Determinants of Longevity of Smart City Innovation Ecosystems and Projects

A framework to build, integrate and sustain smart city innovation projects and corresponding ecosystems

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Abstract: The study discusses the determinants of longevity of smart city ecosystems and projects. Common dimensions are defined by reviewing literature and constructing interviews with smart city stakeholders in the public and private sector involved in initiatives and projects in Europe. The factors and mutual relationships are assembled in a conceptual model aligning technology, governance and strategic factors. The study offers strategic guidance and recommendations for stakeholders to improve collaboration and create and continue smart city ecosystems and projects.

Key words: Smart cities, Innovation ecosystems, Ecosystem longevity
Preface

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Acknowledgements

The author would like to thank the thesis coach Dr. Tobias Brandt for helping to define the research question and providing constructive feedback and the co-reader Dr. Koen Dittrich for giving advice about qualitative research methods and sending interesting academic articles. I also want to thank my company coach Andre Brugman for giving me the chance to write my thesis at Cisco and connecting me with smart city stakeholders. I would like to thank Marcel van Oosterhout for providing me with useful information about projects and bringing me in contact with interview contacts. I want to thank my colleagues at Cisco, especially Steve Shaw and Minke Huizenga, and the experts I have interviewed for sharing their knowledge and their contribution to my research.
Executive summary

The Internet of Things is a new, rising phenomenon that connects people, processes, data, business and things. A horizontal Internet of Things use case that becomes more popular is smart cities. Due to limited knowledge, public and private parties are not able to develop smart city solutions on their own and therefore need to reunite internal and external partners and create an ecosystem. The success of smart cities brings with it the challenge for longevity of the smart city innovation ecosystem and the associated project. Since the Internet of Things is a relatively new subject, there is not a lot of research done yet, especially not in the field of smart city innovation ecosystems and continued innovation. This study focuses on finding determinants of longevity of smart city ecosystems and the relationships between these determinants.

After reviewing existing literature, a pre-conceptual model could be defined with multiple theoretical constructs that could influence the longevity of smart city ecosystems, like ability to innovate, silo mentality, public-private collaboration, triple helix collaboration, local adaption, data collection, platform standardization, platform integration, central authority, IT-business fusion, bottom-up/top-down approach, transition-experiments, living labs, platform openness, ease of integration, use of the cloud, institutional factors, technology factors, human factors and entrepreneurial activity.

This qualitative research is conducted in cooperation with Cisco to generate a new theory, also grounded theory. For this qualitative research, in-depth interviews are conducted with European smart city stakeholders with smart city expertise working for a private company, the government or a public-private partnership. Building upon the responses, this study focuses on the development of a framework to ensure longevity of the smart city ecosystem. First of all, four exploratory interviews with mainly open questions are conducted to establish a set of constructs that can add to the pre-conceptual model. Secondly, 16 expert interviews with semi-structured questions validate or modify the constructs. Interviewees are selected by taking differences in role, age and organization type into account and sampling adequacy that ends when concepts are saturated. This study uses the three different coding methods, open coding, axial coding and selective coding, to turn the interview data into new theories. The coding methods are part of the inductive qualitative research method called grounded theory. Open coding defines first-order concepts, where selective coding brings together these first-order concepts into a more general second-order concept or category.
The results section describes main issues that stakeholders experience and stop the survival of the ecosystem. Thereafter, co-occurrence codes are determined and analyzed to clarify or modify the co-occurrence of factors. Often mentioned concepts can be classified into ten categories: smart city governance, silo management, public-private partnership, ecosystem creation, project development, business model, knowledge sharing, ability to innovate, data use and innovation platform implementation. The ability to innovate directly effects the longevity of smart city ecosystems in a positive way, because through innovation smart cities can handle the differences in pace between technology, management and policy. Smart city governance, silo management, public-private partnerships and ecosystem creation are related to each other and can be classified into governance factors. Project development, business model and knowledge sharing affect each other and can be seen as strategic factors. Data use and the innovation platform implementation are technology factors. Governance factors, strategic factors and technology factors influence the ability to innovate. The interview data defines four propositions and a number of recommendations for the public and private sector.

This study builds on the small number of research that has been done in the field of smart cities, especially on the fundamental components of a smart city (Nam & Pardo, 2011), and at the same time extends this existing academic literature. This study not only focuses on defining the smart city as many studies do, but links determinants of ecosystem longevity to create a practical model that can be used in the implementation of smart city projects and creation of smart city ecosystems. Research limitations mostly occur in the sampling process. Most interviewees are project managers who might be biased about the research topic, and from the Netherlands which reduces generalizability.

The findings of this study contribute to the continued existence of smart city ecosystems and corresponding projects by emphasizing the factors that need to be considered. Both public and private parties can use the framework that connects the most common factors in setting up smart city initiatives instead of focusing on one single factor.

Parties involved in the ecosystem, especially public and private parties, should take technology, governance and strategic factors into account to be able to innovate and sustain the ecosystem.
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1 Introduction

It is going to be a fast ride, but we are heading towards an autonomous world with smart components that establish connections between people, processes, data, business and things. This phenomenon is termed the Internet of Things (IoT) or the Internet of Everything (IoE). This next big direction in our future is the second stage of the Internet. By digitizing smart assets, it will be possible to connect everything to everything (Kranz, 2017).

A horizontal Internet of Things use case that is becoming more popular is smart cities. The increasing city population demands for more flexible services, governments and the private sector should come up with solutions that fit the citizens’ needs. In most cases, the Internet of Things is used in energy, transportation, mobility or manufacturing industry projects (Kranz, 2017). All systems in a city need to be assembled to simplify and improve the quality of citizens’ lives.

1.1 Purpose

Despite the fact that many cities have already implemented Internet of Things solutions, a lot of research still needs to be done in order to ensure a successful Internet of Things future. While most previous studies have focused on the ‘not yet determined’ definition of a smart city, only few studies elaborate on the future of smart cities. One of the issues that can be elaborated on is the need for an integrated framework to ensure standardization and durability of projects and ecosystems.

Cities should focus on collaboration between different stakeholders to make cities smarter. Reuniting internal and external partners by creating an ecosystem makes sure that the Internet of Things becomes a competitive advantage for the organization (Noronha, Moriarty, O’Connell, & Villa, 2014). Therefore, it is essential to connect all stakeholders in a structured way, so all stakeholders stay involved in the project.

1.2 Research question

The question that comes to mind is what the essential factors are for building ongoing ecosystems and projects in smart city environments. This study arises from a question of the RUGGEDISED
project and gains insights from smart city projects in Europe on the basis of interviews with stakeholders in collaboration with Cisco, a multinational technology company developing a variety of networking hardware, telecommunications equipment and other technology services and products. The research question of this study is:

*Which factors influence the longevity of smart city innovation ecosystems and projects?*

To find an answer on this research question, the sub-questions of this study are:

i. What are essential factors in smart city environments?
ii. How do factors affect other factors?
iii. How do factors influence the longevity of smart city ecosystems and projects?

Despite studies about the definition and characteristics of smart cities, cities still need a framework, recommendation or best practice to connect all resources. Interviews with representatives from smart city projects provide insights into common resources, data, approaches and techniques used in innovative and successful smart city projects. This study enables developers of smart city projects to make better decisions during the process and collaboration with other developers, whether they are independent or working for a private or public organization. A question often faced by many smart city stakeholders is: how do we keep the ecosystem alive? This study elaborates on the essentials to ensure longevity of the smart city ecosystem in cities, also smart cities, governments, public companies, public organizations or municipalities.
2 Literature review

Since the Internet of Things is a well-discussed topic over the past few years, dividing the literature review in four clear aspects helps to organize the information. First, this study discusses the general Internet of Things concept to understand the starting point of smart city projects. Then the focus is on smart city environments, illustrating the application of the Internet of Things in cities. Third, the study explains the development of projects in smart city environments as well as the partnership between public and private parties and the smart city governance. The literature review ends with the elaboration of innovation platforms that play a role in connecting different silos and the discussion about the openness of a platform. These aspects cover the complete literature review and are of importance to identify occurring problems and commonly used concepts of smart city projects. The literature review also confirms that little research has been carried out on the topic of this study and an open-ended approach is the right approach to address this study (Stebbins, 2001).

2.1 The Internet of Things

People talk about the Internet of Things as the next phase of the Internet. It will be the second stage of the Internet that offers a new dimension by connecting ‘anything to anything’ or ‘everything to everything’. Organizations are mostly interested in the many opportunities the Internet of Things offers, but do not see the need for faster innovations and more efficient operations to stay competitive. When an organization effectively integrates the Internet of Things solutions with their processes, the Internet of Things could provide many advantages and useful insights when organizations focus on data capabilities as integration, automation and analytics (Noronha et al., 2014).

The technological developments in the field of the Internet of Things have established many possibilities to develop services and applications, but just a small part of these developments is available to our society (Atzori, Iera, & Morabito, 2010). Usually, it is not the technology that is not sufficiently developed to ensure implementation, but the society and organizational aspect. The possibilities and new solutions the Internet of Things can bring are in exhaustive and still unpredictable. The position of the phenomenon on the top of Gartner’s Hype Cycle indicates great expectations that cannot directly be met. Practice shows that there is currently a lack of
standardization, structure, overall vision and cooperation between parties that hinders developments and creates isolated projects (Libbenga, 2014).

2.2 Smart cities
It is estimated that 66% of the world’s population will live in cities by 2050, so cities are facing an increasing pressure to deploy themselves as livable and sustainable places that offer many services to improve the quality of life of citizens (United Nations, 2014). Although many cities, often too self-congratulatory, are aiming to become the smartest city in the world, cities can only claim to be smart when they perform well in the areas of human capital, social cohesion, economy, governance, public management, environment, mobility and transportation, urban planning, international outreach and technology (IESE Business School, 2016).

The exact definition of a smart city is still not completely defined, although a lot of studies focus on the definition of this phenomena. Smart cities are mostly characterized by its innovative, entrepreneurial and creative ecosystem and a strong information technology network (Anttiroiko, Valkama, & Bailey, 2014). In order to keep up with the increasing global competition in the field of smart cities, European cities need to develop an entrepreneurial character and an innovative and creative vision (Lombardi, Giordano, Yousef, & Farouh, 2012). Next to using technologies to build infrastructures and services for a more livable city, social capital and governance participation can also improve sustainable growth and the quality of life (Nam & Pardo, 2011). Fusion or a strong convergence between business and IT is necessary to ensure integration of IT into the business instead of alignment or a relationship between IT and business where both functions adapt their strategy (Luftman, 2004). In this way, IT becomes part of the business strategy instead of being treated as a separate function in the business (Hinssen & Derynck, 2009). Smart cities need to focus more on socio-technical analyses to completely understand interactions between technology, institutional and human factors as indicated in figure 1 (Meijer & Bolívar, 2016).

Most studies define a smart city as smart technology in the city or a combination of smart technology, smart people and smart collaboration in the city (Meijer & Bolívar, 2016).
Smart cities need to be contextual, collaborative and collective in order to transfer the utopia of a parametric city into practice (Ballon, 2016). Most cities owe their smart city reputation to extensive marketing campaigns while these cities do not always have intelligent solutions (Hollands, 2008). A universal framework should assess the smartness or intelligence of a city. The different characteristics and visions of cities make it difficult to compare all cities. The smart city definition formulated by Cisco is: “the seamless integration of public and private services, delivered across a common network infrastructure, to individuals, governments and businesses” (Goulden, 2015). This definition emphasizes an open platform for knowledge and data sharing among stakeholders. Smart city solutions do not automatically improve the quality of life of the urban community or solve the social issues crowded cities face. Therefore cities need to involve citizens to create a smart city environment where information technology is socially used to create a smart community (Hollands, 2008). Second, the rise of big data there increases uncertainty about the collection and use of data by organizations. Organization need to be more transparent about their operations and need to ensure safety and protection of personal data. ‘Vulnerability’ can therefore be added to the 5 Vs of big data: volume, velocity, variety, veracity and value (Marr, 2016).

To conclude, common smart city characteristics or indicators are given in table 1.

Table 1 Overview of smart city characteristics

<table>
<thead>
<tr>
<th>Reference</th>
<th>Smart city characteristics</th>
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<tbody>
<tr>
<td>(IESE Business School, 2016)</td>
<td>Human capital, social cohesion, economy, governance, public management, environment, mobility and transportation, urban planning, international outreach, technology</td>
</tr>
<tr>
<td>(Anttiroiko et al., 2014)</td>
<td>Innovative, entrepreneurial and creative ecosystem, strong information technology network</td>
</tr>
<tr>
<td>(Caragliu, Del Bo, &amp; Nijkamp, 2011)</td>
<td>Urban transportation networks, social capital, environmental interests, the ICT distribution, human capital</td>
</tr>
<tr>
<td>(Giffinger, 2010)</td>
<td>Smart economy, people, governance, mobility, environment and living</td>
</tr>
<tr>
<td>(Lombardi et al., 2012)</td>
<td>Creative and innovative vision, entrepreneurial character, use of technology and industries in the IT area</td>
</tr>
<tr>
<td>(Kranz, 2017)</td>
<td>Environmental, ICT, mobility, water, energy, waste, nature, built domain, public space, open government, information flows and service</td>
</tr>
<tr>
<td>(Ballon, 2016)</td>
<td>Smart mobility, participation and creativity, sustainability, retail and tourism, care and safety.</td>
</tr>
</tbody>
</table>
2.2.1 The silo mentality

The lack of cooperation and the creation of disconnected smart city projects results in a silo mentality. Silo mentality arises when different parties work on their own projects without sharing information, budgets or data. Cities operate in an inefficient way in silos for traffic management, public safety, city lighting, environment, waste management and parking optimization (Denderen, 2017). The silo mentality also exists in the collaboration between cities (Ballon, 2016). Many start-ups try to set up their own smart city projects, but most of these ultimately focus on the same solution (Krell, 2017). This results in less efficiency through limited knowledge, skills and experience. It is impossible to create a complete and successful smart city solution on your own. It is necessary to build a strong ecosystem of partners and a co-economy that will be economically and socially sustainable in the long-term to learn, co-develop and successfully complete Internet of Things projects (Kranz, 2017). Lessons learned and developed resources should be used for the creation of new smart city projects (Mitchell, Villa, Stewart-Weeks, & Lange, 2013). Thereby, platforms can offer possibilities to keep ecosystems alive, stop inefficiency and the formation of silos and create a non-fragmented experience (Ballon, 2016).

2.2.2 Smart city main concepts

The development of smart city projects becomes more understandable when holding on to three main concepts infrastructure, platform and applications. Building a platform is a step that needs to be considered to allow stakeholders to co-create or share knowledge, resources and expertise (Goulden, 2015). A smart city can be seen as living lab and way of working where the livable layer improves the quality of life in the city through applications and the environment (Gubbi, Buyya, Marusic, & Palaniswami, 2013). Clear insights from data could be used in the living lab to create a value proposition and build better solutions that lead to successful innovation and a smarter place while learning from failures (Goulden, 2015). Flexibility caused by changing needs is guaranteed through the use and scalability of the cloud (Gubbi et al., 2013).

2.2.3 Bottom-up and top-down approaches

The planning processes in smart city environments are applied in two ways, namely the bottom-up approach, with a more creative view, and the top-down approach, with a more centralized, planned view and a vision. The integration of the bottom-up and top-down approaches is crucial
and stimulates innovation and co-operation (Ojasalo & Tähtinen, 2016). However, partnerships outperform top-down approaches looking at implementing urban services in an effective way (Kelly, 2012). By applying a bottom-up approach citizens can be stimulated to create applications and solve existing issues with the use of the right platform (Almirall, et al., 2016).

2.3 Smart city projects

Smart city projects can often be managed as small enterprises (Visnjic, Neely, Cennamo, & Visnjic, 2016). Technology infrastructures that exist in these projects include networks for data transmission, sensors for data collection and platforms for data access. To stimulate the extension of smart city projects across the city, cities can easily use existing networks. The question remains as to who decides which network the city will use as common platform for projects or whether and how disparate networks can be integrated to deliver the underlying platform (Nieuwenhuyzen, 2017). City governments do not see the need to invest in expensive infrastructures, which results in uncoordinated and inefficient networks across the city.

Cities also need to deal with the financial, organizational and social challenges. In order to learn about transitions and solve challenges, projects can be seen as transition-experiments (Kemp & Bosch, 2006). Transitions focus on the mechanisms deepen, broaden and upscaling. Deepen relates to learning from experience; broaden relates to repeating the experiment in a broader context; upscaling focuses on implementing the innovation on a higher level (Hoeven, 2010).

2.3.1 Public-private partnerships

In general there are multiple stakeholders involved in a project, since a single party often lacks the complete skill, knowledge and resources needed (Ballon, 2016). Parties that are usually involved in smart city development include civil societies, governments, industries and universities, so a smart city can be seen as an ecosystem of ecosystems existing from the interdependent needs and strategies (Visnjic et al., 2016). Despite the fact that these parties pursue different interests, studies show that all sectors emphasize an entrepreneurial vision (Lombardi et al., 2012). Diversity, fragmentation and contradictory values among stakeholders often causes problems (Anttiroiko et al., 2014).
Only a few newly developed projects in the private sector succeed, most projects fail. The high number of failing projects does not fit the typical inflexible and unresponsive character of the public sector and the community expects the government to be sustainable and risk averse. The public sector cannot afford to develop failing projects and does not have the right information and knowledge in the field of networks and technology to shape the smart city (Ballon, 2016). This causes a timing problem between technology readiness, market readiness and policy readiness. Thereby, the bureaucratic decision-making processes of the public sector and procurement counteract the collaboration between parties (Ojasalo & Tähtinen, 2016). Often, public-sector bodies create solutions that are already developed by the private sector or improve existing ones focusing on the short-term (Mitchell et al., 2013). To become a successful smart city, the city government must provide large budgets to enable the implementation of a city-wide project or the integration of freestanding projects (Krell, 2017).

Looking at the Triple Helix model of university-industry-government relations, the government normally takes responsibility for providing the city’s infrastructure expertise in standard public services where the industry delivers the technology (Leydesdorff, 2012). The contribution of universities includes research about the project (Zygiaris, 2011). All smart city projects produce data and information that can give smart insights about the citizens’ lives. The question remains whether this data should be publically shared or kept private. Companies in the private-sector want to keep the data to themselves to gain a competitive advantage.

2.3.2 **Smart city governance**

Ecosystems and public-private partnerships should ensure that parties that have never previously worked together will cooperate effectively and sustainable. Ecosystem orchestration selects the right ecosystem structure in order to deal with independent strategies and the complexity of projects. The city government can act as direct provider delivering services, managing the smart city as enterprise and fulfilling the integrator role for all parties. The city government can also act as indirect service provider, taking only responsibility for the platform or infrastructure that connects services and citizen’s needs (Visnjic et al., 2016). City governments constantly need to deal with the trade-off between delivering better public services or serving as an orchestrator in the ecosystem by engaging with all stakeholders (Almirall, et al., 2016; Visnjic et al., 2016). Smart
city concepts ask for an approach that focuses on collaboration instead of competition. This approach is more difficult to manage, so the role of governance will become more important than ever (Anttiroiko et al., 2014).

### 2.4 Innovation platforms

The term platform is used in a broad sense and defined as a social, physical or technological starting point for the processes surrounding the city’s infrastructure. Innovation platforms can serve as an intermediary between public and private parties. These platforms provide interaction within ecosystems and the resources needed for innovation, such as knowledge and governance for economic and sustainable value. Thereby, platforms unite stakeholders around a vision for project development (Ojasalo & Tähtinen, 2016).

Stakeholders get access to a platform with its data, resources, communication and control possibilities to create innovative applications (Nieuwenhuyzen, 2017; Ojasalo & Tähtinen, 2016). These applications interact with the platform through interfaces and all elements share the same infrastructure as shown in figure 2 (Tiwana, 2014). Horizontal ICT platforms that can link applications create efficiency and harmonization and are crucial to a smart city (Ballon, 2016).

The emerging service economy asks for integration between physical products or applications and service devices on one service exchange platform (Anttiroiko et al., 2014). The current smart city environment is often characterized by freestanding, small projects that cover just a small part of the city. The city of Antwerp is a great example to emphasize the added value of a strong integration of Internet of Things solutions. This city has integrated sensors in objects throughout the city and uses the gathered data to ensure a more efficient organization of the city. Another example is Barcelona, in which the local government wants to create an Urban Platform that
connects all technologies in the city and easily shares information and data in a safe way across the current existing silos (Zygiaris, 2011). The future is in developing a ready-made solution that can easily be implemented or adapted to local demands (Nieuwenhuyzen, 2017).

Platforms include a set of common rules, standards, hardware and software that facilitate transactions between the demand and supply sides of the platform. Efficient two-sided platforms take into account the roles of platform providers, platform sponsors, supply-side users and demand-side users. The sponsor can be both public and private, but benefits from opening the platform and allowing a wide range of services and parties on the platform (Ballon, 2016). City governments can operate as the owner of the platform by investing in the platform, but the platform remains independent and transparent. The innovation platform is then subordinated to the city government (Ojasalo & Tähtinen, 2016). Most ICT platforms benefit when they position themselves as bottleneck by controlling the demand- and supply-side users, even though this reduces functionality (Ballon, 2016). A platform provider can become a monopolist by bundling third-party components that are convenient and add value for users (Eisenmann, Parker, & Van Alstyne, 2008). In practice, monopolization occurs when there is centralized power and a diversity of applications and services (Ballon, 2016). A smart city platform needs an independent central authority that monitors the planning process and takes on the leadership role (Zygiaris, 2011).

2.4.1 Open and private platforms

The openness of a platform can vary by role and depends on horizontal strategies and the willingness to collaborate with rival platforms. A joint venture takes place when different parties sponsor the platform by sharing development costs and knowledge, and one party takes on the role of provider. The licensing model implies one single sponsor and several providers. Rival platforms compete with each other by offering technologies that cannot integrate because of its incompatibility (Eisenmann et al., 2008).

The city of Antwerp shares their gathered sensor data on an open platform and makes it available for developers, so they can combine data and create new services (Ballon, 2016). The municipality of Barcelona provides the industry and citizens with access to public data which ensures a new distribution of roles whereby the government increases their control over public services (Cisco,
This openness emphasizes transparency, citizen participation and collaboration (Chun, Shulman, Sandoval, & Hovy, 2010).

Open innovation is emerging and cities will become more efficient, effective and sustainable when cities share their knowledge, skills, resources, best practices and strategies for developing services and new projects (Paskaleva, 2011). Open platforms allow all parties to participate in building and improving the platform or use the data and services provided by the platform under general restrictions. The owner of the platform, whether public or private, benefits from opening the platform to other parties (Ballon, 2016). However, private companies need to find a way to gain revenue from open data and privacy concerns has to be taken into account (Almirall, et al., 2016). When new business models and legal frameworks are developed, private parties might be willing to share their data with the city government.

Relationships that occur in open intermediate innovation platforms are governing relationships based on carrying power, sparring relationships based on sharing knowledge, and collaborative relationships based on developing new solutions to issues (Ojasalo & Tähtinen, 2016). In conclusion, open data platforms can add value to cities, although a general framework or hybrid governance model with central control, closed sponsorship and an open provide role, is necessary to guide the strategic process and achieving the city’s goals (Eisenmann et al., 2008).
3  Pre-conceptual model

Based on the literature review, multiple constructs can be defined and connected to support the aforementioned research question:

Which factors influence the longevity of smart city innovation ecosystems and projects?

3.1 Pre-conceptual model

This study contributes to the literature by providing a solution on how to ensure collaboration between stakeholders to create long-term smart city ecosystems. Constructs from the literature that stimulate longevity are explored by getting insights that are used to see statements of the study in context and make comparisons in the collected data (Flick, 2009). These constructs serve as starting point of the study when little research has been done on the topic (Glaser & Strauss, 1967).

Measurements of longevity are continued project activities, continued benefits for new clients and maintained community capacity (Scheirer, 2005). Besides this, recognized standards for measurement and indicators from first principles can serve as reference point to let stakeholders understand the set goals based on the company’s strategy (Keeble, Topiol, & Berkeley, 2003). The project must include a customizable, exceptional case that fits with the mission of the companies involved and perceives benefits to employees and clients (Scheirer, 2005). An essential part of measuring the productivity of an ecosystem is the effectiveness in converting innovation into new products and services, so the ability and motivation to continue innovating is key to ensure longevity of the ecosystem and creation of new projects (Iansiti & Levien, 2004).

3.2 Theoretical constructs

This section elaborates on the identification of factors obtained by the literature review that could influence the longevity of a smart city ecosystem. Table 2 provides an overview of the factors.

<table>
<thead>
<tr>
<th>Table 2 Constructs retrieved from the literature review</th>
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<tbody>
<tr>
<td>Ability to innovate</td>
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<tr>
<td>Local adaption</td>
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<tr>
<td>Bottom-up/top-down approach</td>
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<tr>
<td>Use of the cloud</td>
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**Ability to innovate:** A main concept in the definition of a smart city is the ability to innovate. A smart city can be distinguished from a normal city through a strategic innovation unit and the ability to switch from innovation to application to extract knowledge (Allwinkle & Cruickshank, 2011; Ballon, 2016).

**Silo mentality:** Smart cities address challenges occurring in the development of services and applications in silos. All these silos are responsible for their own budgets, goals and strategies making efficient cooperation difficult (Denderen, 2017).

**Public-private collaboration:** A constant dual play exists between public and private parties within city environments which can be solved with a successful partnership (Brugman, 2017). The level of partnership can be measured through the agreement with the focal problem, transparency, problem-solving capacity, stakeholder representativeness, intensity of collaboration, stakeholder’s capacity to participate, resource availability and perceived effectiveness (Kelly, 2012).

**Triple Helix collaboration:** The Triple Helix model stimulates innovation, entrepreneurship and co-creation (Lombardi et al., 2012). It is necessary to gain knowledge about the project through university research before the project starts (Nyman, 2015).

**IT-business fusion:** To be able to respond to the current dynamic environment, technology and strategy need to be closely aligned taking architecture into account (Tiwana, 2014). Strong leadership and business and technical understanding are required to achieve alignment. However, fusion between IT and business is more powerful than alignment (Hinssen & Derynck, 2009).

**Local adaption:** The complexity of smart city projects is in the need to adapt organizations to local circumstances, since there are different networks differ per city (Nieuwenhuyzen, 2017).

**Data collection:** To make data more valuable, data capabilities such as integration and analytics are useful (Noronha et al., 2014). By collecting data in one place, parties can use the data for developing new services and applications.

**Platform standardization:** In order to ensure efficient implementation of smart city projects adapted to cities’ needs, a ready-to-use platform could be developed. In this way, cities can choose what to implement and which local partners to involve (Nieuwenhuyzen, 2017).

**Platform integration:** One platform can integrate different types of data from different city systems to generate a general view of the city (Beecham Research, 2015).

**Central authority:** When there is one central sponsor that owns the platform, all services and parties can be easily allowed to the platform making it easier to develop suitable solutions (Ballon, 2016).
**Bottom-up/top-down approach:** The integration of the bottom-up and top-down approaches is essential for innovation and co-creation between citizens and leaders (Ojasalo & Tähtinen, 2016).

**Transition-experiments:** By setting up small transition-experiments, parties learn about solving challenges and developing the optimal solution for a transition that focuses on deepening, broadening and scaling up (Hoeven, 2010; Kemp & Bosch, 2006).

**Living lab:** Cities adopt a model, living lab, to monitor the progress of a smart city and determine the conceptual layout (Zygiaris, 2011). It is an essential concept in smart city environments, because new insights provide better solutions while learning from failures (Goulden, 2015).

**Platform openness:** An open platform stimulates the development of new applications and services by stimulating the use of data provided by the platform (Eisenmann et al., 2008).

**Ease of integration:** Integration in smart cities is necessary to create cooperation between freestanding, small projects spread across the city (Krell, 2017). The projects cover just a small part of the city and their effect could be increased when the projects are linked to other projects.

**Use of the cloud:** Cloud computing is necessary in order to analyze real-time data, make real-time decisions and optimize the operations of sensors in the city (Cisco, 2016). Using the cloud for data analytics, visualization, sharing and storage, makes the city more innovative (Goulden, 2015).

**Institutional, human and technology factors:** To ensure sustainable growth and quality of life, cities should focus more on socio-technical aspects and the interactions between technology, institutional and human factors (Meijer & Bolívar, 2016).

**Entrepreneurial activities:** The Internet of Things will rapidly transform the way businesses operate, so cities need to be innovative, entrepreneurial and creative to keep up with the changes (Anttiroiko et al., 2014; Kranz, 2017).
4 Research methodology

To interpret the relationship between factors and the longevity of smart city projects and ecosystems, the smart city landscape should be mapped, and problems that occur should be identified. This section elaborates on the study design followed by the selection of interviewees, and discusses data collection, data analysis and different types of validity.

4.1 Study design

In recent years a lot of research has been done on the definition of smart cities and models with characteristics and indicators. Challenges lie in the field of practical implementation of smart city projects with an efficient collaboration between stakeholders. Thereby, existing literature does not satisfy the broad research question. By defining a new context and doing research in cooperation with Cisco, this qualitative, naturalistic research explains how constructs can influence smart city environments and generate a new theory, also a grounded theory, based on data gathered from in-depth interviews with public stakeholders as well as private stakeholders working for Cisco or other companies (Newman & Benz, 1998; Strauss & Glaser, 1967).

To determine the most common factors that can influence the smart city environment, the study is divided in two phases. In the first phase, constructs and issues are determined by conducting interviews for exploration in addition to the findings from the literature review resulting in an overview of the main constructs, rationale and direction (Flick, 2009). The interviews also validate the research question of the study and finalize the interview questions (Yin, 2003). In the second phase, interviews are conducted to verify the importance and influential role of each variable and develop a theory about the longevity of ecosystems (Flick, 2009). Interview insights are combined with information from short conversations and studies done by Cisco (Steenhuis & de Bruijn, 2006). The study’s goal is to define a new theory or best practices for improving ecosystem longevity taking relevant indicators into account, such as stakeholders’ interests and strategies (Reed, Fraser, & Dougill, 2006).

4.1.1 Expert interviews

The literature review mostly elaborates on studies and theories instead of real-life examples. New insights are obtained by conducting one hour interviews with experts with a specific function,
experience, knowledge and authority in the field of the Internet of Things, innovation and smart cities (Flick, 2009). Interviewing stakeholders let them think about the topic which gives access to the topic and new information (Rapley, 2001). By explaining the smart city phenomenon within its real-life context, theories are connected to the empirical reality. In order to exactly define the current problems in smart city environments, two rounds of interviews with industry stakeholders are performed. The first round of interviews is exploratory and less structured and defines some theoretical constructs where the second round of interviews has a more structured and confirmatory character and validates or modifies these constructs. Since there is no previous knowledge about the main issues occurring in the longevity of smart city projects, interviews exist of open and semi-structured questions ensuring that there is no information overload (Flick, 2009).

4.1.2 Level of analysis
Smart city strategies have an enormous impact on city areas and the collaboration between different cities. In order to prevent an information overload and a too broadly defined population, the level of analysis is cities in Europe. The analyses of this study is therefore on macro-level of the European continent focusing on the interactions between different groups of people in and between urban areas.

4.1.3 Unit of analysis
This study analyzes the level of integration of smart city projects. Therefore possible units of analysis are the smart city environment and the ecosystems and projects developed in this environment. Smart city projects have formulated a strategy to deal with problems occurring in the city landscape due to high density in urban areas (Chourabi, et al., 2012). Since this information is provided through interviews with stakeholders of smart city environments, a more specified unit of analysis is the interviewee, also the stakeholder or expert. The stakeholder should be directly involved in the processes of the project and be able to make key decisions in this process to ensure reliability. To conclude, this study focuses on the level below the smart city project, namely the stakeholder.
4.2 Interviewees selection

Interviews are conducted among experts who were chosen during the research process based on gained insights which indicates an inductively oriented approach (Strauss & Glaser, 1967). Expert knowledge includes specialist and practical knowledge and can become hegemonic in a certain context. Therefore, the expert has more power on processes than other stakeholders (Flick, 2009). The sample of the interviewees should be homogenous to understand the opinions of people involved in smart city developments. Since close cooperation between parties is an essential aspect in the development of smart city projects, experts from private companies, city governments and research institutions with experience in working with other parties are included. By also selecting on age and role on different levels within the organization, maximum variation sampling is ensured and the richness of the data is maximized (Crabtree & DiCicco-Bloom, 2006). Purposive sampling is used to establish a substantial and concrete selection of experts based on the objective of the study (Flick, 2009). The study focuses on sampling adequacy and saturation for determining the sample size with grounded theory (Charmaz, 2014). When categories are saturated, the sampling ends. Cisco and the Rotterdam School of Management have valuable contacts that were approached for an interview. Table 3 shows the frequency distribution of the interviewees based on sector, organization type, role and gender.

Table 3 Frequency distribution of the interviewees based on sector, organization type, role and gender (Auerbach & Silverstein, 2003)

<table>
<thead>
<tr>
<th>Category</th>
<th>N</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Sector</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Private</td>
<td>7</td>
<td>(44)</td>
</tr>
<tr>
<td>Public</td>
<td>8</td>
<td>(50)</td>
</tr>
<tr>
<td>Private-public</td>
<td>1</td>
<td>(6 )</td>
</tr>
<tr>
<td><strong>Organization type</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Corporation</td>
<td>6</td>
<td>(38)</td>
</tr>
<tr>
<td>Startup</td>
<td>1</td>
<td>(6 )</td>
</tr>
<tr>
<td>Government</td>
<td>6</td>
<td>(38)</td>
</tr>
<tr>
<td>Public Municipal Company</td>
<td>2</td>
<td>(12)</td>
</tr>
<tr>
<td>Partnership</td>
<td>1</td>
<td>(6 )</td>
</tr>
<tr>
<td><strong>Role</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Project manager</td>
<td>6</td>
<td>(38)</td>
</tr>
<tr>
<td>Co-owner</td>
<td>2</td>
<td>(13)</td>
</tr>
<tr>
<td>Business developer</td>
<td>1</td>
<td>(6)</td>
</tr>
<tr>
<td>Director</td>
<td>2</td>
<td>(13)</td>
</tr>
<tr>
<td>Manager</td>
<td>4</td>
<td>(24)</td>
</tr>
<tr>
<td>Solution architect</td>
<td>1</td>
<td>(6)</td>
</tr>
<tr>
<td><strong>Gender</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Male</td>
<td>13</td>
<td>(81)</td>
</tr>
<tr>
<td>Female</td>
<td>3</td>
<td>(19)</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td>16</td>
<td>(100)</td>
</tr>
</tbody>
</table>

4.2.1 First round selection

The first round of expert interviews serves as an exploratory phase to gain more general insights about the empirical reality and the practical issues in the execution of smart city projects. Interviewing experts that work for the company for a longer period of time improves reliability. Table 4 specifies the four selected experts, some of them anonymized for privacy reasons.
### Table 4 Overview of the experts interviewed in the first round

<table>
<thead>
<tr>
<th>Expert</th>
<th>Role</th>
<th>Expertise</th>
</tr>
</thead>
<tbody>
<tr>
<td>E1</td>
<td>Architect Solutions</td>
<td>Smart &amp; connected communities, local government, Internet of Things/Internet of Everything, smart city architecture, public safety, Internet of Things architecture</td>
</tr>
<tr>
<td>E2</td>
<td>Account Manager Sales</td>
<td>Public sector, public safety, smart &amp; connected communities</td>
</tr>
<tr>
<td>E3</td>
<td>Manager Systems Engineering Sales</td>
<td>Internet of Everything, Internet of Things, public sector</td>
</tr>
<tr>
<td>E4</td>
<td>Systems Engineer Sales</td>
<td>Internet of Things, Internet of Everything, connected car, mobility, transportation, talking traffic</td>
</tr>
</tbody>
</table>

### 4.2.2 Second round selection

In-depth interviews verify or adjust the estimated impact of the predefined factors. Taking the Triple Helix into account, experts working for research institutions, the industry and government are included in the selection. Table 5 provides an overview of the sample of 16 experts.

### Table 5 Overview of the experts interviewed in the second round

<table>
<thead>
<tr>
<th>Expert</th>
<th>Sector</th>
<th>Role</th>
<th>Organization</th>
</tr>
</thead>
<tbody>
<tr>
<td>A1</td>
<td>Private</td>
<td>Solution Architect Smart City Team</td>
<td>Cisco Systems International B.V.</td>
</tr>
<tr>
<td>A2</td>
<td>Private</td>
<td>DVN Program Director</td>
<td>Cisco Systems International B.V.</td>
</tr>
<tr>
<td>A3</td>
<td>Private</td>
<td>Sales Business Development Manager</td>
<td>Cisco Systems International B.V.</td>
</tr>
<tr>
<td>A4</td>
<td>Private</td>
<td>Strategic Account Manager</td>
<td>Cisco Systems International B.V.</td>
</tr>
<tr>
<td>A5</td>
<td>Private</td>
<td>Process Manager</td>
<td>Heijmans N.V.</td>
</tr>
<tr>
<td>A6</td>
<td>Private</td>
<td>Business Developer</td>
<td>Eneco Holding N.V.</td>
</tr>
<tr>
<td>A7</td>
<td>Private</td>
<td>Co-owner</td>
<td>Mobility Heroes</td>
</tr>
<tr>
<td>B1</td>
<td>Public</td>
<td>Programme Director Sharing Cities</td>
<td>Greater London Authority</td>
</tr>
<tr>
<td>B2</td>
<td>Public</td>
<td>Project Manager RUGGEDISED</td>
<td>City of Umea</td>
</tr>
<tr>
<td>B3</td>
<td>Public</td>
<td>City Manager / H2020 RUGGEDISED</td>
<td>Glasgow City Council</td>
</tr>
<tr>
<td>B4</td>
<td>Public</td>
<td>Program manager Smart City and Digital Economy</td>
<td>City of Rotterdam</td>
</tr>
<tr>
<td>B5</td>
<td>Public</td>
<td>Coordinator RUGGEDISED</td>
<td>City of Rotterdam</td>
</tr>
<tr>
<td>B6</td>
<td>Public</td>
<td>Head of Department of Planning and the Environment / coordinator GrowSmarter</td>
<td>City of Stockholm</td>
</tr>
<tr>
<td>B7</td>
<td>Public</td>
<td>Replicate Project Coordinator</td>
<td>Fomento de San Sebastián S.A</td>
</tr>
<tr>
<td>C1</td>
<td>Public</td>
<td>Business Director</td>
<td>TNO (independent)</td>
</tr>
<tr>
<td>C2</td>
<td>Public-private</td>
<td>Director</td>
<td>STRIJP-S</td>
</tr>
</tbody>
</table>
4.3 Data collection

Data for this single-case study is collected through 20 expert interviews. Ten interviews are conducted face-to-face and six interviews are conducted using Cisco WebEx video conferencing. All interviews have a duration between the 35 and 75 minutes. The interviews collect data for theoretical interest, so collecting technical information is irrelevant (Flick, 2009). Possible ethical issues occur when interviewees do not respond to the invitation, are not willing to participate in the interview, do not have the appropriate information or do not respond to certain questions.

After selecting the interview sample, invitations need to be sent and the interview guidelines need to be prepared before conducting the interviews. Interview guidelines were based on the theoretical constructs, information from company websites and insights from the first round of expert interviews and were adapted during the interview process. Asking standardized, semi-structured questions ensures personalization and flexibility, but also obtains reliable and valid data, so data can easily be compared (Barriball & While, 1994). The final version of the interview guidelines can be found in appendix A.

A necessary step after recording the interviews is the transcription of the interviews to interpret the data. The transformation of spoken language into written data should be easy to write, read and search taking the rules for the layout of the transcription into account (Flick, 2009). Interviews with native Dutch speaking experts are conducted in Dutch and interviews with non-Dutch speaking stakeholders are conducted in English. Stakeholders for whom English is a second language can experience a language barrier.

4.3.1 First round interviews

Interview questions for the expert interviews are open-ended in order to give experts the chance to come up with main concepts in smart city projects and very diverse answers. The general question about the smart city projects the interviewee is currently working on, is asked to map experience in practice. Some of the interviews are informal without a lot of predetermined questions to have the possibility to adapt to the interviewee’s answers. In combination with the literature review, the outcome of the expert interviews leads to common insights validating the theoretical constructs.
4.3.2 Second round interviews

Based upon constructs defined through literature review and the first round of interviews, subsequent interview questions are defined to more deeply understand the concepts that occur in the smart city environment. The questions are reviewed by the experts of the first round to assess content validity and completeness of the interview. Since little is known about the research topic, the interview questions are likely to be adjusted (Barriball & While, 1994). During the second round of interviews, semi-structured questions are asked to confirm or reject concepts in combination with open questions in the beginning to ensure that the interviewee guides the interviewer through the interview (Steenhuis & de Bruijn, 2006). Conducting interviews to the point and limiting the gain of new information improves theoretical saturation. The first questions focus on the implementation of smart city projects in general where the second part of the interview contains questions about the specific organization or project, issues in the field of smart city and the cooperation between parties. Interview guidelines ensure that the expert information is similar, so insights from the second round of interviews can be compared with insights from the first round of interviews for further development of the constructs (Steenhuis & de Bruijn, 2006).

4.4 Data analysis

In analyzing qualitative data, going from data collection to theoretical levels of analysis and turning the data into new theories, multiple coding methods need to be applied with the online tool Dedoose. Screenshots from Dedoose can be found in the appendices B to G. A good set of qualitative codes follows from an iterative process that tests and assesses used codes (Carey, Morgan, & Oxtoby, 1996). These coding methods are part of the inductive qualitative research method called grounded theory. The grounded theory method develops new theories for a relatively new problem. Different versions of grounded theory methodology exist, for instance the Straussian or Charmazian version. By comparing these different versions, the common grounds of methodological approach can be determined and the differences in detail serve as alternatives to identify what will be the next step in data collection and data analysis (Corbin & Strauss, 2007; Flick, 2009). Part of the grounded theory is the constant comparative method that defines similarities or differences by comparing every part of the data with other parts of the data (Charmaz, 2014). The goal of interpretation of the data is to reveal statements and put these statements into context or to summarize and categorize the original data. The use of memoing.
during the research process can support the development and discovery of a new theory and improves transparency of the analysis by presenting the data in narrative form (Flick, 2009). The use of hyperlinks or cross-references is also a useful approach (Bauer & Gaskell, 2000).

4.4.1 Coding
Coding aims to create core categories of codes or story lines using three types of coding. To avoid ambiguity, open coding can be applied multiple times to keep developing categories. The coding process is finished when no new insights are gained, so theoretical saturation is achieved (Flick, 2009). In vivo codes estimate whether all significant data is included (Charmaz, 2014). Terms and expressions that occur in the interviews are close to the analyzed data and the basis of in vivo codes (Glaser & Strauss, 1967). First- and second-order codes are used for the creation of themes that are necessary for classification (Flick, 2009).

4.4.2 Open coding
To analyze the expert interviews open coding, also initial coding, can be applied by asking basic questions (Charmaz, 2014). Open coding allows to become more familiar with emergent constraints and learn from experience through comparisons. The open coding process defines descriptions based on the occurrence of quotations or empirical indicators that are interchangeable (Punch & Oancea, 2014). Thereafter, abstract first-order constructs are defined.

4.4.3 Axial coding
Axial coding, also focused coding, is a more structured way of coding what is applied after open coding to define new characteristics of categories (Charmaz, 2014). This coding method identifies relationships between first-order concepts creating one overall second-order concept. Axial coding maps the causes that lead to a specific phenomenon and the actions to manage the phenomenon. These actions lead to specific consequences or solutions taking constraints into account (Corbin & Strauss, 2007). Data analysis and pattern comparison can verify assumptions about relationships and transform assumptions.

Figure 3 Coding paradigm model (Strauss & Corbin, 1990)
into hypotheses by applying a coding paradigm model. As shown in figure 3, this model is based on an axis that indicates the flow from causes to phenomenon to consequences and an axis that links context and strategies to the phenomenon.

4.4.4 Selective coding
The conceptual level of the data raises when the abstract concept is assigned to a more general core category through selective coding (Punch & Oancea, 2014). The selective coding method integrates all second-order concepts to create one grounded theory or category and find more evidence for these core categories (Flick, 2009). Categories always need to be compared to the primary data or literature (Corbin & Strauss, 2007). At first, the study needs to identify the storyline, in this case the continuation of smart city innovation ecosystems and projects, and the characteristics of the categories. Common relationships between these characteristics, also patterns, need to be identified to make the grounded theory more specific. Theories need to be dense and specific, but theoretical variation is essential (Corbin & Strauss, 2007).

4.5 Validity and reliability
Taking the following methods into account is essential in applying the grounded theory approach (Madill, Jordan, & Shirley, 2000). Validity and generalizability have different meanings in qualitative research than in quantitative research where reliability has almost no relevance (Stenbacka, 2001).

Validity, the degree to which the results are measured in the right way, is key to ensure objectivity (Kirk & Miller, 1986). Therefore the use of triangulation in research is essential to get a more in-depth understanding of the problem (Golafshani, 2003). Besides interviewing stakeholders working in different organizations and departments, data is also collected from brochures. By interviewing independent experts that are part of ecosystems, using experience-based questions to give the expert the chance to speak freely and reviewing literature, high content validity is guaranteed (Pulakos & Schmitt, 1995; Stenbacka, 2001).

There are three types of validity, namely construct, internal and external validity. Most validity tests are developed in the data collection phase of the study (Yin, 2003). Using recordings provides
an accurate replication of the interview and detailed insights in interactions. This method improves completeness, accuracy and validity of the research (Barriball & While, 1994). Internal validity establishes a causal relationship and is not a concern for exploratory research (Yin, 2003). External validity refers to the generalizability of the study and is relevant in the complete research design phase (Yin, 2003). The strategic choice of stakeholders from organizations in both the public and private sector, the results of this study are analytical generalizable across many organizations and industries (Stenbacka, 2001). Although only European companies and stakeholders are analyzed, the results of this study can be generalized over different countries, because the Internet of Things is an emerging technology that connects objects through a worldwide network, whereby all countries are in the same stage of development and need to cooperate with one vision and platform (Gubbi et al., 2013). By combining information from different theories and data sources, reality can be confirmed and construct validity, the correctness of measurements for the concept, increases (Yeasmin & Ferdousour Rahman, 2012). The drafts of the transcripts are reviewed by the interviewees to verify the facts, improve the quality and increase construct validity (Yin, 2003).

Reliability tests the quality of the qualitative study to generate understanding and consistency in results. Making the preparation, data gathering and analyses insightful improves reliability of the study (Stenbacka, 2001). Synchronic reliability, the similarity of observations, is ensured by interviewing stakeholders who are all involved in smart city developments (Kirk & Miller, 1986). The context of the interview is vital in analyzing and understanding the interview data. The reliability of the data analysis can more easily be assessed when the context is presented by showing the questions that prompted the interviewees’ answers (Rapley, 2001).
5 Results

By determining the frequency of terms in the interviews, statements can be tested (Flick, 2009). The coding process links all codes to one or more retrievals. In order to investigate the longevity of smart city ecosystems and projects, retrievals about a certain topic from interviewees with common characteristic are compared. This comparison leads to the creation of descriptive typologies, code categories and theories. Each interviewee is represented by a shorthand: NIE (Harm van Nieuwenhuyzen), DEK (Hein Dekkers), DEN (Stefan van Denderen), VIE (Frank Vieveen), PAS (Zdravka Paskaleva Newman), BEE (Alwin Beernink), BLO (Hendrik Blokhuis), VET (Berry Vetjens), DIJ (Peter Dijkstra), ENG (Albert Engels), PIE (Nathan Pierce), LAN (Gustaf Landahl), ASC (Carina Aschan), SIE (Niki Sie), FEU (Jasper Feuth), MKO (Maarten Kokshoorn) and MEN (Nora Mendoza).

5.1 Co-occurrence codes

In order to define new hypothesis, the co-occurrence of codes is included in the analysis. Codes that co-occur are detected by overlapping text segments (Bauer & Gaskell, 2000). By thorough and interpretive analysis of these overlapping text segments, the co-occurrence can be clarified or modified (Bauer & Gaskell, 2000).

There exist many co-occurrences between factors that are related to innovation, like innovation continuation and innovation motivation, innovation stimulation and ability to innovate and innovation stimulation and innovation motivation. The ability to innovate is one of the most important aspects in ensuring longevity of the ecosystem as already emphasized in the literature section. “A smart city is not a final destination, but a continuous journey”¹ (DEN) and has to do with staying open to innovation. Interpretation of the text segments shows that ecosystems also influence new innovations. “New forms of cooperation, such as ecosystems, must be create to chase innovations”² (VIE).

The term that describes the governance role often co-occurs with terms related to smart city management and the role of public parties. Governance can be seen as an institutional factor that has a role in creating a smart community as can be derived from the literature review. “The role

---

¹ Original quote: In gesprekken zeg ik altijd dat een smart city geen eindbestemming is, het is een continue reis.
² Original quote: Je moet naar andere samenwerkingsvormen (ecosystemen) waarmee je tot die innovaties gaat komen.
of the municipality is being the one that brings everybody together”\(^3\) (ASC) and controlling what is happening. On the other hand, the government cannot do it by themselves and need to outsource processes to the private parties without losing control. “The challenge is to determine the level of ownership”\(^4\) (VET). This emphasizes the importance of central smart city governance to carry out projects. Thereby, the **role of public parties** needs to be tuned to the **role of private parties**. “We see more often that public and private parties need each other”\(^5\) (ENG).

The **use of data** is linked to **data availability** and **open data**, factors that are related to the construct data collection. “It is good that data could be accessible for several applications, so start-ups can develop services”\(^6\) (DIJ). Also, data needs to be visualized and understandable for citizens, so they can create business to be involved in smart city developments. “Open data is a basic need if you want to innovate with ICT”\(^7\) (VET). **Open data** is also related to **platform openness**, a construct that was already included in the pre-conceptual model. Codes related to open data, such as data use, open platform and intrinsic data value are most mentioned by public sector stakeholders. Most stakeholders emphasize that it is the role of the governance to make data available through a platform. Open data issues are often mentioned by private sector stakeholders, since data includes commercial sensitives and intellectual property and has an intrinsic value making it complex to publish. “One of the issues cities face with completely open data is that large companies may use that data to make a profit since it has a commercial value”\(^8\) (PIE) making it harder for small and medium sized companies that cannot afford to pay to compete. Therefore, cities also need to be more commercially adept at defining a good balance between making data available for free and asking money.

**Pilot implementation** helps to proof a concept, so early adopters start to use the product. The urge of pilot implementation is often mentioned in the interviews and differs from the transition-experiments mentioned in the pre-conceptual model as pilots focus less on the follow-up phase.

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3 Original quote: The role of the municipality is being the one that brings everybody together.
4 Original quote: Tot op welk niveau moet je vastleggen, tot welk niveau is het nog aantrekkelijk en op welke manier kan dat dan. Daar zit vooral de uitdaging en in een pilot loop je daar niet tegenaan.
5 Original quote: We zien steeds vaker in dat publieke en private partijen elkaar nodig hebben.
6 Original quote: Dat data beschikbaar kan zijn voor verschillende toepassingen, zodat start-ups er diensten mee kunnen ontwikkelen, dat is een prima geheel.
7 Original quote: Open data is een van de belangrijkste dingen als je met ICT wilt innoveren.
8 Original quote: One of the issues cities face with completely open data is that larger companies may use that data to make a profit since it has a commercial value.
Most pilots end when the concept is proven and do not become scalable projects. Nowadays, “you need to design a pilot as it will be implemented on a larger scale”\textsuperscript{9} (SIE).

### 5.2 Influencing factors

Often mentioned factors in the second round of interviews are elaborated in this section. Table 6 shows an overview of the normalized code count based on interviewee ratio per factor per sector. The text segments to which the factors are attached are compared (Bauer & Gaskell, 2000).

<table>
<thead>
<tr>
<th>Factor</th>
<th>Private sector</th>
<th>Private-public sector</th>
<th>Public sector</th>
</tr>
</thead>
<tbody>
<tr>
<td>Governance model role</td>
<td>8.0</td>
<td>22.0</td>
<td>17.0</td>
</tr>
<tr>
<td>Public-private collaboration</td>
<td>42.0</td>
<td>12.0</td>
<td>23.0</td>
</tr>
<tr>
<td>Silo management</td>
<td>34.0</td>
<td>2.0</td>
<td>5.0</td>
</tr>
<tr>
<td>Ecosystem creation</td>
<td>44.0</td>
<td>10.0</td>
<td>16.0</td>
</tr>
<tr>
<td>Knowledge sharing</td>
<td>28.0</td>
<td>0.0</td>
<td>19.0</td>
</tr>
<tr>
<td>Project scalability</td>
<td>44.0</td>
<td>2.0</td>
<td>13.0</td>
</tr>
<tr>
<td>Pilot implementation</td>
<td>44.0</td>
<td>0.0</td>
<td>12.0</td>
</tr>
<tr>
<td>Role of business model</td>
<td>20.0</td>
<td>8.0</td>
<td>23.0</td>
</tr>
</tbody>
</table>

#### 5.2.1 Smart city governance

The role and definition of the governance model is an often mentioned factor especially by interviewees from the public or private-public sector. “Cities need to define the role of the local government, the central government and the consortium”\textsuperscript{10} (BEE) to ensure standardization on the governance side. Therefore, the traditional, classical processes should be redefined, also internally. Smart city governance has to do with smart city management. “A project can be completely private or completely public. An organization needs to be set up that will carry out the project”\textsuperscript{11} (VET) and ensure central authority, an important factor as can be seen in the pre-conceptual model. The city needs to appoint a person with authority and mandate that decides which projects or solutions can be implemented. “It is not so much about technology, but about the business side, so how do

\textsuperscript{9} Original quote: Daarom moet je een pilot insteken alsof het al op grotere schaal wordt ingezet.
\textsuperscript{10} Original quote: Dan kom je op de rol van de lokale overheid. Wat is dan de rol van de centrale overheid? Wie moeten er in een consortium?
\textsuperscript{11} Original quote: Zet daar een organisatie op die belast is met de uitvoering van dat programma.
you connect everything and how does the operator model looks like”12 (BEE). The governance role should be filled with an operator role, but the government cannot completely take the role of urban operator and private companies can take advantage of their power when they take this role. All before mentioned strategies can contribute to a more stable control of the city over the long-term. Figure 4 summarizes the descriptions, concepts and category related to smart city governance derived from the interviews.

| Empower cities to know what they want by offering them tools. | Smart city management |
| Shape the role of the urban operator in developing the ecosystem. | Operator role |
| Fill the governance role with an operator role. | Authority role |
| Partner and scale with urban operators. | Internal governance |
| Appoint a program manager with mandate who is supported by the Supervisory Board and strengthens the primary processes of the services, organizes cross-links and puts topics on the planning in all cities. | Socio-technical factors |
| Solve the tension between the external and internal way of working. | Citizen involvement |
| Smart cities not only have to do with IT, but also with organization and social aspects. | |
| Do not bridge the gap between technology and politics at once. | |
| A smart city is 25% technology and 75% attitude and behavior. | |
| Citizens are part of the innovation and the most important measure of the city's success. | |
| Use smart technologies for citizen engagement. | |
| Involve people through gamification to make them part of the solution. | |

Figure 4 Smart city governance descriptions, concepts and dimension

5.2.2 Public-private collaboration

The literature review and interviews stress out the importance of a strong public-private collaboration most mentioned by stakeholders working in the private sector. “We see more often that public and private parties need each other”13 (ENG) and the willingness to cooperate is a new dimension in the development of public-private partnerships. Both parties are now in a transition phase whereby it is the challenge to align the traditionally different interests of both parties to develop a common interest, project goal and vision. All parties need to keep comfort and trust each other in the cooperation although “the pace differs between public and private parties”14 (DJI). A possible solution for collaboration complexity should focus on the reorganization of governance and internal processes in order to ensure local adaption of standardized solutions. The government

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12 Original quote: Het gaat niet zo zeer om de technologie, maar om de business kant, dus hoe plug je alles op elkaar, hoe ziet het operator model eruit.
13 Original quote: We zien steeds vaker in dat publieke en private partijen elkaar nodig hebben.
14 Original quote: Het tempo ligt ook vaak uit elkaar.
needs to create a fast track or digital program that is understandable for all parties and includes strong content to support public-private partnerships. By appointing a smart city leader, “the municipality creates direction and space for entrepreneurship which creates the opportunity for public-private collaboration from companies”\(^{15}\) (VET). The roles of both parties need to be clearly defined. For public parties, “a mix of outsourcing and doing it yourself is preferred”\(^{16}\) (ENG). “Public parties are willing to cooperate, but they are afraid for vendor lock-in”\(^{17}\) (DIJ). Nevertheless, the government must be able to build a strong relationship with suppliers, so they keep abreast of the latest innovations and can express their innovation needs to companies. “The municipality must develop the vision, but it needs to be shaped with several different parties”\(^{18}\) (DIJ). Cities need to determine if they take the leadership, control and responsibility role in which they bring all parties together without excluding parties. “Municipalities have the task to keep the city livable, attractive and sustainable, but they also have the task to stimulate growth and entrepreneurship”\(^{19}\) (VET). The continuous weighting between controlling and stimulating is hard for cities. The government needs to provide subsidies or start-funding to keep costs for businesses and start-ups down and chase projects, flexibility and innovation (DIJ). “When this is successful, then the market needs to take over”\(^{20}\) (FEU). This emphasizes the important role of private parties in a public-private partnership. “Private partners can approach the city to determine which projects can deliver added value from the private company and which eco partners are missing to start the project”\(^{21}\) (DIJ). Companies can influence projects by sharing successful examples and engaging with people, but should not take the consultancy role. The role of private companies consists of being responsible for the technology in a project, gaining international visibility and making sure cities do not stay behind on developments. “Nowadays the government provides private parties with a predetermined budget and market parties can distinguish themselves with

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\(^{15}\) Original quote: Dat is regie en ruimte voor ondernemerschap vanuit de gemeente en dat is ondernemerschap en ruimte voor publiek-private samenwerking vanuit bedrijven.

\(^{16}\) Original quote: Een mix van uitbesteden en deels zelf blijven doen heeft de voorkeur.

\(^{17}\) Original quote: Momenteel willen publieke partijen wel, maar zijn bang voor en vendor lock-in.

\(^{18}\) Original quote: De gemeente moet de visie oppakken, maar daaronder moet je het met meerdere verschillende partijen vormgeven.

\(^{19}\) Original quote: Gemeentes hebben een taak om de stad leefbaar, aantrekkelijk en duurzaam te houden. Ze hebben de taak daarvoor te waken, maar ze hebben ook de taak om groei en ondernemerschap te stimuleren.

\(^{20}\) Original quote: De overheid investeert door middel van subsidies in een start-up en is dat succesvol, dan moet de markt het overnemen.

\(^{21}\) Original quote: Op een gegeven moment ga je actief kijken welke projecten toegevoegde waarde kunnen leveren vanuit jouw bedrijf en welke eco partners dan ontbreken om de totaliteit van de grond te krijgen.
the quality”²² (ENG) instead of price. Cities often judge private parties, since private parties can be too small cyclic and focus on profit to delight shareholders. “Companies are very impatient and want to invest, but do focus on ROI”²³ (BEE). They want to create a solution that can be resold and further developed. There are different levels possible in a public-private cooperation. “There need to be one party, probably the government, which is responsible for data governance and one party which is responsible for business rules and policies”²⁴ (DEK). The descriptions, concepts and overall dimension derived from the interview responses are shown in figure 5.

Solve issues with regulations and handle the areas of complexity.
Change the organization.
Define the level of ownership and outsourcing.
Know how to improve their primary process using technology.
Develop the vision, take decisions and bring parties together.
Control and stimulate growth and entrepreneurship.
Come up with a plan of action, listen to the cities’ needs and deliver the technology.
Share successful examples and gain international visibility.
Create a product or service that can be resold.
All parties must have a shared goal and need to invest.
Solutions designed for own interest, will eventually contribute to improving the city.
Ensure measurable goals, sub-goals, concrete results and no overlapping business.
Companies can bring the investment forward when they can make profit and ROI.
Invest to show what is possible, when there is a demand and the city is not able to invest.
Match investors with start-ups or invest in start-ups.
The government often expects the market party to do the investment.
Chase projects with subsidy or start-funding, especially for start-ups.
Cities need to map investments in new solutions.

Figure 5 Public-private collaboration descriptions, concepts and dimension

5.2.3 Silo management

Silo related concepts are often mentioned by stakeholders working in the private sector and emphasize on the different governmental services that often operate separately. To successfully manage these so-called silos, services should only be aware of how to use technology to improve their primary process. The development of a project starts with looking together with the service department for a flexible solution for one compelling event in their department (MKO). To stimulate change and cooperation between silos, demonstrations can be used with “monitoring systems, KPIs and some indicators” (MEN) defined from the beginning that give an idea about the

²² Original quote: Tegenwoordig geeft de overheid vaker een vooropgesteld budget mee aan de private partij en kunnen marktpartijen zich onderscheiden op kwaliteit
²³ Original quote: Bij bedrijven zit vaak het ongeduld, die willen best investeren, maar richten wel op ROI.
²⁴ Original quote: There need to be one party, probably the government, which is responsible for data governance and one party which is responsible for business rules and policies.
performance. All departments need to have the same strategic approach and “the goals of the business units need to be reversed, so that innovative projects become a priority. However, this often contradicts the short-term obligations of a business unit”\textsuperscript{25} (FEU). The main step for innovation and successful silo cooperation is “to get all stakeholders together”\textsuperscript{26} (DEN) and create “a smart city board with all managers of all city services to stimulate cooperation”\textsuperscript{27} (NIE). “The people that work on business unit transcending projects need to be close to the business unit, so you should not create a separate department to coordinate all business units”\textsuperscript{28} (FEU). The commission of a program manager supported by senior management who connects business units, mobilizes funding and creates a shared goal to establish inter-departmental coordination and tell people a few steps down to focus on innovation is another solution (Donostia Sustapena Fomento San Sebastián, 2015). Figure 6 summarizes interview responses related to silo management clustered in a concept and dimension.

<table>
<thead>
<tr>
<th>Divide issues and data over silos.</th>
<th>IoT connects different departments.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lease from other silos, taking part of the responsibility or create an agreement.</td>
<td></td>
</tr>
<tr>
<td>Strengthen the primary processes instead of mapping them all.</td>
<td>Use a uniform platform to improve the primary processes.</td>
</tr>
<tr>
<td>Mix people from different departments in working groups.</td>
<td>Create a cross-domain view.</td>
</tr>
<tr>
<td>Develop smart things in the cross-overs of the services.</td>
<td>Create a central IT department and department that overlooks the operations.</td>
</tr>
<tr>
<td>One person at higher level can control the process to get all silos together.</td>
<td>Create a smart city board with all service managers.</td>
</tr>
<tr>
<td>All departments have their own budget.</td>
<td>Silos have their own targets and need to realize their goals at lowest possible costs.</td>
</tr>
<tr>
<td>An organization for all services, including budget.</td>
<td>Reverse the short-term goals of the business units, so innovative, long-term projects become more priority.</td>
</tr>
</tbody>
</table>

Figure 6 Silo management descriptions, concepts and dimension

\textsuperscript{25} Original quote: De doelstellingen van de business units moeten worden omgebogen, zodat innovatieve projecten meer een prioriteit worden. Maar dit staat vaak haaks op de korte termijn verplichtingen van een BU.

\textsuperscript{26} Original quote: Bij andere projecten is er altijd wel iemand die leider is van smart cities en die zorgt dat de juiste mensen van zijn organisatie erbij zitten om over smart cities te praten.

\textsuperscript{27} Original quote: One city has created a smart city board with all managers of all city services to stimulate cooperation.

\textsuperscript{28} Original quote: De personen die BU overstijgende projecten doen moeten volgens mij dichtbij de business unit laten zitten, dus je moet geen aparte afdeling maken om alle business units te coördineren.
5.2.4 **Ecosystem creation**

There is not yet a fixed success formula for the **creation of an ecosystem** which slows down innovation. To become part of the ecosystem, you need to be present from the beginning of the project. Especially interviewees working in the private sector mention factors that focus on ecosystems and agree with the fact that “*cities need to create plans involving different parties, like universities and start-ups, so an ecosystem and living lab are created to demonstrate things*”\(^{29}\) (DIJ) while defining roles and keeping the Triple-Helix model in mind, as described in the literature review. Cities need to facilitate the creation of an ecosystem around a vision that operates as a whole keeping it lean and mean (BEE). On the other hand, some interviewees argue that private parties can also create an ecosystem by making the city enthusiastic, showing the projects they have completed, involving the right parties and trying to make connections between ecosystems. “*Some private companies are partner-driven companies and take a complete partner ecosystem*”\(^{30}\) (DIJ). Start-ups can also be the founders of a particular ecosystem. “*Start-ups are often involved in new services on a platform or when they get space to develop new services*”\(^{31}\) (VET) which stimulates entrepreneurial activity, an essential construct for innovation mentioned in the literature review. It is hard to maintain an ecosystem, so the ecosystem will be created per project starting with a coalition of the willing and constantly reflects on the ‘why’, questioning the status quo (Goulden, 2015). Ecosystem creators approach parties that are leaders in a certain area, have a good relationship with the municipality and a strong network and are positive about the project. Being a front leader and being recognized in the smart city domain helps to be approached to be part of an ecosystem. “*Partners have largely been driven by the local partners*”\(^{32}\) (PIE), but larger companies present in the city of the project can also be selected. In order to maintain the ecosystem and develop a successful project, it is key to have “*a very good kick-start to get everybody understand that they are part of the project*”\(^{33}\) (LAN). Partners need to accept the culture, focus on what is best for the project, capture rules and appointments and tailor targets from

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\(^{29}\) Original quote: Agenda’s waarbij verschillende partijen, zoals universiteiten en start-ups betrokken worden, dat er een levendig ecosysteem ontstaat en ook een living lab om dingen te proberen.

\(^{30}\) Original quote: Sommige bedrijven zijn een partner gedreven organisatie en nemen ook al een heel partner ecosysteem mee.

\(^{31}\) Original quote: Start-ups worden vaak betrokken als het gaat om nieuwe diensten op een platform of wanneer ze de ruimte krijgen om nieuwe diensten te ontwikkelen.

\(^{32}\) Original quote: Partners have largely been driven by the local partners.

\(^{33}\) Original quote: We had a couple of day of working together to understand the project and try to make sure that everyone was on board, so I think we have had a very good kick-start to get everybody understand that they are part of the project.
the start of the project focusing more on personal relationships and trust than before. Successfully creating a strong ecosystem stimulates the ability to innovate. As can be seen in figure 7, different descriptions and concepts result in the dimension ‘ecosystem creation’.

| Get an ecosystem with different parties around a vision at the right time. | Ecosystem characteristics |
| All parties need to keep comfort and accept the culture. | |
| The plan must have understandable and strong content, so all parties accept the plan. | |

| Create cooperations that almost feel like private relationships. | Personal relation |
| Partners can become good friends and individuals keep in touch. | |
| Smart city is all about human relations. | |

| The involvement of partners stops when the project ends, but a new project will take over. | New project |
| Make appointments and tailor targets from the start of the project. | |
| Start with a coalition of the willing. | |

| Include local private sector companies, city municipalities, local academic institutions and local start-ups with every party having own responsibility. | Triple-helix collaboration |
| Cities are in between research and industrial partners. | |

Figure 7 Ecosystem creation descriptions, concepts and dimension

### 5.2.5 Knowledge sharing

In order to keep innovating and keep partnerships alive, it is necessary to share knowledge internally and between parties as mentioned mostly by private sector stakeholders. Interviewees do not agree on the extent to which knowledge is shared, especially for difficult information. Knowledge could be shared through conversations, living labs involving start-ups as well as corporates, meetings and task groups spreading lessons learned at coordinating level (SIE). However, there are too many meetings that do not contribute to solving current issues. The main problems in the knowledge sharing process have to do with time and resource shortage and the legal rules that exist on how to handle information. “People responsible for smart cities are mostly hired externally, so few knowledge remains in the organization. Those externally hired are willing to share and know what is going on, but they are much less part of the municipal organization which makes it hard to share knowledge”\(^{34}\) (VET). Thereby, stakeholders that were involved in successful projects, continue their daily activities after the project and do not have the priority to share knowledge. Cities can ensure knowledge sharing by appointing someone who is responsible for knowledge sharing or creating a living lab, a construct already elaborated on in the literature review, and including other cities that can learn from the city’s experiences. Impactful cities can

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\(^{34}\) Original quote: Over het algemeen zijn dat mensen die extern ingehuurd worden en de wil om te delen is er zeker, maar er bekluift veel te weinig in de organisatie.
set up a program together to create a solution that is valuable for all parties, but developed in one city. “The problem is that this kind of projects have to be made locally relevant as well” (VET). Cities exchange information with one another and must cooperate with the industry to gain more knowledge about the latest developments. The problem is that “companies do not want to share that knowledge without having an interest or a chance of new sales” (FEU) and intellectual property plays a role in that as well. The focus for these parties should be on creating a complete experience instead of offering a product. “Market parties are active in multiple cities and may have an interest, from sales or operational perspectives, in facilitating a community and letting users learn from each other” (VET). “Brussels sees knowledge as an investment that you can earn back” (ENG) and that needs to be shared to become successful. This approach can cause a change in the stakeholders’ opinion about sharing knowledge. Figure 8 provides an overview of the descriptions and concepts that are clustered in one dimension ‘knowledge sharing’.

<table>
<thead>
<tr>
<th>Private parties need to focus on the complete experience instead of offering a product. The government needs to cooperate with the industry to gain more knowledge and to stay updated about latest developments.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Light house cities should recruit a group of follower cities to get solutions to the market. Cities need to create plans and a living lab involving different parties to demonstrate things.</td>
</tr>
<tr>
<td>Pay the involved persons or appoint someone to ensure that knowledge is shared. Sharing is mostly done at coordination level.</td>
</tr>
<tr>
<td>Sharing knowledge is an investment that you can earn back. People can learn more when they are more open. If one person joins the network, the network value will double.</td>
</tr>
<tr>
<td>Share internal knowledge to become successful in the field, especially for difficult parts. Silos can benefit from knowledge sharing.</td>
</tr>
<tr>
<td>Share through conversation, meetings and the creation of task groups. Organize meetings where city leads from different cities learn from each other.</td>
</tr>
</tbody>
</table>

5.2.6 Project development

Private and public organizations have become more reluctant, since many projects did not grow into scalable projects or did not continue to exist, “because of various barriers, for instance

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35 Original quote: Daar zit de problematiek, het moet namelijk lokaal relevant gemaakt worden.
36 Original quote: Bedrijven willen die kennis niet zomaar delen zonder dat ze er belang bij hebben of er kans is op nieuwe omzet.
37 Original quote: Een marktpartij is actief in meerdere steden en die kan er een belang bij hebben, uit sales of operationeel perspectief, dat gebruikers van elkaar leren en dat ze een community faciliteren.
38 Original quote: Brussel ziet kennis als een investering waar je iets voor terug krijgt.
regulation or the lack of large-scale thinking”\textsuperscript{39} (VET). Condition for successful projects are visibility and scalability. “If it is scalable within the region, then it also needs to be replicable”\textsuperscript{40} (BEE). Replication to other cities is essential, especially for companies, but remains a difficult process, since different parties invent the same solution. An issue in the scaling process is the difference in the pace of development between technology and procurement. Many parties want to work with a go-to-market model, but it is really difficult to provide scalability in these models partly because of local adaption, a construct that was already mentioned in the pre-conceptual model. Cities can adapt off-the-shelf use cases to their needs by collaborating with partners that are locally relevant. “Scaling is done within a specific domain and there is no cross-domain view”\textsuperscript{41} (DIJ). Smart city program managers could stimulate a cross-domain view, but can never be responsible for all domains which makes it difficult to scale solutions. The only thing they can do “is strengthening the primary processes and organizing cross-links”\textsuperscript{42} (VIE). They can also link themes to projects and put these on the planning. The city needs to start with an off-the-self use case that matches the city’s challenges. Once a party is collaborating with the municipality and starts to innovate within a specific city area or department, they eventually can scale to other areas or departments. A strong partner channel or network with service providers offer scale worldwide. A common way for companies to convince the municipality is to implement a pilot or proof of concept designed to be implemented on a larger scale to demonstrate solutions with a follow-up phase. This concept is most often mentioned by private sector interviewees. “When the project is successful, the greatest effort is in finding the right resources for the roll-out of the project”\textsuperscript{43} (VIE). An essential factor in applying a scalable pilot is making good arrangements in advance, like the unknown factors that scale up once they are validated. “You cannot test a pilot and then look for scaling possibilities”\textsuperscript{44} (SIE). Not all interviewees see a pilot as the right way to scale a project. They argue that a project should start directly from the primary process and achieve a goal in a phased manner instead of setting up a pilot. Pilots also cause friction, since parties expect

\textsuperscript{39} Original quote: Dat komt door allerlei barrières, bijvoorbeeld regelgeving is een barrière, maar ook het gebrek aan grootschalig durven denken.

\textsuperscript{40} Original quote: Als het binnen de regio schaalbaar is, dan moet het ook repliceerbaar zijn.

\textsuperscript{41} Original quote: Je ziet veel opschaling plaatsvinden op het gebied van verlichting in Nederland, maar het blijft altijd binnen een bepaald domein en er wordt nog niet cross-domain gekeken

\textsuperscript{42} Original quote: Je kunt nooit het totale speelveld plus alle primaire processen in kaart brengen, dus het enige wat je kunt doen is het versterken van die primaire processen en daar dwarsverbanden over organiseren.

\textsuperscript{43} Original quote: De techniek is bekend, eigenlijk zit er nog het meeste werk in het vinden van de juiste middelen voor het groter uitrollen wanneer het project succesvol is.

\textsuperscript{44} Original quote: Je moet niet een pilot testen en dan pas verder kijken.
commitment when they offer a free pilot. “As long as a project is a pilot, it is not an operational service and as long as it is not an operational service, there is no good business case. Cities need to stop with developing pilots”\textsuperscript{45} (VET). The descriptions and concepts that lead to the dimension ‘project development’ are shown in figure 9.

| Always ensure scalability of a go-to-market model and avoid the lack of large-scale thinking. |
| Prove the business model in one small area, then roll out the solution. |
| When it is scalable, then it also needs to be replicable. |
| Many different parties are working on the same solution, so there is no replication. |
| Operators need to work together to create a proposition that can be copied to decrease costs. |
| Cities have the same issues, so can learn from other cities by looking at how cities have implemented a project, but not at the specific implementation. |
| Start with off-the-shelf use cases that are not too risky and in line with city challenges. |
| Design the pilot as it will be implemented on larger scale using a business model. |
| Ensure that pilots are related to each other, exploitable and can be copied. |
| Pilots test something more easily with less risk. |
| Pilots are being overtaken by time, since developments are going really fast. |
| Invest to offer the product for a lower price to validate if it is successful. |
| Achieve something in a phased manner instead of implementing a pilot. |
| The complexity is in adapting use cases to local circumstances to maintain local power. |
| Companies must anchor in the region to become relevant on a regional level. |
| Integrate the standard ecosystem with the mini ecosystem on local level. |
| All projects are restricted to procurement which stops innovation. |
| Procurement is really slow, where technology is really fast. |
| Cities need to think about procurement to solve issues and move forward. |

Figure 9 Project development descriptions, concepts and dimension

### 5.2.7 Business model

A financial business case is part of the much wider business model. A business model is essential in the first phase of a project and is mentioned almost as often by private stakeholders as by public stakeholders. “The role of a business model is decisive in a smart city. Smart cities as concept are very attractive, but it is stuck to earning money with a solution”\textsuperscript{46} (VET). The business model brings all learnings and successes together and can be used to convince any commissioner or senior leader. To reach the goal of continuing the solution, a business model with a strategic approach is required. “Cities need to think different and take the step from the why”\textsuperscript{47} (BEE) taking quicker steps and applying more trial and error. Business models help to create new and better ways of

\textsuperscript{45} Original quote: Het zijn allemaal pilots en daar moeten we vanaf. Zolang het een pilot is, is het geen operationele dienst en zolang het geen operationele dienst is, is er nog geen goede business case.

\textsuperscript{46} Original quote: De rol van een business model in een Smart City project is eigenlijk doorslaggevend. Wat we al jaren zien is dat een Smart City als concept heel aantrekkelijk is, maar het loopt vast op het verdienen van geld met een oplossing.

\textsuperscript{47} Original quote: Je moet op een andere manier nadenken hoe ga je proberen vanuit de why de stap te zetten.
cooperating by focusing on making profit or collaborating through an ecosystem to improve the area. “Companies are very financially driven, so you need to look at the financial interest. The municipality also needs to take that into account more often”\textsuperscript{48} (FEU). The business model could become more attractive by driving the price down through collaboration, joint purchases and measuring innovation or performance in hard numbers. “In developing a business model and a business case for smart technology, the bottom-line is how much do they cost”\textsuperscript{49} (PIE). Factors related to a financial business case are often mentioned by private stakeholders. Cities do not want to apply a business model because of the risks involved, so the focus should be on models that describe the process of implementing “smart services and efficiency based on off-the-shelf technology that is not too risky and complicated”\textsuperscript{50} (BEE). The municipality should apply a new type of business model paying a fixed amount per solution instead of the traditional model. “There is not one business model, there are business models for each of the different solutions”\textsuperscript{51} (LAN). A business model can also be divided into different components that can be applied apart from other components. Figure 10 shows the final data structure of the dimension ‘business model’.

| A good business case is needed to get financial parties involved. | Business case |
| The bottom-line in developing a business model is how much do the solutions cost. |
| Smart city must be part of the vision and strategy pursuing innovation. | Vision |
| The city needs to plan programmatically based on a vision that can always be adjusted. |
| Start with one use case and create a roadmap from the ‘why’. |
| Implement elements of a successful solution in another context. | Model components |
| One part of the model can be tested with a pilot and enter a next phase. |
| Divide into smaller tasks to avoid big, expensive tasks and realize the solution. |
| Innovation needs to be measured in hard numbers. | Performance measures |
| Calculate when money spent on the solution is returned. |

Figure 10 Business model descriptions, concepts and dimension

### 5.2.8 Data use

Data could be really useful for a city, especially when the government makes the data available for all parties, so they can develop business and come up with creative solutions. There is a lot of discussion about open data and the openness of the data. Only useful data should be made

\textsuperscript{48} Original quote: Bedrijven zijn heel financieel gedreven, dus je moet naar het financiële belang kijken. De gemeente moet daar ook meer rekening mee houden.

\textsuperscript{49} Original quote: In developing a business model and a business case for smart technology, the bottom-line is how much do they cost.

\textsuperscript{50} Original quote: Wij proberen een business case te maken van hoe kun je slimme diensten, efficiëntie toevogoen op basis van technologie aan de ene kant en dan vooral off-the-shelf technologie, vooral niet te ingewikkeld en riskant.

\textsuperscript{51} Original quote: There is not one business model, there are business models for each of the different solutions.
accessible and “it is trial and error to come up with the best mix of data”\(^{52}\) (PIE). The mix is based on experience and strategically thinking. The term open data is especially mentioned by stakeholders that work for a public party and are involved in a smart city project that has the purpose to share lessons learned through open data. Data has a commercial value that companies could use to make business and profit. Governments “need to be more commercial headed with the information they gather”\(^{53}\) (PIE) and “need to make sure that they create a transaction model”\(^{54}\) (VIE) so stakeholders can access the data and companies pay for the data based on size. Data must come in open standards to make data representable and easier accessible. The final data structure of the dimension ‘data use’ is shown in figure 11.

| Keep al data together to make it useful for a city. |
| Cities must stimulate a new economy by creating a business model around the available data and make data accessible for all parties. |
| Make open data understandable and attractive for citizens by visualizing it. |
| When the government invests in data, they can oblige the supplier to open up useful data. |
| Open data is a basic need if you need to innovate with ICT. |
| The mix of open and closed data is defined through experience and strategically thinking. |
| Custom made data is the solution for open data issues. |
| Develop a transaction model, so parties can access the data and do transactions. |
| The data is owned by the person who collects the data, which can cause problems in determining the price for the data. |
| Governments need to be more commercial headed with gathered data. |
| When data is of good quality and reliable, customers can pay for the data based on size. |
| Data has a commercial value that companies can use to make profit. |
| Data must be the same to make it representable. |
| Take into account open standards and ways to make data available. |

![Figure 11 Data use descriptions, concepts and dimension](image)

**5.2.9 Platform implementation**

The construct “technology factors” in the pre-conceptual model is encountered, since the implementation of an innovation platform by private parties is the basis of connecting different parts. It is not possible to implement just one platform across the city, because of different communication protocols and frequencies. On the other hand, there can be one coordinating platform including several platforms or a system-to-systems approach to link components of different parties. Private parties need to apply standardize use cases, match platforms and integrate...

\(^{52}\) Original quote: It is trial and error to come up with the best mix of data.

\(^{53}\) Original quote: We need to be smarter than that and we need to be more commercial headed with the information we gather.

\(^{54}\) Original quote: Zorg dat je een transactiemodel hebt, zodat mensen de data kunnen benaderen, dan ben je al een heel eind.
all parts dealing with legacies to implement a generic platform. “A generic platform is necessary to combine all data and get access to the data more easily”\textsuperscript{55} (VIE). The importance of platform integration is discussed in the literature review. Parties do not limit themselves and earn more money when they develop an open solution with information and lessons learned that researchers and companies can use to develop solutions. The data structure of the dimension ‘innovation platform implementation’ including concepts and descriptions is shown in figure 12.

<table>
<thead>
<tr>
<th>Concept</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Platform integration</td>
<td>Integrate functionalities, also a system-to-systems approach, and deal with legacies. Start from the bottom by making the platform part of the project and then connect different parts.</td>
</tr>
<tr>
<td>Platform standardization</td>
<td>Standardize use cases, then match the platforms and integrate everything. Develop a stronger conceptual framework for platforms.</td>
</tr>
<tr>
<td>Innovation platform implementation</td>
<td>Develop an open solution to earn money and not limit yourself. Create an open platform to publish all lessons learned for researchers and companies to develop new solutions.</td>
</tr>
</tbody>
</table>

Figure 12 Innovation platform implementation descriptions, concepts and dimension

5.2.10 Ability to innovate

“Innovation is the art of failure”\textsuperscript{56} (BLO), so many new ideas need to be developed. People and technology change at a fast pace, so there is an innovation need with a focus on the ability to innovate constantly. The Internet of Things and digitization create new developments and to continue the innovation, cities should appoint a responsible person or organization or create a smart city roadmap. “With smart cities, there is no end point anymore, but there are cyclical processes that will never stop, so such a community keeps developing”\textsuperscript{57} (BEE). Innovation continuation is harder with a lot of regulations and the lack of large-scale thinking. Cities can stimulate innovation by providing funding for research and development or reducing costs. Cities and companies also “need to point out the urgency of developing smart city projects”\textsuperscript{58} (BLO) and maintain and develop existing ideas. The creation of a self-interest and a group-interest and people staying open to innovation ensure continuous motivation for innovation. “Customers are only open to reflect on

\textsuperscript{55} Original quote: We moeten naar een generiek systeem / platform waarbij je alle data combineert en ook veel makkelijker kan ontsluiten.

\textsuperscript{56} Original quote: Er zullen nooit te veel innovatie projecten zijn, dat lost zich vanzelf wel op, want ‘innovation is the art of failure’, er gaat meer mis dan goed.

\textsuperscript{57} Original quote: Je hebt nu geen eindpunt meer, maar je zit meer in cyclische processen en dat houdt nooit meer op. Dus zo’n community, als het goed is, ontwikkelt door.

\textsuperscript{58} Original quote: Als de ene stad niet wilt, dan probeer je de andere stad, want uiteindelijk komen ze wel tot inzicht dat ze wel moeten en daarom is het goed om op de urgentie te wijzen.
the solution when you can convince them that you are going to do it in a smart way, so processes will become more efficient and income will become even higher\textsuperscript{59} (DEN). Stakeholders are now realizing that it is key to implement smart city developments. The dimension “ability to innovate” and corresponding descriptions and concepts are displayed in figure 13.

\begin{figure}
\centering
\includegraphics[width=\textwidth]{figure13}
\caption{Ability to innovate descriptions, concepts and dimension}
\end{figure}

5.3 Determinants of longevity

Responses to the question ‘how to ensure longevity of smart city innovation ecosystems and the corresponding impact?’ are summarized in order to gain stakeholders’ perspectives that can be brought together in one dimension. Table 7 shows the different answers given by interviewees.

\begin{table}
\centering
\begin{tabular}{|l|l|}
\hline
\textbf{Interviewee} & \textbf{Answers} \\
\hline
DEN & \begin{itemize}
  \item You need to guide the customer and determine what the next use case will be.
\end{itemize} \\
\hline
VIE & \begin{itemize}
  \item This has to do with staying open to innovation and this requires a different customer-supplier relationship.
  \item A different way of working is from a ready-made product, whereby it is essential to define the parties’ role and the forms of collaboration, such as ecosystems.
\end{itemize} \\
\hline
PAS & \begin{itemize}
  \item If the pilot is a success, implement the solution in other cities as well. In that way, the platform keeps all ecosystems together.
\end{itemize} \\
\hline
\end{tabular}
\caption{Answers to the question ‘How would you ensure longevity of smart city innovation ecosystems and the corresponding impact?’}
\end{table}

\textsuperscript{59} Original quote: Enkel wanneer je de klant weet te overtuigen dat doordat je het op een slimme manier gaat doen, je nog efficiënter gebruik kan maken van parkeren, waardoor inkomsten nog hoger worden, staan ze open om er verder over na te denken.
| BEE   | ▪ An ecosystem is constantly changing and that change needs to be embraced, which is very difficult.  
▪ Cities need to find a public-private partnership model with the possibility to work with several stakeholders.  
▪ Coalitions cluster around new projects and these are interesting developments, especially for the parties that are already involved.  |
| BLO   | ▪ Ecosystems can die, but that is no problem.  |
| VET   | ▪ Do not create a project, because a project has a beginning and an ending, especially for the finance, but create an operating model or program to achieve something.  
▪ The chance of survival is way bigger when there is a business case from the beginning.  |
| DIJ   | ▪ Hereby it is about open data and the way you facilitate data over all silos.  
▪ The data must be accessible to other parties that are creative and come up with new, dynamic solutions that can drive innovation.  |
| PIE   | ▪ Some things that we do will naturally end at the end of the project.  |
| LAN   | ▪ When the project ends, the involvement of the partners from that project end, but then new projects takes over.  |
| ASC   | ▪ Meet and discuss together how to develop the area.  
▪ If there is mutual understanding that parties are not involved in the project to make money, but to make the area a good place for people.  |
| SIE   | ▪ That is a challenge, because as a start-up you are never the only one with a certain idea.  |
| FEU   | ▪ People have the ambition to engage in collaborations between companies that continue when the project has ended, but that almost never succeeds.  
▪ When parties also enter into mutual partnerships besides the collaboration for the project, then there is a high chance of long-term cooperation.  
▪ A new ecosystem will be created per project or development, so you have different ecosystems on a different scale.  |
| MEN   | ▪ Working with the local stakeholders and involving them in local clusters and new projects while looking for new opportunities.  
▪ It depends on how each of the involved partner invests resources.  
▪ The companies involved will get other contracts, because they have visibility and a case to show that their solution is working.  |
| MKO   | ▪ It depends on the role stakeholders have and to what extent the party remains involved.  
▪ Incentives are required to keep partners involved.  
▪ The government needs to set up a project group that expands the project, creates a long-term process, makes the project profitable and keeps innovating, since the government has a general interest and decides on the policy.  
▪ The solution must be financially relevant by making it cheap, unique and scalable.  |
A lot of interviewees are skeptical about the possibility to maintain the ecosystem. Ecosystems are created around projects, so the involvement of partners probably ends when the project is finished and new ecosystems come up around new projects (LAN). Ecosystems need to be agile with the common goal to continue the solution through a program or operating model with the possibility to work with multiple stakeholders (VET). A pilot is not the best way to achieve innovation and continuation of the solution. Private parties need to guide customers to determine projects and keep innovating. All parties should be open to innovation and to even ensure innovation across different silos, open data should be made available for the creation of solutions. This requires a different customer-supplier relationship and a mutual understanding between partners (ASC, DEN). To create a platform for innovation and increase the ability to innovate, internal smart city processes should be reorganized, especially with public parties. A platform can keep the ecosystem together to implement the solution in another area (PAS). Longevity of an ecosystem can be ensured when parties form a mutual partnership or through incentives (FEU).

### 5.3.1 Co-occurrence codes ecosystem longevity

Terms that co-occur often with the term ecosystem longevity determine factors that influence the longevity of smart city ecosystems. First of all, **innovation continuation** is an important aspect of ecosystem longevity. “*With smart cities, there is no end point anymore, but there are cyclical processes that will never stop, so such a community keeps developing*”\(^{60}\) (BEE). The longevity of an ecosystem is also closely related to the **creation** and **characteristics** of the ecosystem. With a continuously changing demand of the market, ecosystems are combined with other ecosystems, become more agile and constantly cluster around new projects keeping the base of the ecosystem (BEE). Some parties remain part of the ecosystem while other parties leave or new parties start to join the ecosystem.

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\(^{60}\) Original quote: Je hebt nu geen eindpunt meer, maar je zit meer in cyclische processen en dat houdt nooit meer op. Dus zo’n community, als het goed is, ontwikkelt door.
6 Discussion

The following section includes the final conceptual model consisting of the determinants derived from the data analysis that provides an answer to the research question. The section shows a visual representation of the conceptual model tested with insights from additional literature, describes the theoretical relevance and defines unique propositions and recommendations that can be valuable for parties involved in smart city developments.

6.1 Conceptual model

This study defines the factors that influence the longevity of the smart city ecosystems and projects. The main factor in the conceptual model is the ability to innovate. The model supports stakeholders to build, integrate and sustain smart city innovation ecosystems and corresponding projects and provides answers to the sub-questions that make sure the research question can be answered:

i. What are essential factors in smart city environments?
ii. How do factors affect other factors?
iii. How do factors influence the longevity of smart city ecosystems and projects?

Figure 14 Conceptual model of the longevity of smart city innovation ecosystems and projects
What are essential factors in smart city environments?

Some factors discussed in the pre-conceptual model are encountered in the results section, such as ability to innovate, public-private collaboration and platform integration. Rejected terms include for instance bottom-up/top-down approach, IT-business fusion, human factors, use of the cloud and transition-experiments, since these terms go too deeply into a specific topic or were not mentioned by the interviewees. Newly discovered factors are discussed in this section. A visual representation of the conceptual model clarifies the concepts and relationships of the proposed theory (Flick, 2009). Figure 14 shows the essential factors in smart city environments that contribute to the ability to innovate which influences the longevity of smart city concepts.

How do factors influence the longevity of smart city ecosystems and projects?

Several studies give an explanation for the positive effect the ability to innovate has on the longevity of smart city ecosystems and projects. The model emphasizes the essential combination of governance, collaboration, technology and strategy that creates new business opportunities. The city’s innovation ability is used to benefit from smart city opportunities and attract promising companies and individuals (Zygiaris, 2011). A smart city is an evolution instead of a revolution and a long-term strategy instead of a short-term solution. Innovation involves long-term evolutionary projects, so a smart city can keep handling the differences in pace at which technology, management and policy change (Nam & Pardo, 2011).

How do factors affect other factors?

Factors that have a positive influence on the ability to innovate are ecosystem creation, the implementation of innovation platforms, knowledge sharing and the creation of a business model. Communities, ecosystems and networks play a crucial role in innovation (Komninos, 2006). Innovation ecosystems are used to create an innovative culture that attracts promising partners that will be valuable in the smart city’s future (Zygiaris, 2011). Innovation platforms are positively related to the ability to innovate. Initiatives will not be stalled without a common technology or policy framework. Developing smart city solutions successfully requires understanding of technology and the corresponding value (Meijer & Bolívar, 2016). Selecting the right platforms that allow broader developments is in line with the future planning (Snow, 2017). Platforms have a role in pushing and coordinating innovation by establishing
sparring relationships based on sharing information, uniting stakeholders around one vision and offering the possibility to access external information from for the evolution of projects (Frey, Lüthje, & Haag, 2011; Kilelu, Klerkx, & Leeuwis, 2013; Ojasalo & Tähtinen, 2016).

Knowledge sharing has a positive influence on the ability to innovate. Interactions and innovation flows between stakeholders to bridge knowledge fields are key to stimulate creative thinking processes, innovations and the city of the future (Vanolo, 2014). Integration and knowledge sharing are essential to ensure smart city innovation (Nam & Pardo, 2011).

The business model also has a positive influence on the ability to innovate. Developing a business model expresses the innovative character of an ecosystem that fits the smart economy (Zygiaris, 2011). Organizations should maintain their business model until the new business model takes over and helps the organization to renew profit, revenue and growth (Chesbrough, 2010). The readiness for business process integration, standardization and the business model is key in stimulating innovation (Nam & Pardo, 2011).

Smart city governance has a positive effect on silo management, since smart city governance focuses on smart urban collaboration between different stakeholders and communities within the city and across departments (Batagan, 2011; Meijer & Bolívar, 2016).

Strong silo management improves the public-private partnership also in a positive way. A public-private partnership performs better when there are only good operational challenges instead of managerial and organizational challenges, so the partnerships need managerial assistance from the service departments (Hodge & Greve, 2005). Nowadays, the silo approach is replaced by joined-up government, which stands for connections and sharing common concerns between service departments and the public and private sector (Barrett, 2003).

Strong partnership between public and private parties has a positive influence on the ecosystem creation. Public and private parties create an open innovation ecosystem when they collaborate to achieve a common goal applying value co-creation. Sharing the value will provide personal and general benefits. Interconnections between different parties to share information and create value, causes smart innovation ecosystems, so cities can cooperate and compete with other ecosystems.
(Domingue, 2011; Letaifa, 2015). Ecosystem creation succeeds when organizational support, such as coalitions, is included (Thomas & Autio, 2013).

A positive relationship exists between the presence of a business model and project development. Successful smart cities need to define measurable and ambitious goals in line with the city’s priorities (Ballon, 2016). Smart city goals exist of solutions that deal with the city’s challenges to ensure long-term sustainability and will be achieved with feasible business models (Schaffers, et al., 2011). To develop smart city solutions, a business model is as equally important as technological knowledge (Jin, Gubbi, Marusic, & Palaniswami, 2014).

The development of projects has a positive influence on the creation of ecosystems. Each ecosystem is unique and adaptable. When a stimulating impact, a specific issue, arises, new actors will enter the market and start developing solutions together which causes the emergence of certain types of ecosystem (Thomas & Autio, 2013). The creation of an ecosystem exists of a five phase model, starting with an initiation phase to make appointments and tailor targets. Partners need to accept the project’s culture to become part of the ecosystem (ASC).

Knowledge sharing positively influences project development. A broad diversity of knowledge allows stakeholders to combine different solution elements and understand elements provided by other stakeholders (Frey et al., 2011). This competence contributes to the ability to scale solutions or replicate projects to other areas. Knowledge translates the company’s vision into new developments and innovative products, so innovative ideas and insights will arise and solutions are improved when stakeholders reexamine the received information and knowledge to look at it from their own perspective (Nonaka, 1991).

Data use is positively linked to the implementation of innovation platforms. Each system in the city produces its own data that can be integrated into one secure, open data platform to capture, analyze and share data also across platforms (Jin et al., 2014; Menon, 2016). City governments first need to define the general open data framework before they implement platform infrastructures (Berrone, Ricart, & Carrasco, 2016). The platform connects devices with different
data types and creates a community, so organizations can use the data across the city to realize the smart city co-economy (Beecham Research, 2015; Bell, 2016).

The presence of an innovation platform facilitates silo management in a positive way. Innovation starts with the development of solutions in separate city departments that can be included in the service platform (Anttiroiko et al., 2014; Menon, 2016). The platform easily shares data in a safe way across the existing silos and unites stakeholders around one vision to create smart city projects (Zygiaris, 2011). Open platforms stimulate governing and collaborative relationships to solve issues and sharing costs (Menon, 2016; Ojasalo & Tähtinen, 2016).

All determinants can be subdivided to technology, governance and strategy factors that influence the ability to innovate that positively influences the longevity of smart city innovation ecosystems and projects. Most relationships between the factors in the conceptual model are substantiated with academic articles. The influence of governance and technology factors is also encountered in the fundamental components of smart city in figure 1 that also include human factors. When the foundations of a strong ecosystem are designed, other factors, such as the often-mentioned aspect ‘citizen involvement’, can be included.

6.2 Propositions
This section presents propositions that could be useful for smart city stakeholders. Answering the research question ‘Which factors influence the longevity of smart city innovation ecosystems and projects?’ summarizes the results discussed in the previous section.

Proposition 1: Technology factors influence smart city innovation.
Technology factors that influence the ability to innovate and success of a smart city initiative are data use and innovation platform implementation and contribute to the digital network and smart technologies in a city (Chourabi, et al., 2012; Nam & Pardo, 2011). Technology is an intensively used factor in many smart city initiatives and therefore a factor that could influence other factors (Chourabi, et al., 2012). Data should be made partly available to citizens and organizations to improve productivity and efficiency in the development of projects and stimulate companies to create new services in favor of the city (Manyika, et al., 2011). The implementation of standardized
use cases and a unifying platform that connects devices in a reliable way ensures connection between stakeholders and handling data (Manyika, et al., 2011). This stimulates collective innovation, especially when the platform comes with a partner network providing infrastructural solutions (Trollope, 2016). A platform connects stakeholders’ interests (Goulden, 2015).

**Proposition 2: Governance factors influence smart city innovation.**

The base of establishing collaboration to develop successful smart city initiatives is the execution of strong control and governance that is strongly linked to innovation (Chourabi, et al., 2012; Meijer & Bolívar, 2016). Aspects related to smart city governance are the focus on attitude, role definition and behavior, the connection of technological and business interests and the alignment of the external and internal processes. The senior management of the city should be involved in developments to distinguish the smart city from a normal city, since they have a general interest and decide on the policy (Ballon, 2016). The senior management should appoint a program manager with mandate responsible for a strategic innovation unit for new developments and keeping everyone involved (Nam & Pardo, 2011). Ensuring smart governance provides the possibility to manage collaboration across silos (Nam & Pardo, 2011). Reversing short-term goals, reallocating budgets and improving the silo’s primary process ensures that silos will be open to cooperation and creating cross-links. A stable control of public organizations makes it easier for private parties to collaborate with different silos which stimulates public-private partnership. Key aspects in this kind of partnerships are clear agreements about for instance outsourcing, a common, measurable goal, sub-goals and collective investments. A strong, multidisciplinary public-partnership or even a triple-helix collaboration is essential to create a long-lasting ecosystem driven by a new project under innovative conditions, such as strong human relationships and agreements from the beginning (GDF Suez, 2013; MKO; Schaffers, et al., 2011).

**Proposition 3: Strategic factors influence smart city innovation.**

Innovation is driven by a strong strategic approach driven by a business model, sharing knowledge and project developments. A project can start from the primary process and achieve goals through an iterative process learning from other projects and knowledge exchange (Meijer & Bolívar, 2016). Initiators need to think about the follow-up phase and scalability possibilities at the start of the project. Standardized use cases that are adaptable to local communities ensure replicable
projects that can be copied and scaled to other areas or used by other parties (Anttiroiko et al., 2014). A unique and viable business model including a business case describing a financial relevant solution, clear long-term vision and performance measures should be present from the start of the project to ensure longevity (Schaffers, et al., 2011). Components of the business model could be implemented separately in another context. Internal and external knowledge sharing is an investment that is recouped when parties are open to this and learn from each other to market new solutions. Private parties want to market repetitive solutions including an ecosystem and business model.

Proposition 4: Innovation ability influences the longevity of an ecosystem.

The need for innovation as a city’s long-term strategy is high in this fast-moving world if the city wants to keep evolving (Nam & Pardo, 2011). Parties will be motivated when they open up to innovation and experience the benefits of developments. By providing funding, reducing costs for research and development or creating an innovation roadmap, parties are stimulated to innovate.

6.3 Recommendations

Public and private stakeholders are the main stakeholders and their smart city project approach really differs, so the recommendations are made separately for public and private parties. The recommendations contribute to the alignment of both parties with a common goal being the basis. Public organizations play a role in smart city developments and continuation of ecosystems and projects. This study provides public parties with recommendations to define their role in the smart city building, integrating and sustaining processes. Private parties have a different role and the following recommendations can support them in establishing a relationship with the city while doing business and earning money. The recommendations are displayed in table 8.

Table 8 Recommendations for public and private parties

<table>
<thead>
<tr>
<th>Public parties</th>
<th>The city needs to take the initiative, bring parties together and take decisions.</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>The city needs to stimulate growth and entrepreneurship, partly by investing in start-ups.</td>
</tr>
<tr>
<td></td>
<td>The city needs to appoint a program manager that takes responsibility for innovation solution.</td>
</tr>
<tr>
<td></td>
<td>The city needs to chase projects with start-funding or subsidy.</td>
</tr>
<tr>
<td></td>
<td>The city needs to map investments in order to handle procurement, make investments less risky and move forward.</td>
</tr>
</tbody>
</table>
**Private parties**

- A private party needs to create a business model, plan or new case of action adapted to the city’s needs.
- A private party needs to develop a simple technology solution together with the municipality making their platform part of the solution.
- A private party needs to develop a solution that can be resold or scaled, so focus more on transition-experiments than pilots.
- A private party needs to invest, also in start-ups, to show the possibilities of smart city solutions when there is a demand.
- A private party needs to take over the project after the city has provided the start-funding.

### 6.4 Implications

Insights from this study lead to practical implications. The model presented in this study could be applied and the recommendation could be used by smart city planners in all sectors to keep smart city ecosystems alive and solve social and ethical issues. In the beginning it would be difficult for municipalities and companies to implement the framework, since all parties have their own vision and ideas and are not open to change their point of focus. Managers in public and private companies as well as start-ups and knowledge institutions must have strong communication skills. When all parties communicate well internally as well as externally, all parties can focus on the same framework.

This study provides theoretical implications as it adds to the existing literature and contributes to modeling the emerging smart city innovation ecosystems. There is no study into creating and maintaining ecosystems and no one is sure how to create the ecosystem as the smart city topic is quite young and still in development. The conducted interviews investigate stakeholders actively involved in smarty city initiatives and ecosystems which results in an overview of common determinants for longevity of an ecosystem and the interaction between these determinants. As a lot of parties are involved in smart city environments, all parties must understand and apply one general model to stimulate innovation and create a successful, long-term ecosystem.
7 Conclusion
This section provides a summary of the core insights as well as the limitations of this study and the recommendations for future research.

7.1 Core insights
This section discusses the core insights or grounded theory developed in this study to answer the research question: Which factors influence the longevity of smart city innovation ecosystems and projects?

Different studies address smart city constructs, but do not assemble these into one model. Without cohesion, a smart city is just a trick. This study on the longevity of smart city ecosystems and projects presents a holistic conceptual model that provides a common understanding and elucidation among smart city stakeholders and takes into account local adjustments. Considering the conceptual model from the start of a smart city initiative ensures projects and ecosystems with proper foundations that are economically and socially sustainable. The model emphasizes the importance of assembling technology, governance and strategic factors to be able to build a smart city and innovate in cities across Europe with different ecosystem partners.

7.2 Limitations
One limitation is the high number of project managers in the interview sample (40%). These project managers have a high amount of knowledge about the development of a project or consortium. Project managers are usually initiators of the project and might be biased. The interview sample also includes a lot of male (80%), Dutch-speaking stakeholders (60%) and interviewees living in the Netherlands (50%) which reduces generalizability. Despite the fact that the interview sample includes a start-up, including a start-up incubator as well ensures the discussion of smart city concepts from an extra perspective. Since the research topic is quite new and only a few articles are written on this subject, the analysis is quite experimental causing interviewee answers that do not align with behavior in non-experimental, real life environments. Mostly Internet of Things and smart city experts are interviewed which can make the conceptual model less generalizable. Although these interviewees are experts, they all refer to the same set of solutions and examples, which points out that smart cities is still a very young area of research.
7.3 Recommendations for future research
This study has gained new insights, but also opportunities for additional research to further investigate each factor. This study focuses on the constructs that influence the longevity of smart city ecosystems and projects and contributes to the small number of scientific research in the field of smart cities and the Internet of Things. Further research on the role of innovation platforms in the longevity of smart city concepts could be extremely interesting for private companies. Possible architectures could be mapped or the ownership and governance model of the platform could be discussed. Business model concepts such as the business case, vision, model components and performance measures, can be investigated to define the exact role of a business model and the best way to create the model. Knowledge sharing and public-private partnerships are often mentioned factors and more research can be done to the specific role of these concepts, for instance with an experiment to investigate knowledge sharing internally and externally. Key performance indicators could be explored to measure the impact or success of these factors. Few interviewees have mentioned the importance of citizen involvement or the social aspect, despite the fact that it was a frequently mentioned factor in the literature review. Future research among citizens could be interesting to investigate what the role of citizens can be in smart city environments. Although the open data aspect was not included in the interview questions, a lot of stakeholders mentioned this aspect during the interview, so it could be interesting to investigate the role of open data in smart city projects and ecosystems. Lastly, it could also be interesting to investigate which factors influence the longevity of smart city ecosystems and projects in continents other than Europe, since there is a huge difference between smart city approaches in Asia, America and Europe.
8 References


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9 Appendices

9.1 Appendix A: Interview guidelines

The interview questions for experts were adjusted during the process.

Introduction

- Thank you for your time and your willingness to participate.
- Explanation of the duration of the interview and the goal of the research.
- Ask for permission to record the interview and explain how the interview data will be used.

Context

- Could you give a description of your position?
- Could you explain the smart city projects you are currently working on?

General impact *

- What is your definition of a smart city?
- What plays an important role in the integration of different smart city projects into one platform?
- How would you ensure longevity of smart city innovation ecosystems and the corresponding impact?

Specific impact *

Human factors / Institutional factors

- With which parties do you frequently cooperate in smart city projects?
- How do you assess the cooperation between different silos in a smart city?
- How do you experience the cooperation between public and private parties?
- How do you ensure continued motivation for innovation and development of smart city projects?
- How do you make sure that you are part of the IoT ecosystem?
- To what extent are gained knowledge and available resources shared within a network?

Technology factors

- Which infrastructures and networks are currently used in smart city projects?
- To what extent are uniform smart city use cases implemented?
Closing

- Do you maybe have any useful documents for this research?
- Would you like to add some additional information to the interview?
- Thank you for your time and cooperation.

*Mostly experience-based questions*
## 9.2 Appendix B: Code applications in Dedoose

| Coding Zdravka Paskaleva.docx | 1 | 1 | 1 | 1 |
| Coding Stefan van Denderen.docx | 1 | 1 | 2 | 1 |
| Coding Stefan van Denderen | | | | |
| Coding Peter Dijkstra.docx | 1 | 1 | 1 | 4 | 3 |
| Coding Niki Sie.docx | 1 | 1 | 2 | 4 |
| Coding Nathan Pierce.docx | 1 | 1 | 1 | 2 | 3 |
| Coding Jasper Feuth.docx | 4 | 1 | 1 | 1 | 2 |

Figure 15 Code applications

## 9.3 Appendix C: Code co-occurrences in Dedoose

<table>
<thead>
<tr>
<th>Codes</th>
<th>European smart cities</th>
<th>IT-business alignment</th>
<th>Innovation</th>
<th>ability to innovate</th>
<th>innovation continuation</th>
<th>innovation decrease</th>
<th>innovation motivation</th>
<th>innovation need</th>
<th>innovation stimulation</th>
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<td>European smart cities</td>
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</tbody>
</table>

Figure 16 Code co-occurrences
9.4 Appendix D: Coded expert interview example in Dedoose

money with. The government cannot decide to shed something and you have a lot of different parties, so you have a huge impossibility, because you cannot forge a coalition anymore. It is no longer possible to go to the future step by step, so it is necessary to think as a lean start-up. Cities need to think different and take the step from the why. That is a lot more trial and error, quicker steps and faster scaling and replication. The organization of cities is still classically organized. Cities have to consider how to operate from programming to operating. Then they need a wider coalition. We are always looking for partners, both in business and in knowledge institutions. You cannot do it on your own anymore and you need to look for parties who really want to partner. New coalitions need to be developed, so it is no longer classic contracting and commissioning, but there are other partnerships, where everyone wants to make money, especially businesses. If a city has already implemented certain sensors where they already have paid for, then they can also be used for other applications and interactions, so you can do more with less manpower. It is also possible to create a community by using sensors for social interactions. The Netherlands need to present themselves as one populated city.

What is your definition of a smart city?

For me, it is making a city smarter through technology. Technology is often the enabler of the city’s flows with the aim of making that place more attractive. Smart becomes too much technological and often it is a matter of applying smart technology, which is more a mean instead of a goal. The different kind of initiatives that arise are part of the change and dynamics. Smart becomes a bit scary and very much on the data and the feeling people have with it. It is a threat to the security side, but it can also help us enormously. It is not convenient that we all make our own definition of smart and all start inventing the same solution. We need to think about a framework and we need a new language. People need to understand the ICT language, because otherwise you will end up in a language confusion. Then the government will buy solutions without understanding. They must first consider which service they want to deliver and what technique they need for this service. If the technique is there, you can start thinking about how to use that technique further. Today smart cities are all about the problems we face, so the transition we are in.

What plays an important role in the integration of different smart city projects into one platform?

Nowadays every system has its own platform. I do not believe in one platform, because there actually needs to be one platform that links all systems and above that you need a platform that activates the services. There must also be a stronger conceptual framework for platforms, for instance a software platform that connects several systems, generates data and can be transported to a services platform or portal. You have to think about potential issues (hackers) from the beginning. It is not so much about

Figure 17 Coded expert interview example

9.5 Appendix E: Exported coded expert interview example in Word

How do you ensure longevity of smart city innovation ecosystems and the corresponding impact?

| Codes (6866-6958) ecosystem characteristics |
| Codes (6958-7101) ecosystem characteristics ecosystem longevity innovation continuation |
| Codes (7101-7231) governance role institutional factors citizen involvement |
| Codes (7231-7232) governance role institutional factors citizen involvement role of public parties |

An ecosystem is constantly changing and that change needs to be embraced which is very difficult. With smart cities, there is no end point anymore, but there are cyclical processes that will never stop, so such a community keeps developing. It is questionable whether this should organize itself or whether the participation society or an urban operator needs to do that. The government cannot completely take the role of urban operator. In my opinion, the government will not be able to take this role. I do not believe in that the operator role can be completely taken by the market, then you must have a lot of confidence in the market. Cities need to find a public-private partnership model with the possibility to work with several stakeholders. More and more companies are changing from product supplier to service supplier and that happens on all different themes. The layer that activates the infrastructure should be as thin as possible. Parties often remain involved in the ecosystem, but there are also new parties or parties that will quit. Coalitions cluster around new projects and these are interesting developments, especially for the parties that are already involved. If there are only bigger parties in an ecosystem, then there will be no development by smaller parties.

Figure 18 Exported coded expert interview example in Word
9.6 Appendix F: Dimension example in Dedoose

![Diagram showing the dimension 'ability to innovate' and its subcategories: innovation motivation, innovation decrease, innovation continuation, innovation need, innovation stimulation.]

Figure 19 Example of the dimension 'ability to innovate'

9.7 Appendix G: Example of normalized code count

![Table showing normalized raw counts based on interviewee ratio per factor per sector.]

Figure 20 Normalized raw counts based on interviewee ratio per factor per sector