each other in order to find recurring issues or deviations.

4.5 Trustworthiness of the study

The final part of this chapter discusses the trustworthiness of the study. The trustworthiness of a research is often defined in terms of its reliability, validity, and objectivity. According to Saunders et al. (2007, 149), reliability refers to the extent to which the data collection and analysis techniques result in consistent findings, and validity to the extent to which findings are really about what they intend to be about (Saunders 2007, 150). Validity can be further divided into internal and external validity. Internal validity refers to the extent to which ideas about cause and effect are supported by the research. External validity, on the other hand, refers to the extent to which findings of the research can be generalised to other populations or settings. (Walliman 2011, 104) Objectivity refers to the ability to separate the researcher's opinions, assumptions and actions from the research and findings of the study (Aaltio & Puusa 2011, 153).

While concepts such as reliability and validity are usually appropriate for quantitative research, they tend to be less applicable to qualitative research, making the evaluation of the trustworthiness of such research difficult or impossible (Aaltio & Puusa 2011, 155). Single case study strategies, such as the one used in this thesis, are sometimes criticised for their inability to provide validity and generalisability (Bryman & Bell 2015, 69). In fact, case studies are inherently particular as research strategies because their purpose is not to produce a theory that is generalizable to all populations (Saunders 2007, 151). Nevertheless, even though concepts such as reliability and validity may not be as applicable to qualitative research, the trustworthiness of such research should not be

overlooked. Although qualitative research, such as case studies, may not produce generalizable theories, it needs to reflect the views and experiences that it explores as accurately and thoroughly as possible. (Aaltio & Puusa 2011, 157.) Thus, researchers using case studies should not use a single case as a sample of one and try to identify a typical case that could be used to represent others (Bryman & Bell, 2015, 69). Rather, the objective of a case study, such as the one used in this thesis, is to try to explain what is happening in a particular research setting (Saunders et al. 2007, 151), and to concentrate in the uniqueness of the case in order to gain a deeper understanding of its complexities (Bryman & Bell 2015, 69).

The inapplicability of concepts such as validity and reliability to qualitative research has resulted in some researchers suggesting that qualitative research should be evaluated according to different criteria (Bryman & Bell 2015, 51). For example, Lincoln and Guba (1985) suggest that trustworthiness of such research can be better evaluated by focusing on its credibility, transferability, dependability, and confirmability. In this thesis, these four categories were utilised to evaluate of the trustworthiness of the study.

Credibility is related to internal validity and entails, for example, that the research is conducted in a way that maximises the probability that the findings are credible (Lincoln & Guba 1985, 296). In this study, credibility has been fostered by researching the unit of analysis of the case study well before the interviews were conducted. This made it possible to sample for appropriate interviewees for primary data collection. The use of operational table for interview guides helped to ensure that the data collection process was in line with the purpose of the research and its theoretical framework. Semi-structured interviews helped to redesign and expand interview questions as more information became available. In addition, secondary data for this study was collected and analysed by taking into account the original purposes of the data and its impact on the way such data are presented (Saunders et al. 2007, 262). The credibility of this study was negatively affected by time constraints which limited the number of sources that could be interviewed as part of the study. Time constraints also made it difficult to review findings and interpretations with the sources of the data.

Transferability refers to the degree to which the research provides a data base that makes transferability judgements possible for other researchers (Lincoln & Guba 1985, 316). The study should be reported in such way that makes it possible for others to evaluate its transferability. In this study, transferability has been supported by shedding a light on the research process by explaining and justifying the methods used in data collection and analysis. Limitations of the study have also been explained and taken account when reporting the findings and conclusions of the study. In addition,

backgrounds for the case study and the unit of analysis have been explored and described. Nevertheless, the transferability of this study has been negatively influenced by the fact that the names of interviewees and the names most of the companies and organisations used as data sources have not been made public. This anonymity was granted for the interviewees as it was seen as way to increase their willingness to answer questions honestly and without the need to censor their views. In this sense, the anonymity of most primary data sources can be seen as beneficial in terms of credibility of the study. It does, however, hinder the transferability of the study. Transferability has also been hampered by the particular characteristics of the unit of analysis and the scope of the case study which may make it difficult to find applicability in other contexts.

Dependability of the study is evaluated in terms of the consistency and coherence of the research (Lincoln & Guba 1985, 299). It refers to the extent to which the findings of the study are in accordance with the data that has been collected. In this study, most of the data was collected by the means of semi-structured interviews. The reasons behind this choice, the ways the interviews were prepared and conducted, and the data analysed were discussed in the methodology chapter and in the appendices of this thesis. The purpose has been to explain the research process so that its appropriateness and objectivity can be evaluated in terms of the findings and conclusions of the study. Such information also makes it more feasible to compare the findings and conclusions of the study to those of other studies (Aaltio & Puusa 2011, 164). Nevertheless, the dependability of the study is partly impeded by the fact that interviews by default make it challenging for the researcher to convey interviewees' exact thoughts and views objectively as some subjective interpretation is always involved in the process (Aaltio & Puusa 2011, 161). Issues such as personal experiences and views may have influenced the interpretations of the data and subsequently also the findings and conclusions of this study.

Finally, confirmability refers to the extent to which the findings are confirmable by others, i.e. whether they are reliable, free of bias and affirmable by others (Lincoln & Guba 1985, 300). To avoid biases, the interviews in this study were designed and conducted carefully to avoid issues such as inadvertent omissions of questions or unrepresentative sampling (Ghauri & Grønhaug 2010, 132). Data from the interviews was analysed thoroughly and without exclusions to ensure that the findings were representative and accurate. The methodology of the research has been explained as part of the study to make it possible for others to evaluate its appropriateness in the light of the findings of the study. However, the anonymity of the data sources, the scope of the study, the characteristics of the unit of analysis, and the nature of semi-structured interviews make it difficult for others to replicate the study for confirmability.

5 INNOVATING A SMARTER CITY

The previous chapters of this thesis have focused on building a theoretical background for the research purpose of this thesis and describing the research design in more detail. The purpose of this chapter is to present the findings of the empirical study that was conducted to find answers to the research questions of this thesis. This chapter introduces and describes the unit of analysis used in the case study, and presents the findings of the study.

5.1 Description of the unit of analysis

As was mentioned earlier, a single case study was chosen as the most suitable research strategy for this thesis. The unit of analysis selected for the case study is Kalasatama district which provides a platform for smart city development in the Finnish city of Helsinki. Kalasatama is located on the sea shore at the edge of Helsinki city centre. It is a former industrial and maritime district which used to be a location for a port, wholesale markets, a marketplace, and a gas plant (Bergström 2015, 48). The following sub-chapters describe the smart city development processes and Kalasatama's relationship with innovations in more detail.

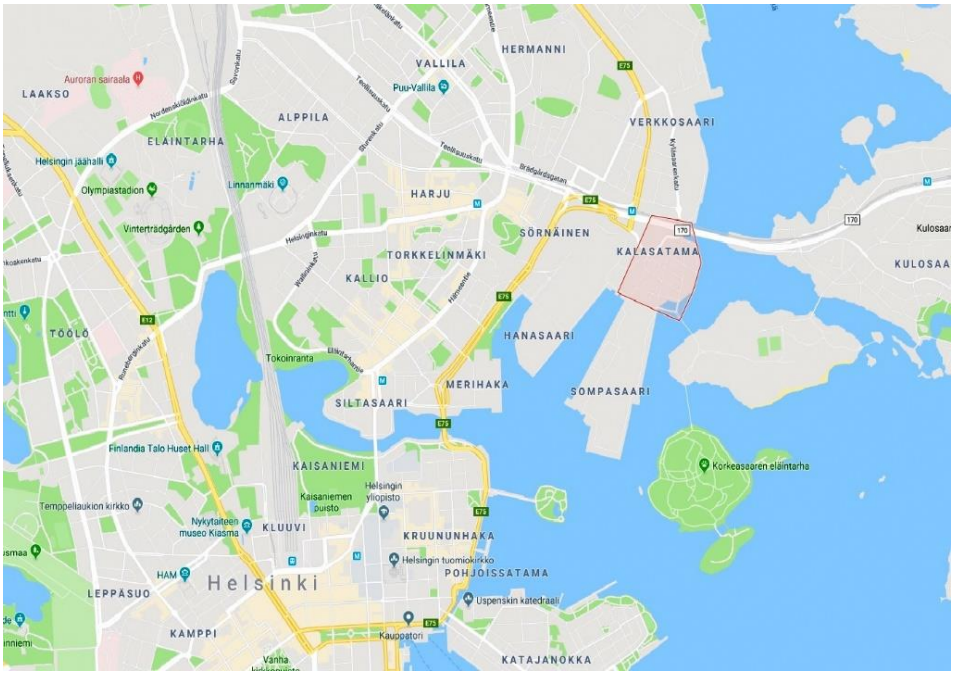

Figure 8 Location of Kalasatama

5.1.1 Kalasatama as a smart city development project

In 2013, the city council of Helsinki decided that Kalasatama would become the model of smart urban development and the primary location for smart city related innovations in Helsinki (Mustonen 2015, 157) Smart Kalasatama project was created to oversee and coordinate the development. During the first two years, Smart Kalasatama was part of Tekes – the Finnish Funding Agency for Technology and Innovation's Witty City smart city programme. Between the years 2015 and 2017, the project ran as part of the Six City Strategy which included the six largest cities in Finland joining forces to tackle urban challenges. Funding was granted by the European Regional Fund, the City of Helsinki, and the Ministry of Employment and the Economy. Between the years 2017 and 2020, the Smart Kalasatama project receives funding from the City of Helsinki Innovation Fund. (Smart Kalasatama, 2018)

A Living Lab approach was chosen to foster collaboration between the City of Helsinki, companies, academia, and citizens in Kalasatama's smart city development (Mustonen 2015, 158). Living Labs are based on the idea that a city can be utilised as a real-world testing environment for new solutions and technologies. Within cities' structural framework, experiences, routines, and conditions are created to develop ideas into innovation. (Cosgrave et al. (2013, 671.) In essence, Living Labs function as innovation areas where users co-create with developers and researchers (Cosgrave et al. 2013, 672). The Smart Kalasatama Living Lab developed into a diverse network of public and private stakeholders with expertise in various different domains. The coordination of the Lab and Smart Kalasatama development project was assigned to Forum Virium which is a subsidiary of the City of Helsinki and operates as an independent development and innovation enterprise. (Mustonen 2015, 158.)

The objective of Smart Kalasatama project is to accelerate smart city development, to engage start-ups in the development processes in order to provide them an early start and a platform to test their innovations, to engage the citizens in community development, to involve larger companies to gain momentum, and to help the city concretise its visions about smart services (Carlström 2016). A shared vision to direct different smart city development initiatives for Kalasatama was developed during a series of workshops and benchmarking activities facilitated by Forum Virium for representatives from different stakeholder groups (Mustonen 2015, 162). Creating a shared vision entailed that different viewpoints of stakeholders as well as the more general smart city development issues were taken into account. The vision-building process ended up adopting a vision that living in Kalasatama will save the residents one hour of their time each day. (Mustonen

2015, 163) The time saving vision is to be achieved through developments and solutions such as smart mobility, logistics and services. The focus is on smart lifestyle that is supported by services which can be implemented as both top-down or bottom-up solutions. (Mustonen 2015, 164) The objective is to deliver services to the people rather than vice versa (Smart Kalasatama 2018.) In addition to efficiency in terms of time, Smart Kalasatama project strives to leverage technologies to provide sustainable and environmentally friendly alternatives for the consumption of natural resources (Luoma 2016).

Kalasatama is expected to provide a home for approximately 25,000 residents and a working environment for 10,000 people by the year 2035. At the moment, around 3,000 pioneering residents live in the area which is continuously developed in close co-operation with over 200 different stakeholders including residents, companies, city officials and researchers. (Smart Kalasatama 2018) The land is owned by the city of Helsinki and is leased to investors interested in smart services (Abu-Fadil 2016). According to Mustonen (2015, 157) Kalasatama development is part of the global smart city trend which is based on municipalities seeking new ways to address public issues with diverse partnerships and by utilising ICT and data as enablers in the development process.

5.1.2 Role of innovations in Kalasatama development

Innovation and collaboration are often mentioned as the key factors of smart city development in Kalasatama. According to its website, Smart Kalasatama project promotes and facilitates innovation in four main ways. Firstly, it is experimenting new smart services in real life with its residents. Secondly, Smart Kalasatama project brings companies, entrepreneurs, researchers, public sector actors, and citizens together to solve problems. Thirdly, Smart Kalasatama initiates new projects and business development opportunities. Finally, Smart Kalasatama runs an agile piloting programme with innovators co-developing their smart solution prototypes with Kalasatama residents. The programme is aimed at short, flexible smart solution pilot projects that can be executed during a maximum period of six months. The first three calls of the programme received over 130 offers and engaged over 500 citizens, 10 city departments and 30 companies in innovation co-development. (Smart Kalasatama 2018.)

Although the Kalasatama district is still largely under development some innovative infrastructural projects, such as a pipeline-based waste removal system sucking trash into

the ground and sending them directly to a waste collection facility, are already in place (Snow 2017). The innovative infrastructure of the district also includes a smart energy grid which supports new energy storage facilities, electric vehicle use, as well as energy-efficient building automation and local energy production. A space sharing pilot project makes it possible for citizens to rent out available private and public spaces and facilities for work and leisure. Furthermore, Internet of Things (IoT) and MyData solutions are being tested in Kalasatama as ways to enable personalized services and customized solutions. (Smart Kalasatama 2018.) Some of the apartments have been equipped with home automation systems delivered by Helen Ltd. and ABB. The systems enable residents to monitor their electricity and water consumption data online, making them aware of where and when they consume these resources. This combination of energy technologies helps residents to understand, for example, where they can make savings by switching their consumption to periods of cheaper rate. (Helen, 2015)

Kalasatama is also a home for various other innovative smart city projects such as a co-created senior house for active elderly, a health and well-being centre focusing on digital health services and new practices, floating apartments, smart lighting systems, and a school which during the daytime operates as a hub for new ways of teaching and learning supported by latest learning technologies, and in the evening as a meeting place for residents. (Smart Kalasatama 2018) The district is also developing logistics solutions for getting groceries and health services without leaving the house as well as cultivating peer-to-peer services which enabling neighbours to share with each other (Snow 2017). In addition, Kalasatama has acted as the site for a public experiment with self-driving busses (Carlström 2016).

Collaboration between different stakeholders has been an essential part of Kalasatama development from the very beginning. Businesses and entrepreneurs are encouraged to introduce their smart city ideas and projects which are then developed further, tested, and finalised together with the residents and other stakeholders. (Bergström 2015, 49.) Innovations developed and tested in the Kalasatama are expected to scale up elsewhere. Kalasatama has its own Innovators' Club which functions as a collaboration network bringing together start-ups, established businesses, researchers, city officials and resident innovators (Smart Kalasatama, 2018). At the club's quarterly meetings, participants work together in mixed groups to develop solutions to urban challenges (Carlström 2016.) Meetings are also a way for participants to share news and receive information about upcoming events and future projects (Smart Kalasatama, 2018). According to Bergström (2015, 49), the role of Smart Kalasatama project can be defined as the orchestrator who engages participants and networks, organises the network meetings, enhances

collaboration, provides working facilities and methodological knowledge to support the activities of the living lab.

5.2 Views on smart city development

All the interviewees of this case study had participated in Kalasatama's smart city development in some capacity. While their roles in the development processes differed, all the interviewees described smart city development as something that is happening for specific reasons. Certain drivers, barriers and approaches were also identified as influential in terms of the development processes. Most interviewees were also able to identify features they viewed as essential for smart cities and smart city development in general.

5.2.1 Driving forces behind smart city development

Chapters 1 and 2 of this thesis discussed some to the factors driving smart city development. Megatrends such as increased urbanisation and its by-products were identified as central motives behind smart city development. Similar issues were also mentioned by the interviewees who noted that global challenges and opportunities were among the most pressing reasons behind the interest in smart cities. The need for cities to become denser, more efficient and sustainable while also providing a good quality of life for the citizens was discussed as one of the main driving forces behind smart city development. In this respect, the reasons behind smart city development were viewed almost as imperative. Most interviewees commented that in order to create or maintain well-functioning, safe and sustainable cities and a good quality of life for urban inhabitants, smarter solutions are needed.

At the same time, smart city development was seen as attracting both public and private interest because it provides commercial opportunities for enterprises and businesses. Trends such as digitalisation and sharing economy were mentioned as drivers for many commercial smart city solutions. The influence of the private sector on smart city development was perceived as significant, and private sector innovations, such as Uber and Airbnb, were viewed as leading the way and setting the standards for cities. The growing importance of cities in relation to nations was also mentioned as one of the reasons for cities interest in becoming smart. In this respect, smart city development was

perceived as means to compete with other cities and to promote a city's image to make it more attractive for businesses, employees and investors.

Most of the interviewees recognised the haziness of the smart city concept and were somewhat wary of how the concept is used. However, the interviewees were also of the opinion that the interest in smart city development has not born out of nothing and that there is a need for development projects such as Smart Kalasatama.

> *[…] in a way, it is a discussion that is quite easy to join in. Or it is difficult to say why such development would be a bad thing. The way the development is organised or how the things are done may be controversial. But I think that the general objectives are quite positive. And there is a need for improvement, when you look around. You can see that things could be done better.* (Interviewee D)

As for the future of smart city development, some interviewees noted that the concept of smart cities has lost part of its allure because it has been overused and quite frequently misapplied. Nevertheless, developments and trends such as digitalisation, automation, open data, and citizen activism were considered as factors driving smart city development in the future.

5.2.2 Factors facilitating smart city development

While the factors driving smart city development were mostly discussed in terms of emerging trends, global demands and business opportunities, the factors facilitating smart city development were viewed in more specific terms. Technological development was the most common factor mentioned as a facilitator of smart city development. Even though all the interviewees made a point of noting that the smartness of a city cannot be measured in terms of the level of technological development, they also emphasised the opportunities technological development creates for smart city development. For example, Kalasatama was described as a unique platform for smart city development because most of its housing and infrastructure have been designed and built in a way that accommodates latest technologies and makes it possible to develop, test and use smart city solutions. Increasing level of digitalisation in most parts of the Western world was described as extremely beneficial for smart city development as it enables systemic development of services and, together with open data practices, creates opportunities for citizens to participate in smart city development.

In addition to technological conditions, the rise of the start-up culture and entrepreneurship were viewed as positive phenomena for smart city development because smaller actors were perceived as more innovative, creative and generally braver. For example, the agile piloting programme of Smart Kalasatama was created because the coordinator wanted to engage entrepreneurs and start-ups into smart city development.

> *Smaller actors can take smaller steps […] It is also easier to get closer to the citizens when you are working with smaller companies, to create shared spaces for discussion and development for different stakeholders.* (Interviewee C)

The interviewees also mentioned changes in consumer culture as facilitating factors in smart city development. The increasing emphasis on environmental values and the impact of such values on consumer behaviour have boosted sharing economy –related activities which are often in line with smart city development. Value-based judgements were also noted as a potential decisive factor for people choosing their living environments. Furthermore, the need and willingness of people to live in cities which are overcrowded and messy has, according to some interviewees, made people more inclided to participate in activities that strive for a smarter way of living. Finally, the aptitude of younger urban generations to, for example, use mobile devices and utilise digital technologies, was noted as a one of the main facilitators of smart urban development.

5.2.3 Factors hindering smart city development

While some of the interviewees discussed younger generations as facilitators of smart city development, older generations were seen as a hindrance for such development by some of the business representatives interviewed for the study. Generational differences were mainly discussed in terms of technical aptitude and persistence of traditions. Interviewees found generational differences especially frustrating in situations in which joint decision-making processes are lengthy and archaic, and when traditions and old ways of doing things were the only apparent reasons standing in the way of new solutions. A couple of the interviewees used the way Finnish housing cooperatives are managed as an example of such hindrances which make it difficult to introduce smarter solutions into housing.

Another factor identified as a barrier for smart city development by most interviewees was the bureaucracy of city governments and organisations. Business representatives discussed the lengthiness of decision-making processes and the challenges in reaching

city officials responsible for certain issues as frustrating barriers for their development ideas and solutions. While Forum Virium as a city subsidiary received largely favourable comments, cities as organisations were described as challenging to work with.

> *Businesses will do it as long as they have money to do it. That is… especially with a small business… you need a cash flow. If the city says that 'yes but maybe in two years' time'… well, we are dead by then.* (Interviewee B)

A few of the business representatives also mentioned the market potential and value of certain smart city innovations as a factor hindering smart city development. While private sector was generally perceived as the driver of smart city development, the ability to commercialise smart city innovations was not a given. This was especially true in a relatively small country such as Finland. Thus, even though smaller cities were considered advantageous in terms of their flexibility and ability to execute things faster, the market opportunities they are able to provide were perceived as disadvantageous for smart city development.

> *But then, in Helsinki one of the main hindrances is the inability to commercialise smart city ideas. The volume is too small and people do not live densely enough. Berlin has 3.5 million residents and Helsinki has like, I don't know, 500.000 or maybe even less.* (Interviewee A)

Finally, existing urban infrastructure was mentioned as an issue affecting smart city development earlier in this thesis. Many of the challenges the interviewees' had encountered in smart city development were also to do with existing infrastructure in cities. While the new infrastructure of Kalasatama provides suitable premises for smart city development activities, business representatives noted that Kalasatama is a unique case because it is such a new residential area that it is still largely under construction. Thus, the solutions developed for areas such as Kalasatama may not be suitable for or easily transferable to other settings, especially if they need to be installed into existing infrastructure. When asked about whether similar smart city development could be achieved elsewhere, most of the interviewees were of the opinion that it could be achieved but that the development needs to take account contextual requirements.

5.2.4 Approaches to smart city development

Different kinds of approaches to smart city development were discussed earlier in this thesis. At that point, it was noted that smart city development may involve top-down or bottom-up approaches or a combination of both. The interviewees of the study were largely in favour of bottom-up approaches. Such development was perceived as more efficient and inclusive. Bottom-up development was also seen as a better way to develop the city according to the needs of its citizens. For example, some interviewees thought that top-down approaches are mostly to blame for the expensive but essentially useless systems procured by some cities as part of their smart city strategies. Bottom-up approaches, on the other hand, were described as essential for the development of smart city projects such as Kalasatama because they are focused on citizen engagement.

However, despite the preferences for bottom-up approaches, some interviewees noted that the suitability of the approaches may be down to cultural factors. For example, the bottom-up approach was perceived as appropriate and natural for Nordic Countries with inclusive, democratic cultures and traditions. However, countries like China and India were discussed as being more centrally managed and their smart city approaches were described as mostly top-down in terms of both planning and development. Furthermore, top-down approaches were recognised as necessary in cases of large infrastructural projects because such projects are often too costly and complicated for bottom-up development.

5.2.5 Ideal smart cities

When asked about their opinion on what makes a city smart, all the interviewees were fairly quick to point out that the level of technological development should not be the decisive factor or the main objective in smart city development. The interviewees considered real smart cities to be people-oriented and people-driven, efficient in terms of how they make the life of citizens easier, brave and experimental, anticipatory and adaptable, focused on citizen engagement, committed to sustainability, as well as all-encompassing and integrated when it comes to smart development. Technologies and data were considered a big part of smart cities because they can be utilised in meaningful ways. However, data and technology just for the sake of data and technology were not regarded as a way to smartness.

Most of the interviewees considered Kalasatama as a fairly good example of smart city development. Positive views were mainly based on the way Smart Kalasatama has managed to engage residents and other stakeholders into development processes and on how innovations have been incorporated into the development of the area and its living arrangements. Differing opinions were largely based on how perceivable or visible the smartness of a city should be.

> *[…] if you did not know what goes on in there, it would come across as a normal city district with new buildings. It is kind of traditional in a way, all the buildings and cars on the streets. You would not understand there is anything special about unless somebody told you […]maybe it is because the area still largely under construction. But I think that smartness should be perceivable. When you walk into the district, you need to see and feel that something is different here. That is still missing in Kalasatama.* (Interviewee A)

The absence of big and visible systemic changes was also noted by Forum Virium representatives. However, it was also pointed out that such changes are impossible to achieve in such a short timeframe. In addition, some of the interviewees were of the opinion that smart city development does not have to happen fast, and that in many cases smaller steps can make development easier and the objectives more achievable.

For many interviewees, Copenhagen stood out as one the best real-life examples of smart city development. It was also one of the cities used in benchmarking in the beginning of Kalasatama's smart city development. The interviewees noted that, to them, the smartness of Copenhagen was not due to the level of technological development in the city. Rather, the interviewees emphasised the consistency and commitment in Copenhagen's development. It was described as a city in which all the relevant stakeholders and actors have been committed to developing the city for the people ever since the 1970s. Copenhagen's smart energy and transportation solutions were seen as supporting the well-being of both people and businesses.

5.3 Diffusing innovations in smart cities

Chapters 2 and 3 of this thesis discussed existing theories and literature on smart cities and diffusion of innovations noting that smart cities are expected to utilise technologies, especially ICT, creativity, innovation, and democratic participation processes to build

urban settlements that embrace sustainability, innovations, citizen-centric and citizen-driven governance, and business-led urban development. Smart city innovations were defined as those new ideas, practices, objects and solutions which aim for such urban development by changing cities into more liveable, prosperous, sustainable, resilient, efficient, and inclusive places. Although innovations were discussed as one of the prerequisites for smart urban development, deploying and diffusing innovations that support smart city development appeared to be a challenging task for many cities.

The interviewees of this study also saw innovations as an integral part of smart cities. Most were of the opinion that smart urban development necessitates novel solutions in the form of new services, products and practises. The nature of such solutions varied as some of the interviewees discussed the need to introduce radically new innovations while others were somewhat more inclined towards incremental changes in existing practices. Regardless of the level of change, the interviewees saw innovation development, adoption and diffusion as challenging. Some of the ways Smart Kalasatama project strives to facilitate innovation development and diffusion were perceived as helpful in overcoming such challenges.

5.3.1 Innovation development in a smart city context

Two of the companies whose representatives were interviewed for this study had participated in Kalasatama development through Smart Kalasatama's Agile piloting programme. The third company had participated in a longer development project which had been part of Smart Kalasatama activities. In each case, the companies had developed their smart city innovations in collaboration with other stakeholders while the city subsidiary Forum Virium had coordinated and facilitated the development projects. Forum Virium had also been in charge of choosing the innovations which were developed as part of the projects.

The co-development activities of Kalasatama received mostly positive feedback. From the residents' point of view, co-development enabled them to have a say in the overall development of their living environment which, in turn, made it more compelling and natural for them to commit to the development processes. The ability to self-educate was mentioned as one the motivators for some residents to participate in innovation development as they saw it as an opportunity to expand their existing knowledge-base. In addition, co-development and resident engagement in innovation development were compared to co-ownership which was seen as a positive thing as it promotes a sense of

shared responsibility and commitment. Positive views were also expressed by the representatives of Forum Virium who were mostly satisfied with the way innovation co-development and resident engagement has worked.

> *I think that with agile piloting we have managed to liberate people from their traditional roles. People participate to those kinds of development projects as themselves and they have been really enthusiastic, sharing their ideas and knowledge, discussing with others […] It is also to do with the phase we are at. When the ground is neutral and it is still that pre-commercialisation phase, the economic interest and pressures are not very substantial at that point.* (Interviewee E)

From the viewpoint of business representatives, co-development with other stakeholders was also perceived as mostly positive for innovation development. Business representatives were generally happy with how they had been able to receive feedback, ideas and help from other people to develop their innovations further. For one interviewee, contact with other businesses had been crucial because the innovation could not be utilised without the access to infrastructure designed by others. Another business representative emphasised the way co-development enabled them to create ideas for the future, and how they had been able to build up their own network by raising interest in other stakeholders. In relation to innovation co-development, Smart Kalasatama's Agile piloting programme and Innovators Club received largely positive feedback as interviewees viewed them as easy ways to participate in smart city development. Negative feedback was mostly to do with the lack participants with relevant experience in such forums.

> *I am all for research and academia but you also need business representatives. Most of those involved in Kalasatama development are interested in the issues but their own contribution in helping those testing their solutions is lacking. […] The residents were of course important to us because they were the users. As for other actors or organisations… they were not very helpful because they did not have previous experience. You need people with relevant experience.* (Interviewee A)

5.3.2 Innovation adoption in a smart city context

When discussing adoption of innovations in smart cities, the interviewees focused on how cities as environments accommodate innovation adoption, what influences citizens' willingness to adopt innovations, and how innovation adoption can be facilitated. City environments were viewed as challenging for smart city innovations that need to be installed into existing infrastructure or which should be otherwise compatible with the surrounding environment. In such cases, the risk is that even though citizens would be willing to adopt the innovation, the incompatibility of the innovation prevents any adoption attempts or at least makes the process complicated. Furthermore, even if innovations can be integrated into existing systems, regulatory issues, such as privacy and data protection, or lengthy decision-making processes may eventually prohibit their adoption.

In terms of citizens' willingness to adopt innovations, attributes such as the compatibility, complexity and trialability of an innovation were viewed as especially important because citizens were noted to be more likely to adopt innovations which are familiar, easy and available for testing beforehand. In this respect, engaging residents into innovation development processes was considered an effective way to facilitate innovation adoption. However, it was also noted that because development processes in Kalasatama mostly focus on innovations that are still in their early stages or can even be mock-ups, it can be quite difficult to ensure continuity with such innovations. For example, residents may be willing to adopt a prototype of an innovation as long as it free. However, they may not be willing to pay for it once the pre-commercialisation phase is over. Citizens' willingness to adopt innovations was also associated with how well innovations matched their values. For example, Kalasatama residents were described as environmentally conscious citizens which, in turn, was thought to contribute to their aptness to test and adopt eco-innovations. Generally speaking, the interviewees described Kalasatama residents as relatively venturesome which was reflected in their willingness to test and adopt new solutions.

Communication was mentioned as a key tool in efforts to facilitate innovation adoption in smart cities. However, the interviewees emphasised that communication needs take into account the needs and interests of the citizens. In other words, the interviewees saw that communication should focus on how the adoption of an innovation will affect the life of citizens, their living environments and the general workings of cities. Business representatives and Forum Virium employees also discussed the benefits of promotional and marketing efforts as well as co-development projects in removing adoption-related

barriers by enabling citizens to familiarise themselves with new ideas and solutions. Most of the interviewees were of the opinion that such efforts and approaches should be as pragmatic and participatory as possible.

> *[…]all the advertising or phone calls, they do not really convince you. Concrete explanations and examples are needed and you need to provide opportunities to test the service. Like for a month, to see how it works, what are people willing to pay and so on. It does not have to be permanent.* (Interviewee B)

In some cases, necessity was viewed as an effective way to promote adoption of smart city innovations. For example, as noted by Forum Virium employees, by choosing to live in Kalasatama the citizens had also more or less involuntarily chosen to adopt Kalasatama's pipeline-based waste removal system because it is the only waste removal system available for them. Authority-based adoption decisions were generally perceived as an efficient way to increase the rate of adoption of most infrastructural innovations. As an example, the terms for conveyance of plots created by the City of Helsinki for Kalasatama were noted as a very powerful tool in making developers incorporate smart solutions into their buildings which are required to accommodate smart systems. Such stipulations also make it possible to spread smart zoning and planning development, and they were viewed as helpful in developing a smart city environment that is interoperable.

5.3.3 Innovation diffusion in a smart city context

As was mentioned earlier in this thesis, diffusion of smart city innovation is likely to be affected by factors such as the roles of cities as both contexts and actors in smart city development, the roles of citizens as both potential users and co-developers of smart city innovations, and the general influence of social systems on smart city development. Similar issues were also raised in the interviews for this study. Interviewees discussed various barriers to the diffusion of smart city innovations as well as potential ways to overcome such barriers. Most of the interviewees were of the opinion that innovations developed for or tested in Kalasatama can be diffused to other locations. However, the interviewees also noted that the uniqueness of Kalasatama as a smart city testbed meant that diffusion experiences there were not directly replicable in other contexts. The social

system of Kalasatama was described as fairly homogenous in terms of its values and population characteristics and this was seen to contribute to the area's uniqueness.

> *It is probably partly to do with the area; most of the people moving to Kalasatama come from 3 kilometres radius, from districts like Kallio and Sörnäinen. And if you look at voting data, well that is the green-left bubble right there…Most of the residents are also highly educated. There is diversity in terms of ages, which I think is a good thing. But, yeah they tend to be highly educated and I think that contributes to their willingness and ways to participate, and influences how things can be done. (Interviewee D)*

Most of the barriers described earlier in this thesis in tables 4 and 5 were also noted by the interviewees of the study when discussing innovation diffusion. General barriers identified by the interviewees included issues such as technical and legal restrictions, especially in terms of issues such as data protection and management. Such issues could prevent or hinder innovation diffusion simply by stipulating the conditions of their use. Supply-side barriers were mostly structural barriers manifested as challenges in adapting innovations suitable for one setting to different contexts, or as difficulties encountered when working with the governing structures of cities. As for the demand-side, innovations' incompatibility with existing solutions, adopters' uncertainty and attitude towards change, and the lack sufficient information were discussed as the most prominent barriers for innovation diffusion. Such demand-side barriers were associated both with citizens and institutional actors.

> *So the barriers are more to do with habits and customs: "can we do this because we have never done this before?" […] Especially in terms of the older generations and those traditional big institutions, like representatives from insurance companies and banks. They tend to be very careful […] And cities, they are still quite stiff because of their organisational structures.* (Interviewee B)

Despite the barriers, the interviewees did not perceive smart city innovations as inherently difficult to diffuse. In fact, all the interviewees were fairly positive that those innovations developed, tested and diffused in Kalasatama could be diffused in other locations. Forum Virium employees emphasised the importance of timing and strategy. Diffusion was viewed as probable for those innovations mature enough for scaling up to full-scale solutions. Maturity was defined not just in terms of the attributes of the

innovation but also in terms of the business model supporting the innovation. For example, some of the interviewees noted that innovations developed as part of Smart Kalasatama's Agile Piloting programme were more likely to diffuse elsewhere if they had been supported by a market expansion strategy already during the development phase. However, the interviewees also noted that diffusion can be impossible for reasons not directly dependent on the innovation or the business rationale behind it. For example, Smart Kalasatama's shared spaces project is viewed as ripe for diffusion in terms of its open ecosystem and interfaces, technological solutions, business model, and the benefits it can provide. The challenge is that most spaces and facilities belong to different owners and utilise different systems which has hindered the diffusion.

> *[…] the problem is that it is a disruptive idea and there is no one who could scale it up individually […] As long as we are missing that entity that comes in and says that this is the system that can be used for all your spaces and facilities, it will cost you this much… before that happens, there is no mechanism for scaling it up. So scaling such ideas and innovations up, you either need a business that comes up with a solution that incorporates all the necessary issues and sells it as a package to cities, or you need a city that develops its own system that is then copied by other cities.* (Interviewee E)

As for ways to facilitate innovation diffusion in smart cities, the interviewees focused on the roles of communication, co-development, and city authorities. Communication was seen as an essential tool for facilitating both adoption and diffusion of innovations. While both interpersonal and mass media channels were discussed as appropriate communication channels, interpersonal face-to-face exchanges were seen as the most effective channels for the diffusion of innovations in a smart city context. Interviewees talked about the importance of conveying the experiences of cities and citizens to others in a setting that enables exchange of information. Smart city innovations were talked about as fairly context-sensitive solutions which meant that their diffusion can be facilitated by communicating positive experiences while also taking into account the concerns and needs of different cities and citizens. Effective communication was also discussed as a way to engage those stakeholders most influential for diffusion. The interviewees did not refer to opinion leaders or change agents as such but talked about the importance of reaching individuals and actors whose interest were most likely to be tied to the innovation and its potential benefits.

Co-development activities, such as Smart Kalasatama's Agile piloting programme and Innovator's Club, were discussed as an effective way to facilitate innovation diffusion because such initiatives blur the traditional boundaries of supply and demand. From the citizen perspective, ability to participate in co-development activities enabled citizens to voice their opinions and influence the end result. Such re-invention was seen to increase citizens' sense of ownership and made diffusion more fluent because innovations were developed by taking into account the needs of citizens. Business representatives discussed the usefulness of initiatives such as Agile piloting programme also in terms visibility and communication.

> *And through the pilot, we were able to demonstrate our ideas to the wider public and to raise interest in what we do and what we can offer. And what is possible as well, how things can be done in Finland. The pilot was a good way to raise ideas of how green innovations can work.* (Interviewee F)

Finally, although public administration and city governance systems were described as potential barriers for innovation diffusion, the interviewees were of the opinion that the cities as actors and stakeholders can also foster innovation diffusion. In this respect, the interviewees discussed the roles of cities as enablers, regulators and facilitators. These discussions are explored next in the final part of this chapter.

5.4 Involvement of cities in innovation diffusion

The theoretical part of this thesis noted that smart cities seem to require different governance and development approaches when compared to traditional city governance. When discussing innovation diffusion in smart cities, the business representatives of this study expressed their frustration with city organisations. Cities as governing entities were perceived as difficult, remote, too big, bureaucratic and complicated to work with. Two of the companies had experienced difficulties in simply trying to find and reach civil servants or units responsible for certain issues affecting their innovation development. Some business representatives were also fairly sceptical of the ways city organisations execute their strategies and visions. On the other hand, business representatives also acknowledged the importance of cities as actors in creating the framework for smart city development and providing leverage which can help ideas and innovations to scale up.

They were also of the opinion that smart city development requires coordination which a city can provide.

Contrary to their views on working with city organisations, the interviewees were largely satisfied with their cooperation with Forum Virium which operates as a subsidiary of the City of Helsinki and is in charge of the coordination of Smart Kalasatama. As opposed to city organisation, Forum Virium was described as being neutral, flexible, helpful, responsible and easy to reach. The interviewees put the differences between cities as governing entities, such as the City of Helsinki, and city subsidiaries, such as Forum Virium, down to the relative independence of city subsidiaries. Similar views were expressed by the Forum Virium employees interviewed for this study. According to them, the position of Forum Virium as an independent subsidiary means that they are able to be more active, take risks and make mistakes. At the same, as a subsidiary of the city of Helsinki, Forum Virium is able to funnel information to and from the city organisation.

5.4.1 Cities as enablers

When discussing the ways cities as actors and stakeholders are able to facilitate innovation diffusion in smart cities, the interviewees were united in their view that cities should act as enablers. The interviewees were of the opinion that cities are in a position to provide opportunities and resources needed for innovation-based smart city development. In some cases, providing opportunities could simply manifest itself by a city's willingness to embrace bottom-up development by letting citizen-led pop-up events, such as the Restaurant Day, to flourish and grow. In other cases, cities' willingness to provide facilities, connections and funding for innovation development were perceived as beneficial for innovation development and diffusion.

> *I think that the agile piloting programme in Kalasatama is a good example of the role of the city. They create situations and conditions in which to test and try things. Supporting and providing opportunities. Those opportunities will find… they will bring people together. That kind of cooperation, it may develop into something unexpected. And the fact that those pilot projects are quite small, that is a good thing I think. They can be managed more easily and the risks are not overwhelming. If those pilots work, they can be expanded later on. So I think agile piloting was a very good way of the city to support us*. (Interviewee G)

Smart Kalasatama activities were generally perceived as successful examples of the city's role as an enabler. However, due to the project-based nature of Smart Kalasatama activities, some interviewees expressed their concern with the city's commitment and the continuity of such activities once the project had ended.

5.4.2 Cities as regulators

The role of cities as governing entities and regulators was perceived as beneficial for innovation diffusion because such role enables cities to create favourable conditions for smart city innovations. For example, the way the City of Helsinki has stipulated the terms for conveyance of plots in Kalasatama was mentioned as a powerful way to facilitate the diffusion of innovations such as smart energy systems. In essence, every developer is required to follow those stipulations and incorporate smart solutions into their buildings. According to the interviewees, such stipulations do not just facilitate the diffusion of certain innovations. They can also help to create platforms for testing of other related ideas and innovations. Furthermore, if successful, such regulatory measures can also be diffused to other locations quite effortlessly. According to Forum Virium representatives, such diffusion has happened in the Skanssi area of the City of Turku which has more or less copied the terms for conveyance of plots from Kalasatama.

In addition, the role of cities was also regarded as important in terms of the way city strategies and policies incorporate smart city development, thereby also fostering the diffusion of smart city innovations. Such strategies and policies were discussed as efficient ways to diffuse smart city innovations into city-wide structures and practices. Because cities as organisational entities are often fairly large and influential, the impact of their strategies and policies can be far-reaching and extensive. However, some interviewees were sceptical of the extent to which cities actually commit to their strategies and policies.

> *[…] they need to incorporate that into their strategies. Create those policies […] And then those policies need to be implemented. As a Helsinki resident and taxpayer, I am amazed that despite those policies, nothing seems to be happening. As a representative of my business, I am equally amazed that things do not really seem to be moving forward.* (Interviewee B)

5.4.3 Cities as facilitators

The Forum Virium employees interviewed for this study referred to themselves primarily as facilitators of development and innovation. This role was also acknowledged and appreciated by the business representatives interviewed as part of the study. The role of cities or city subsidiaries as facilitators was perceived as especially helpful when communication and cooperation with other stakeholders was needed to spread knowledge about innovations. Business representatives noted that working with Forum Virium had enabled them to meet relevant stakeholders which, in turn, had promoted innovation diffusion. While such meetings could have happened in other circumstances as well, interviewees valued the way Forum Virium organised and facilitated meetings and events, and searched for suitable contacts. Because of Forum Virium's coordinating role in Smart Kalasatama development, its employees were most familiar with the area, its resident base and other actors involved in the development, and were thus able to bring relevant stakeholders together.

In some cases, the contact network of Forum Virium proved essential for finding the right stakeholders for diffusion. For example, Smart Kalasatama's project on shared spaces organised a roadshow to introduce the project and Kalasatama's experiences with it to other cities. In order for the roadshow to reach those relevant actors with potential interest in shared spaces, Forum Virium was able to use its contacts and partners in other cities. Such cooperation with other cities was discussed as an important factor for the diffusion of smart city innovations.

> *[…]And we asked those partners to identify those people and stakeholders who should know about this and be present. So our partners in these cities searched for and contacted relevant people and businesses. And during those events and workshops, we presented what we were doing in Helsinki, what we had learned so far, and discussed what had been happening in those other cities. So we could compare practices and experiences*. (Interviewee D)

Cities were also noted as important for innovation diffusion because they are able to procure innovations and thus facilitate their spreading within and among cities. City organisations' ability to adopt innovations for their own use was viewed as an important contribution to the overall scalability of innovations.

> *[…]Cities are able to do it because they own so many facilities and properties. If they can develop a model for all their schools, community centres, offices…how those are organised within a city, which access control systems they use, what are the locking systems, how are things such as insurances and facility management integrated on a larger scale. If such a model was developed in Helsinki, I am pretty sure other cities would copy it immediately.* (Interviewee E)

While top-down approaches and centralised decision-making were generally not considered as an optimal route to smart city development, the interviewees recognised that in some cases city-led developments could facilitate the diffusion of smart city innovations. For example, the terms for conveyance of plots in Kalasatama were viewed as a good example of top-down measures that facilitate innovation development and diffusion, and which can be fairly easily copied by other cities. This, in turn, fosters diffusion even further.

The discussions above indicate that the findings of the empirical study conducted as part of the thesis are mostly in line with the existing research on both smart cities and innovation diffusion. However, the study also raised some issues which were not as prominently noted in existing research and may be significant in terms of the purpose of this research. The concluding chapter explores the theoretical and managerial implications of the study's findings and proposes ideas for further research.

6 CONCLUSIONS

The purpose of this thesis has been to explore the ways innovation diffusion can be facilitated in the context of smart city development. The preceding chapters have explored the relationship between smart cities, innovations and innovation diffusion. Relevant literature and existing research on smart cities and innovation diffusion have been discussed and used as theoretical background for the case study which focused on smart city development and innovation diffusion in Kalasatama. This concluding chapter focuses on the theoretical contribution of the thesis, discusses its practical implications, and suggests directions for further research.

6.1 Theoretical contribution

The theoretical background built for this thesis has focused on smart cities and innovation diffusion. While both topics have received academic interest in their own right, they have rarely been discussed together. This thesis has chosen to focus on both topics in order to gain a better understanding of the relationship between smart city development and innovations. The study conducted as part of this thesis was designed to address the research questions of the thesis by reflecting on existing theories and research with the help of a real life case of innovation-based smart city development. The findings of the study are discussed in relation to the theoretical background on smart cities and smart city development, the relationship between smart cities and innovation, diffusion of innovations in smart cities, and the role of cities as actors and stakeholders in innovation diffusion.

As for smart cities and smart city development, existing literature and research into smart cities proposes that because urban areas face many socio-economic and environmental challenges caused by increased urbanisation, many cities have begun to focus on smart urban development as means to tackle such challenges (Schaffers et al. 2011; Albino et al. 2015; Neirotti et al. 2015; Dameri 2015). According to existing research, smart cities are usually expected to focus on features such as the utilisation of ICT, creativity, innovation, and democratic participation to create and maintain urban settlements that cultivate sustainability, innovations, citizen-driven and citizen-centric governance, and business-led urban development (Caragliu et al. 2011; Schaffers et al. 2011; Srivastava et al. 2012; Albino et al. 2015; Kraus et al. 2015; McLaren & Agyeman 2017). However, research also discusses smart city development as a challenging

endeavour because cities differ from each other in various ways (Cosgrave et al. 2013; Neirotti et al. 2014; Kraus et al. 2015; Shelton et al. 2015) and because the coordination of smart city development needs to take into account the diverse needs, roles and responsibilities of various stakeholders (Zygiaris 2013; Angelidou 2014; Ben Letaifa 2015; Dameri 2015; Angelidou 2015). As a result, smart cities require new coordination and governance approaches which can combine stakeholder engagement, empowerment and bottom-up participation with central monitoring practises (Zygiaris 2013; Angelidou 2014; Neirotti et al. 2014; Ben Letaifa 2015; Shelton et al. 2015).

The findings of the study conducted as part of this thesis largely support the views of existing research on the reasons behind smart city development, the characteristics of a smart city as well as it coordination and governance approaches. The findings also emphasise the competitive element and the role of commercial opportunities in smart city development. Thus, while smart cities can be perceived as a response to pressing challenges caused by increasing urbanisation, the findings suggest that they are also regarded as opportunities for cities to stand out and prosper. However, findings of the study also indicate that smart city development should be guided by priorities and visions that place citizens, sustainability, and the quality of life in cities at the heart of development. In this respect, smart technologies were viewed as the means rather than the end goal of smart city development. Findings of the study also suggest that the coordination of smart city development needs elements of both bottom-up and top-down approaches because while bottom-up approaches make it easier to develop the city with the citizens and on their terms, top-down approaches enable coordination and systematic, large-scale changes.

In terms of the relationship between smart cities and innovation, existing research into smart cities suggests that while cities as environments are often ideal places for innovations to flourish (Shearmur 2012; Srivastava et al. 2012; Neirotti et al. 2014; Angelidou 2015, Dameri 2015), the infrastructure, resources, and governance structures of cities can hinder innovation-based development (Cosgrave et al. 2013; Angelidou 2015; Brorström 2015; Global Review of Smart City Strategies 2017). However, research also suggests that in order to become or remain smart, cities need new solutions in the form of innovative products, services, processes, and practices (Zygiaris 2013; Brorström 2015). Findings of the study support the view of innovations as essential for smart city development. The findings suggest that smart city development is driven and facilitated by factors such as technological development, the rise of start-up culture and entrepreneurship, and changes in consumer preferences, all of which can be thought to support and promote the role of innovations in cities. However, findings of the study are

in line with research in suggesting that factors such as existing infrastructure and governance structures of cities often act as barriers for smart city development. Furthermore, the study also discovered that generational differences, traditions and insufficient market potential were hindering the deployment of innovations and smart city development.

In order to better understand the factors affecting innovation-based smart city development, existing theories on innovation diffusion were utilised as a theoretical background for the study. Theories on diffusion of innovations were used to explore potential issues concerning the features of smart city innovations, the roles of cities as both environments and actors in smart city development, the roles of citizens as both potential users and developers of smart city innovations, the roles of different stakeholders and their respective characteristics, and the general influence of social systems on smart city innovations. The study conducted as part of the thesis focused on smart city innovations especially in terms of innovation development, adoption, and diffusion activities. The findings of the study are in accordance with theories on diffusion of innovations (Gatignon & Robertson 1985; Rogers 2003; Tidd 2010; Naor et al. 2015) in that the adoption of smart city innovations was discovered to be partly related to the features of such innovations, especially in terms of their compatibility, complexity and trialability. According to the findings, these features are in decisive positions especially when it comes to existing city infrastructures and citizens as adopters. The findings also suggest that adoption of smart city innovations can be fostered by measures such as innovation co-development, targeted communication, and authority-based innovation decisions.

As for innovation diffusion, the findings of the study support the view of diffusion theories (Gatignon & Robertson 1985; Rogers 2003) that innovation diffusion is easier in homogenous social systems with convergent population characteristics and matching norms and values. The findings also suggest that while smart city innovations may not be inherently difficult to diffuse, general, supply- and demand-side barriers (Caiazza 2016) can hinder the scaling-up of such innovations. In a smart city context, general barriers were identified as regulations affecting the deployment of smart city innovations. Supply-side barriers were identified as structural barriers in the form of challenges in adapting innovations suitable for one setting to different contexts, or as difficulties encountered when working with the governing structures of cities. As for the demand-side, features of innovations, such as innovations' incompatibility with existing solutions, adopters' uncertainty and attitude towards change, and the lack sufficient information were recognised as the most prominent barriers for innovation diffusion. However, the findings

of the study also recognise factors such as timing and the maturity of the innovation in terms of the business model supporting it as decisive factors in determining diffusion potential. Furthermore, the study discovered that in a smart city context, innovation diffusion can be fostered by the means of interpersonal communication and innovation co-development with stakeholders.

Findings of the study also support innovation diffusion theories' view that diffusion can be cultivated with the help of cities as actors and stakeholders. Innovation diffusion theories discuss the role of city organisations in innovation diffusion mainly in terms of the regulatory power of cities and their ability to procure innovations for wider usage (Halila & Rundquist 2011; Rolfstam et al. 2011; Naor et al. 2015; Caiazza 2016). The findings of the study for this thesis support such views suggesting that while stipulations can hinder innovation diffusion, the role of cities as regulators can also create favourable conditions for smart city innovations to diffuse. The findings also recognise the influence cities have in terms of innovation procurement in smart cities. Furthermore, based on the findings of the study, cities can promote smart city innovation diffusion by acting as enablers providing opportunities and resources needed for innovation development and diffusion.

Finally, the study also discovered that cities are able to foster innovation diffusion by facilitating communication and cooperation among different smart city stakeholders. However, the findings suggest that the bureaucratic nature of city organisations often hinders such innovation development and diffusion, and that other entities may be better suited for coordinating innovation-based smart city development. For example, in Smart Kalasatama's development model, illustrated in figure 9, Forum Virium as a city subsidiary coordinates and mediates smart city development by funnelling information to and from the City of Helsinki and all the other stakeholders while also facilitating co-development and bottom-up approaches which contribute to the development of Smart Kalasatama. Findings of the study suggest that the model is both efficient and effective when compared to a more top-down coordination by city organisations. Such findings indicate that, as existing research (Ben Letaifa 2015; Dameri 2015) also suggests, smart cities may indeed require different governance and coordination approaches when compared to traditional cities. The managerial implications of these findings are discussed in more detail next.

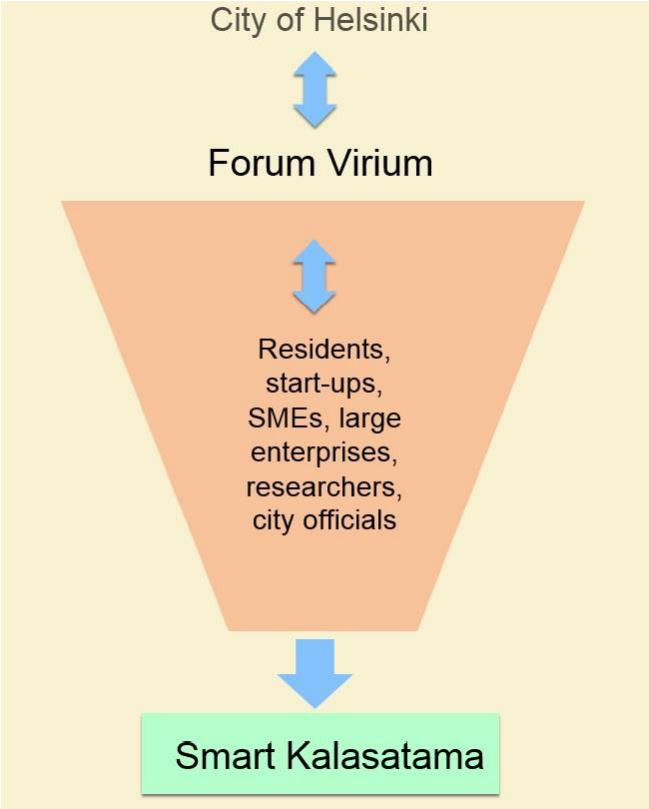

Figure 9 Smart Kalasatama co-development model

6.2 Managerial implications

The findings of the study conducted as part of this thesis and the study's theoretical background (Zygiaris 2013; Neirotti et al. 2014; Ben Letaifa 2015; Kraus et al. 2015) suggest that even though smart city development benefits significantly from bottom-up development approaches, coordination of such development is still important, and cities as actors and stakeholders can adopt several important roles in smart city development. Based on existing research on smart cities and innovation diffusion, and on the findings of the study, four main managerial implications can be surmised.

Firstly, the findings of this study indicate that change is an integral part of smart city development and cities as governing entities and stakeholders should internalise the need for change as a driving force behind smart city development and innovations. Change should thus become a default setting for any vision or policy driving smart city development. While the bureaucratic and vast systems of city organisations may be resistant to the idea of change, this study demonstrates that there are ways for cities to

outsource change-based development activities to actors more suited to dealing with them. Findings of this study suggest that using smaller and specialised entities, such as a city subsidiary Forum Virium in the case on Kalasatama, may make the coordination of smart city development processes easier and more efficient for all the stakeholders involved. Using such entities that are perceived as more neutral and easier to reach can also increase other stakeholders trust and commitment in smart city development processes. City organisations, on the other hand, can utilise their regulatory power to implement measures that support change, as has been the case with the terms for conveyance of plots created by the City of Helsinki for Kalasatama.

Secondly, based on the findings of the study, most changes required for smart city development are likely to come from the outside. In other words, cities as organisations may not be the best sources of innovation-based smart city development. Rather, innovations and the trends on which they are based are likely to emerge from the private sector and from the people inhabiting cities. Thus, cities as organisation should promote innovation-based smart city development by creating conditions that support both business-led development and bottom-up approaches. As the findings of the study suggest, such support can be provided by accommodating and enabling innovation development, as has been the case with Smart Kalasatama's agile piloting programme, promoting co-development by providing connections and facilitating communication between different stakeholders, and by procuring innovations that support smart city development. Measures and approaches such as these appear to be especially relevant and appropriate for cities in countries with traditionally decentralised governance systems and democratic cultures.

Thirdly, even though cities as organisations and stakeholders may not be the optimal sources of innovation-based smart city development, the findings of the study indicate that the stand cities take in relation to smart city development activities bears significance. For example, the study discovered that the main reason Copenhagen stood out as one the best examples of smart city development was the city's consistency and commitment in urban development. According to the findings of the study, in order to foster smart city development and the diffusion of smart city innovations, cities should demonstrate commitment by introducing and implementing relevant strategies and policies that support such development. Commitment is important because it is likely to promote continuity which, in turn, is likely to decrease fragmentation and to foster diffusion of innovations and smart city development.

Finally, the study conducted as part of the thesis indicates that the factors influencing innovation diffusion in a smart city context can be understood and addressed by focusing

on many of the issues raised in innovation diffusion theories. Existing theories can help those private and public sector actors involved in managing smart city development and diffusing smart city innovations to better understand the challenges and opportunities ahead of them, and how diffusion can be best facilitated in different circumstances. Innovation diffusion theories can be useful for exploring issues such as the attributes of different smart city innovations and the way those attributes may affect diffusion processes. They can also make it easier to understand the characteristics of a city's social systems and the way characteristics such as norms and values can hinder or promote the diffusion of innovations. Such information can be useful when exploring how diffusion processes could be facilitated in different cities and communities. Existing theories can help to address some of the challenges caused by heterogeneity among cities by focusing on cities as contexts with, for example, specific market features, political conditions, institutional characteristics, cultures, and geographic settings. It can also make it easier to recognise the individuals and entities who are key actors in diffusion. Innovation diffusion theories can also be useful in clarifying the role of cities as not just environments and urban settlements but as actors in smart city development. Furthermore, diffusion theories' take on user involvement and re-invention as factors facilitating innovation diffusion can help smart city developers utilise citizens as both potential adopters and co-developers of innovations. As this study suggests, involving citizens in the development processes may facilitate diffusion processes by lowering adoption barriers as well as by committing citizens to smart city development processes.

6.3 Suggestions for further research

The study conducted for this thesis focused on smart city development and innovation diffusion in Kalasatama which can be described as a smart city development platform for the City of Helsinki. As explained earlier, a single case study strategy was chosen because it enables the collection of more in-depth data. It was also considered to be feasible in terms of resources such as time, and it provided more room for creativity and freedom as there was no need to replicate steps in other cases for comparison. However, as also mentioned earlier, the lack of comparable data from similar cases can be harmful in terms of the generalisability of the findings of the study. While it has not been the purpose of the study to build a generalizable theory, it is important to recognise that the findings of this thesis may not apply to other cases and settings. To explore the generalisability of the findings of this study, further research focusing on other settings and contexts is needed.

It could, for example, be useful to compare the findings of this study with a study focusing on a case that utilises a more top-down approach to smart city development and innovation diffusion.

Furthermore, Kalasatama was chosen as the unit of analysis for this study because it was thought to encompass those common smart city characteristics summarised in figure 2 of this thesis. Kalasatama development was also believed to offer various angles from which the research questions could be approached. It was thus expected to provide data that is both rich and suitable for the purposes of this thesis. While these assumptions can be defined as accurate, it is worth noting that the findings of the study also indicate that Kalasatama is a unique case, especially in terms of its origins and demography. As a purpose-built smart city development platform with a fairly homogenous resident-base and a designated city subsidiarity coordinating the development, it is fair to assume that such setting may influence the findings of the study. In order to broaden the scope, further research into innovation diffusion in smart cities could focus on those cities and city district which are not build as designated smart cities and which are more heterogeneous in terms of their demography.

The primary data for this study was collected by the means of semi-structured interviews with stakeholders who have been involved in Kalasatama development. Because resource-wise it was not feasible to interview representatives from all the different stakeholder groups, a decision was made to focus on representatives of three stakeholder groups which were viewed as most central for the purposes of this thesis. The findings of this study thus reflect the views and experiences of the representatives of the city subsidiary coordinating smart city the development in Kalasatama, and the business representatives and citizens involved in the development processes. The decision to focus on these three stakeholder groups means that the findings of the study may not represent the views and experiences of those other common smart city stakeholders introduced in table 3 of this thesis. Because the perspectives of other stakeholders may differ from the views of those stakeholders interviewed for this study, it would be beneficial for future studies to incorporate other stakeholders as primary data sources. This would help to expand the explanatory potential of further studies.

Finally, studies focusing on diffusion of innovations are likely to benefit from research that is more longitudinal in nature. Such research would make it possible to observe diffusion processes from the start and to focus on the different phases of diffusion. While it was beyond the means of this study to utilise such approaches, longitudinal studies could expand the explanatory potential and enhance the trustworthiness of future studies by providing a more accurate account of diffusion processes in smart cities.

SUMMARY

This thesis focused on innovation diffusion in smart cities. The purpose of this thesis was to explore the ways diffusion of innovations can be facilitated in the context of smart city development. The research purpose and questions of this thesis were addressed by discussing the relevant literature and existing research on smart cities and diffusion of innovations, and by conducting a case study that explored smart city development and innovation diffusion in the Kalasatama area in Helsinki.

The introductory chapter 1 of the thesis provided an overview of smart cities and the relationship between smart cities and innovation. The overview built a background for the purpose of research which was also presented in chapter 1. Chapter 2 of the thesis explored existing smart city literature and research focusing on the definitions and characteristics of smart cities, and the factors affecting smart city development. Based on existing research, chapter 2 concluded that smart cities are often characterised by the utilisation of ICT and focus on issues such as creativity, innovation, and democratic participation processes which are believed to contribute to the creation of cities that foster sustainability, innovations, citizen-driven and citizen-centric governance, and business-led urban development. Chapter 2 also discussed the ways the differences among cities and the diverse needs, roles and responsibilities of various stakeholders can affect smart city development and make it a challenging endeavour. In terms of smart city innovations, chapter 2 concluded that introducing and diffusing innovations which aim to make cities smarter can be challenging because of the existing infrastructure and governance structures of cities, the habits and mind-sets of citizens, the heterogeneity among cities, the differences between smart city development approaches and subsequent lack of standardisation, and the diverse needs, roles and responsibilities of stakeholders.

Chapter 3 explored theories and existing research on innovation diffusion by focusing on the adoption and diffusion of innovations and the factors affecting both processes. Based on the issues raised in chapter 2, chapter 3 also discussed the relationship between innovations and smart cities in the light of innovation diffusion theories. Chapter 3 concluded that innovation diffusion theories can provide a theoretical background for exploring innovation-based smart city development. Depending on how innovation diffusion theories are utilised, chapter 3 suggested that such theories may make it easier to understand issues such as features of innovations, roles of cities as both contexts and actors, roles of citizens as both potential users and co-developers, and the influence of social systems on smart city development.

The research design of the case study conducted as part of this thesis was explored in chapter 4. The chapter introduced the research approach, strategy, and data collection and analysis methods chosen as appropriate for the purposes of this thesis. The reasons behind choosing a qualitative research approach and a single case study research strategy were explained. Similarly, the premises for primary data collection by semi-structured interviews, the sampling of the interviewees, and data analysis by the means of thematic analysis were discussed. Altogether eight people were interviewed as part of the case study. The interviewees included three representatives from the city subsidiary coordinating smart city development, four representatives from companies which had been involved in the smart city development, and one citizen who had participated in the development as a private resident. Chapter 4 also explored and evaluated the overall trustworthiness of the study.

Chapter 5 of this thesis focused on the empirical research part of the thesis. It introduced Kalasatama as the unit of analysis of the case study and presented the findings of the study by focusing on issues that were raised in the interviews in terms of views on smart city development, diffusion of innovations in smart cities, and the roles of cities in innovation diffusion. In the concluding chapter 6, the findings of the study were discussed further in relation to the theoretical background and the overall purpose of the research. The findings of the study were concluded to be largely in line with existing research on smart cities and smart city development. Because the study focused on the relationship between smart cities and innovation, it was also able to provide an insight on factors influencing the diffusion of innovations in a smart city context, and on the ways cities as governing entities and stakeholders influence the diffusion of smart city innovations. The study concluded that while innovations are an integral part of smart city development, their adoption and diffusion are affected by various facilitating and hindering factors, many of which are also recognised in innovation diffusion theories. Furthermore, the findings suggested that adoption and diffusion of smart city innovations can be facilitated by measures such as innovation co-development, interpersonal and targeted communication, and authority-based innovation decisions.

Based on the findings of the study, it was also concluded in chapter 6 that cities as actors can promote smart city innovation diffusion and smart city development by procuring smart city innovations, by acting as enablers providing opportunities and resources needed for innovation development and diffusion, and by facilitating communication and cooperation among different smart city stakeholders. However, the findings also suggested that the bureaucratic nature and size of city organisations often hinders smart city development and innovation diffusion. Based on these findings of the

study, managerial implications described in chapter 6 noted the imperative of accepting change as an integral part of smart city development, and the need to utilise smaller and specialised entities, such as city subsidiaries, in the coordination of smart city development. Furthermore, the findings indicated that smart city coordination should create conditions that support both business-led and bottom-up development approaches to smart cities, and that cities should show commitment to ensure the continuity of smart city development. The importance of focusing on many of the issues raised in innovation diffusion theories was also discussed as important in terms of smart city development.

The final part of chapter 6 focused on the limitations of the study and proposed directions for further research. It was suggested that because the unit of analysis in the single case study conducted as part of this thesis is unique in many ways, further research into other settings and contexts is needed to explore the generalisability of the findings of the study. Future research was also encouraged to broaden the scope of research into cities which are more heterogeneous, and to incorporate other stakeholder groups as primary data sources as this would help to expand the explanatory potential of further studies. Finally, it was noted that longitudinal studies could expand the explanatory potential and enhance the trustworthiness of future studies by providing a more accurate account of diffusion processes in smart cities.

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APPENDICES

Appendix 1: Interview guide for city and business representatives

Background information	What is / has been your role in the development of Smart Kalasatama? What kind of previous experience do you have in smart city development and/or innovation management?
Smart city development	How would you define a smart city? ▪ In your opinion, is there a city that matches this definition? If there is, what is it and why? If there is not, what do you think is the reason behind it? What do you see as the key issues fostering smart urban development? ▪ Why these issues? What do you see as the biggest barriers hindering smart urban development? ▪ Why these issues? ▪ What could be done to overcome them? In your opinion, what are the issues that deserve more attention in the current smart city development discourse? ▪ Why these issues?
Role of innovations in smart city development	What kind of innovations are needed to help cites to become smart? ▪ Why these kind of innovations? Could you name an innovation or innovations which have been especially important in terms of smart city development? ▪ Why have they been important?

Diffusion of innovations in smart city context	Based on your experiences, what are the key issues facilitating the adoption of smart city innovations? ▪ Why those issues? Based on your experiences, what are the main factors hindering the adoption of smart city innovations? ▪ Why those factors? ▪ How could those factors be avoided or overcome? How can innovations developed in the context of smart urban development be spread more widely within and among communities and cities? Based on your experiences, are there some specific issues affecting the spreading of innovations in a smart city context? ▪ What kind of issues? ▪ How do they affect the diffusion process?
Role of cities as institutions in smart city development and innovation diffusion	In your opinion and experience, what should be the role of cities as institutions and stakeholders in smart urban development? How should/could cities participate in the innovation diffusion processes in smart city development? Based on your experiences or knowledge, could you give examples of cases in which the role of the city as an organisational entity has been beneficial to the spreading of smart city-related innovation(s)?
Innovation diffusion in Kalasatama	In your opinion, is Smart Kalasatama a successful example of a smart city development? ▪ If yes, why? ▪ If not, why? In your opinion, what is the role of the City of Helsinki in the development of Smart Kalasatama? ▪ Is this role beneficial and why? ▪ Is this role necessary and why?

	In terms of innovations, what have been the highlights in Smart Kalasatama development and why? In terms of spreading of innovations, what kind of difficulties or challenges have you encountered in Smart Kalasatama development? ▪ What do you think are the reasons behind them and how could they be overcome? Collaboration between different stakeholders has been highlighted as a key element of Smart Kalasatama development. Based on your experiences, how has collaboration between the different stakeholders influenced the adoption and spreading of innovations in Smart Kalasatama? How does Smart Kalasatama as a context and an environment (a purpose-build smart city) influence the spreading of innovations? Based on your knowledge and experiences, what could / should be done to ensure that the solutions adopted in Smart Kalasatama are taken up in other parts of Helsinki and in other cities?

Appendix 2: Interview guide for residents/citizens

Background information	How have you participated in Kalasatama development? Why have you participated in Kalasatama development?
Smart city development, innovations and citizen involvement	What do you think are the benefits or disadvantages of citizen involvement and engagement in urban development? What kinds of innovations (new products, services, solutions, practices) have you tested or started to use in Kalasatama? Why have you tested or started to use those innovations (new products, services, solutions, practices) in Kalasatama? Have you participated in innovation development (new products, services, solutions, practices) in Kalasatama? ▪ If yes, how?
Smart city development in Kalasatama	How would you define a smart city? How well does Kalasatama match your image of a smart city? What kind of a place would you like Kalasatama to be in the year 2030?

Appendix 3: Themes used in data analysis

SMART CITY DEVELOPMENT	
Main themes	**Sub-themes**
Defining smart city	Ideal smart cities Characteristics of a smart city
Current issues/trends in smart city development	Sustainability Urbanisation Sharing economy Citizen activism Digitalisation Open data
Factors driving smart city development	Technological development Infrastructure Consumer culture Values Generational differences
Factors hindering smart city development	Bureaucracy Lack of market potential Infrastructure Traditions Generational differences
Approaches to smart city development	Top-down vs. bottom-up Cultural differences

DIFFUSION OF INNOVATIONS IN SMART CITIES	
Main themes	**Sub-themes**
Innovations in smart cities	Relevance
	Challenges
Innovation development in smart cities	Co-development
	Citizen engagement
	Co-ownership
	Agile piloting
Innovation adoption	Attributes of innovation
	Citizen engagement
	Communication
	Co-development
	Authority decisions
	Values
	City environment
Innovation diffusion	Communication
	Co-development
	Stakeholder engagement
	Timing
	Infrastructure
	Traditions
	Business strategy

ROLE OF CITIES AS STAKEHOLDERS IN SMART CITY DEVELOPMENT	
Main themes	**Sub-themes**
Cities vs. city subsidiary	Forum Virium City of Helsinki Cooperation
Cities as enablers	Opportunities Resources Continuity
Cities as regulators	Conditions Stipulations Commitment
Cities as facilitators	Co-development Cooperation Communication